V. LABORATORY SAFETY

People who work in scientific laboratories are exposed to many kinds of hazards. This can be said of most workplaces; in some, the hazards are well recognized (those of ordinary fire, for example) and the precautions to be taken are obvious. Laboratories, however, involve a greater variety of possible hazards than do most workplaces, and some of those hazards call for precautions not ordinary encountered elsewhere. Therefore, this manual has been provided to inform and guide the laboratory worker in safe practices which should help to avoid injury.

A. GENERAL SAFETY AND OPERATIONAL RULES

1. General Rules
   a. No running, jumping, or horseplay in laboratory areas shall be permitted.
   b. No employee shall work alone in a laboratory or chemical storage area when performing a task that is considered unusually hazardous by the laboratory supervisor or safety officer.
   c. Spills shall be cleaned immediately. Water spills can create a hazard because of the slip potential and flooding of instruments (particularly on the floor below.) Small spills of liquids and solids on bench tops shall be cleaned immediately to prevent contact with skin or clothing. Specifics of emergency spill tactics are provided in a Standard Operating Procedure “Preplanning for and Responding to Hazardous Chemical Spills”.
   d. Ladders shall be in good condition and used in the manner for which they were designed.
   e. Lifting of heavy items must be performed in the proper fashion, using the legs to lift, and not the back.
   f. It is the responsibility of everyone working in the laboratory to make certain that the laboratory is left clean after work is performed.

2. Personal Hygiene
   a. Wash promptly whenever a chemical has contacted the skin. Know what you are working with and have the necessary cleaning/neutralization material on hand and readily available.
   b. No sandals, open toed shoes or clogs shall be worn by laboratory personnel.
   c. Clothing worn in the laboratory should offer protection from splashes and spills, should be easily removable in case of accident, and should be at least fire resistant. Nonflammable, nonporous aprons offer the most satisfactory and the least expensive

protection. Lab jackets or coats should have snap fasteners rather than buttons so that they can be readily removed. These coats are to be fastened closed while working and removed prior to exit from the laboratory.

d. Laboratory clothing should be kept clean and replaced when necessary. Clothing should be replaced or laundered using appropriate decontamination procedures whenever contamination is suspected.
e. Lab coats are not to be worn outside the laboratory, especially in rest room or break facilities. Any lab coats, respirators, or other protective gear must be left in the lab areas. Employees must, as a matter of routine, be responsible for washing, cleaning, and any other decontamination required when passing between the lab and the other areas. Washing should be done with soap and water; do not wash with solvents.
f. Inhalation is one of the four modes of entry for chemical exposure. "Sniff-testing" should not be done.
g. Never pipette by mouth. Always use a bulb to pipette.
h. Do not drink, eat, smoke, or apply cosmetics in the laboratory or chemical storage areas.
i. Do not use ice from laboratory ice machines for beverages.
j. No food, beverage, tobacco, or cosmetics products are allowed in the laboratory or chemical storage areas at any time. Cross contamination between these items and chemicals or samples is an obvious hazard and should be avoided.

3. Housekeeping

As in many general safety procedures, the following listing of good housekeeping practices indicate common sense activities which should be implemented as a matter of course in the laboratory. These recommendations are designed for accident prevention.

a. THE AREA MUST BE KEPT AS CLEAN AS THE WORK ALLOWS.
b. Each laboratory employee shall be responsible for maintaining the cleanliness of his/her area.
c. Reagents and equipment items should be returned to their proper place after use. This also applies to samples in progress. Contaminated or dirty glassware should be placed in specific cleaning areas and not allowed to accumulate.
d. Chemicals, especially liquids, should never be stored on the floor, except in closed door cabinets suitable for the material to be stored. Nor should large bottles (2.5l or larger) be stored above the bench top.
e. Reagents, solutions, glassware, or other apparatus shall not be stored in hoods. Besides reducing the available work space, they may interfere with the proper air flow pattern and reduce the effectiveness of the hood as a safety device.

f. Counter tops should be kept neat and clean. Bench tops and fume hoods shall not be used for chemical storage.
g. Stored items, equipment, and glass tubing shall not project beyond the front of shelf or counter limits.
h. Stored items or equipment shall not block access to the fire extinguisher(s), safety equipment, or other emergency items.
i. Stairways, hallways, passageways/aisles and access to emergency equipment and/or exits must be kept dry and not be obstructed in any fashion, including storage, equipment, phone or other wiring.
j. No combustible material such as paper, wooden boxes, pallets, etc., shall be stored under stairwells or in hallways. Hallways shall be kept free of boxes and materials so that exits or normal paths of travel will not be blocked.
k. Materials stored near aisles shall be restrained to prevent their falling.
l. Mats and carpeting shall be kept in good condition.
m. All working surfaces and floors should be cleaned regularly.
n. All containers must be labeled with at least the identity of the contents and the hazards those chemicals present to users. Unknown containers present a waste disposal problem.

4. Electrical

The typical laboratory requires a large quantity of electrical power. This increases the likelihood of electrically-related problems and hazards. One must address both the electrical shock hazard to the facility occupants and the fire hazard potential. The following recommendations are basic to a sound electrical safety program in the laboratory.

a. All electrical equipment shall be properly grounded.
b. All electrical equipment shall be U.L. listed and/or F.M. approved.
c. Sufficient room for work must be present in the area of breaker boxes. All the circuit breakers and the fuses shall be labeled to indicate whether they are in the "on" or "off" position, and what appliance or room area is served. Fuses must be properly rated.
d. Equipment, appliance and extension cords shall be in good condition.
e. Extension cords shall not be used as a substitute for permanent wiring.
f. Electrical cords or other lines shall not be suspended unsupported across rooms or passageways. Do not route cords over metal objects such as emergency showers, overhead pipes or frames, metal racks, etc. Do not run cords through holes in walls or ceilings or through doorways or windows. Do not place under carpet, rugs, or

heavy objects. Do not place cords on pathways or other areas where repeated abuse can cause deterioration of insulation.

g. 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.
h. Most of the portable multiple outlets are rated at 15 amps. Employees shall check when all connections are made to determine that the total input average will never exceed 15 amps. (The amperage on electrical equipment is usually stamped on the manufacturer's plate).
i. All building electrical repairs, splices, and wiring shall be performed by Facility Services.

5. Vacuum Operations

In an evacuated system, the higher pressure is on the outside, rather than the inside, so that a break causes an implosion rather than an explosion. The resulting hazards consist of flying glass, spattered chemicals, and possibly fire. A moderate vacuum, such as 10 mm Hg, which can be achieved by a water aspirator, often seems safe compared with a high vacuum, such as 10-5 mm Hg. These numbers are deceptive, however, because the pressure differences between the outside and inside are comparable. Therefore any evacuated container must be regarded as an implosion hazard.

a. When working with a vacuum be aware of implosion hazards. Apply vacuum only to glassware specifically designed for this purpose, i.e., heavy wall filter flasks.
b. Never evacuate scratched, cracked, or etched glassware. Always check for stars or cracks before use.
c. Vacuum glassware which has been cooled to liquid nitrogen temperature or below should be annealed prior to reuse under vacuum.
d. Rotary evaporator condensers, receiving flasks, and traps should be taped or kept behind safety shields when under a vacuum.
e. All condensers connected to rotary evaporators should at least be cooled with circulating ice water. Additional information can be found in the SOP for Rotary Evaporator Use.
f. Do not use a vacuum for the distillation of highly volatile solvent. .
g. Water, solvents, or corrosive gases should not be allowed to be drawn into a building vacuum system.
h. When a vacuum is supplied by a compressor or vacuum pump to distill volatile solvents, a cold trap should be used to contain solvent vapors. Cold traps should be of sufficient size and low enough temperature to collect all condensable vapors

present in a vacuum system. If such a trap is not used, the pump or compression exhaust must be vented to the outside using explosion proof methods.

i. After completion of an operation in which a cold trap has been used, the system should be vented. This venting is important because volatile substances that have been collected in the trap may vaporize when the coolant has evaporated and cause a pressure buildup that could blow the apparatus apart.
j. After vacuum distillations, the pot residue must be cooled to room temperature before air is admitted to the apparatus.
k. All desiccators under vacuum should be completely enclosed in a shield or wrapped with friction tape in a grid pattern that leaves the contents visible and at the same time guards against flying glass should the vessel collapse.

6. Handling Glassware
   a. Glass breakage is a common cause of injuries in laboratories. Only glass in good condition should be used.
   b. Discard or send for repair all broken, chipped, starred or badly scratched glassware. Hand protection should be used when picking up broken glass
   c. Clean all glassware before sending for repair.
   d. When using glass tubing, all ends should be fire polished. Lubricate tubing with glycerin or water before inserting into rubber stoppers or rubber tubing.
   e. Protect hands with leather gloves when inserting glass tubing. Hold elbows close to the body to limit movement when handling tubing.
   f. Do not store glassware near the edge of shelves. Store large or heavier glassware on lower shelves.
   g. Use glassware of the proper size. Allow at least 20% free space. Grasp a three-neck flask by the middle neck, not a side neck.
   h. Do not attempt to catch glassware if it is dropped or knocked over.
   i. Conventional laboratory glassware must never be pressurized.

B. GENERAL SAFETY EQUIPMENT

Workers in a laboratory environment are surrounded by physical and chemical hazards, and the potential for accident and injury is always present. Adequate safety equipment in good working order shall be provided to prevent accidents and injury.

1. Fire Extinguishers

a. Facility Services is responsible for the procurement, placement, inspection, and maintenance of all fire extinguishers on campus.
b. Laboratory personnel should be adequately trained regarding pertinent fire hazards associated with their work.
c. Fire extinguishers must be clearly labeled to indicate the types of fire they are designed to extinguish.
d. Fire extinguishers should never be concealed from general view or blocked from access.
e. If an employee notices a fire extinguisher discharged or not fully charged, an extinguisher with the safety pin pulled out, an extinguisher obstructed from view, or one not hanging in its proper location, please notify Facility Services.

2. Emergency Showers And Eyewash Stations

If all protective measures fail and an employee receives a chemical splash to their body, then safety showers should be provided throughout the laboratory for immediate and thorough washing of the body.

a. All chemistry laboratories and areas where faculty, staff, students, or visitors are exposed to harmful chemicals shall be provided with safety showers and eyewash fountains. These facilities shall be conveniently located and tested frequently, readily available, operable, and known to persons concerned.
b. The valve handle of safety showers and eyewash fountains shall be rigidly fixed and plainly labeled. The valve shall open readily in either direction and remain open until intentionally closed. Water flow pressure shall be sufficient to drench the subject rapidly or gently flow in the case of eyewash fountains. The shower and eyewash fountain area shall be kept clear of obstructions. Water of drinking purity shall only be used in safety showers and eyewash fountains.
c. Emergency eyewash fountains shall deliver a gentle flow of clean, aerated water. A hand-held eyewash spray with a five foot hose is more adaptable to unusual situations including head and body splashes, but shall not be located where it can be contaminated by waste materials. It shall be understood by all that eye protection is infinitely more important than eyewashes. For chemical splashes, very complete irrigation is indicated. (A 15 minute flush is recommended.) Immediately flush the eye with a copious amount of water under gentle pressure checking for and removing contact lenses at once.
d. An eyewash fountain shall be used if available. Forcibly hold the eye open to wash thoroughly behind the eyelids.

e. In the absence of an eyewash fountain, the injured shall be placed on his back and water gently poured into the eye. The injured eye shall be held open.
f. The injured shall be given prompt medical attention, regardless of the severity of the injury.
g. Keep the eye immobilized with clean, wet, cold pads while trans-porting the injured to medical attention.
h. Neutralizing agents shall *not* be used for chemical burns to the eye. Experiments have indicated that this type of treatment is likely to increase the eye damage.
i. The emergency shower and eyewash fountains shall be tested on a regular basis and a record kept of such tests.
j. Periodically inspect each Portable Eye Wash Stations to make sure it is properly filled and ready to use. Check to see if the unit is full. Change the water once a month with water of drinking purity. Test the unit's operation monthly.

3. Refrigerators
   a. Use of domestic refrigerators in a laboratory setting constitutes a unique hazard in that explosions may occur when they are used for storage of volatile or unstable chemicals. Domestic (household) refrigerators shall not be used for chemical storage unless they have been modified in accordance with National Electric Code, Article 501.
   b. Chemicals stored in refrigerators shall be sealed and labeled with the name of the material, the date it was placed in the refrigerator, and the name and phone number of the person who stored the material.
   c. In refrigerators in which any toxic materials are stored shall bear a label located on the outside of the refrigerator door stating "No Food or Drink To Be Stored in This Refrigerator." As indicated, no food or beverages of any kind shall be stored in the same refrigerator as chemicals.

4. Laboratory Hoods

Toxic, pathogenic, radioactive, or unknown properties shall be controlled so that workers/students in the laboratory do not absorb, ingest, or inhale the contaminants. They shall be contained within, captured by hoods or enclosures, or dispersed through spot ventilation. A laboratory fume hood is a ventilated enclosed work space consisting of side, back, and top enclosure panels, a work surface or deck, a work opening called the face, and an exhaust plenum equipped with horizontal adjustable slots for the regulation of air flow distribution.

a. Hood Face Velocity
The American Conference of Governmental Industrial Hygienists (ACGIH), "Industrial Ventilation," and the National Research Council, "Prudent Practices in the Laboratory," recommend a face velocity of between 80 and 100 fpm.

b. Work Practices for Laboratory Hoods (from ACGIH "Industrial Ventilation..."
No large, open-face hood with a low face velocity can provide complete safety for a worker standing at the face against all events that may occur in the hood. The hood may not adequately protect the worker from volatile or otherwise airborne contaminants with a TLV in the low part-per-billion range. For more ordinary exposures, a properly designed hood in a properly ventilated room can provide adequate protection. However, certain work practices are necessary for the hood to perform capably. The following work practices are generally required; more stringent practices may be necessary in some circumstances.
   i. Conduct all operations that may generate air contaminants at or above the appropriate Threshold Limit Value (TLV) inside a hood.
   ii. Keep all apparatus at least 6 inches back from the face of the hood. A stripe on the bench surface is a good reminder.
   iii. Do not put your head in the hood when contaminants are being generated.
   iv. Do not use the hood as a waste disposal mechanism.
   v. Do not store chemicals or apparatus in the hood. However, if hoods are used to store chemicals, they are to be labeled "for storage only." Store hazardous chemicals in an approved safety cabinet.
   vi. Keep the hood sash closed as much as possible.
   vii. Keep the slots in the hood baffle free of obstruction by apparatus or containers.
   viii. Minimize foot traffic past the face of the hood.
   ix. Keep laboratory doors closed (exception: some laboratory designs require lab doors to be open).
   x. Do not remove hood sash or panels except when necessary for apparatus set-up; replace sash or panels before operating.
   xi. Do not place electrical receptacles or other spark sources inside the hood when flammable liquids or gases are present. No permanent electrical receptacles are permitted in the hood.
   xii. Use an appropriate barricade if there is a chance of explosion or eruption.
   xiii. Provide adequate maintenance for the hood exhaust system and the building supply system. Use static pressure gauges on the hood throat, across any filters in the exhaust system, or other appropriate indicators to ensure that exhaust flow is appropriate.

xiv. If hood sash is supposed to be partially closed for the operation, the hood should be so labeled and the appropriate closure point clearly indicated.

c. Sash Operation.
   i. Except when adjustments to the apparatus are being made, the hood should be kept closed, with vertical sashes down and horizontal sashes closed, to help prevent the spread of a fire, spill, or other hazard into the laboratory. Sliding sashes should not be removed from horizontal sliding sash hoods. The face opening of the hood should be kept small to improve the overall performance of the hood. If the face velocity becomes excessive, the facility engineers should make adjustments or corrections.
   ii. For hoods without face velocity controls, the sash should be positioned to produce the recommended face velocity, which often occurs only over a limited range of sash positions. This range should be determined and marked during fume hood testing. For hoods with face velocity controls, it is imperative to keep the sash closed when the hood is not in use.

d. Maintenance and Inspection

Periodic inspections and air velocity checks of hoods are necessary if effective control is to be maintained. The Office of Campus Safety inspects fume hoods once a year. In addition, an in house inspection program shall be developed. This inspection program shall include:

   i. Face velocity checks--if possible. The ACGIH recommends, “Use static pressure gauges on the hood throat, across any filters in the exhaust system, or other appropriate indicators to ensure that exhaust flow is appropriate.”
   ii. Housekeeping--accumulation of chemicals and/or equipment in hood. Such materials restrict air flow.
   iii. Sashes--adequate numbers of sashes, condition, ease of movement, and cleanliness.
   iv. Motor/Belt Inspection--belts and motors shall be checked on a regular basis. Facility Services shall be contacted for this service.

ALWAYS ASSURE THE HOOD IS OPERATIONAL BEFORE INITIATING WORK.

5. Biological Safety Cabinets

Biological safety cabinets are the principal equipment used to provide physical containment. They are used as primary barriers to prevent the escape of aerosols into the laboratory

environment. This is an important function because most laboratory techniques are known to produce inadvertent aerosols that can be readily inhaled by the laboratory worker. Certain cabinets can also protect the experiment from airborne contamination. The selection of a Biological Safety Cabinet is based on the potential of the laboratory technique to produce aerosols and the need to protect the experiment from airborne contamination. Three types of Biological Safety Cabinets are used in the microbiological laboratory: the Class I, the Class II, and the Class III cabinet.

a. The Class I Biological Safety Cabinet
   i. The Class I cabinet is a ventilated cabinet that may be used in three operational modes: (1) with a full-width open front, (2) with an installed front closure panel without gloves, and (3) with an installed front closure panel equipped with arm-length rubber gloves. Materials may be introduced and removed through the panel opening and, if provided, through the hinged front view panel or a side UV air look. Lights, vacuum, gas (do not provide if cabinet is to be operated, sealed, and with gloves installed), water, and drain can be provided. The materials of construction shall be selected to withstand wear, corrosive action of gases and liquids, and decontaminants. Room air flowing into the cabinet prevents the escape of airborne contaminants from the cabinet work area. It flows across the work space, over and under a back wall baffle, out through a HEPA filter and blower in an overhead duct to the building air exhaust system or outdoors. When operated with a full-width open front, a minimum inward face velocity normal to the work opening of at least 75 fpm is required.
   ii. Protection is provided to the user and the environment, but not to the product (experiment). A wide range of activities is accommodated using equipment as varied as pipetting aids, burettes, pH meters, sonicators, shielded centrifuges, blenders, and lyopilizers. Chemical carcinogens and low levels of radioactive materials and volatile solvents can be used in Class I cabinets with minimum face velocities of 100 fpm. When these materials are used in the Class I cabinet, a careful evaluation shall be made to determine that concentrations do not reach dangerous levels or cause problems of decontamination of the cabinet.
   iii. The cabinet is a partial containment unit. Its primary barrier-function can be compromised by the pumping action of sudden withdrawal of the hands, the opening and closing of the room door, or rapid movements past the front of the cabinet. Aerosols created in large quantities may overcome even higher face velocities. Also, the cabinet does not protect the experimenter's hands and arms from contact with hazardous materials. Such protection is dependent on technique and the use of gloves and other protective clothing.

b. The Class II Biological Safety Cabinet
   i. The Class II cabinet is commonly known as a laminar airflow Biological Safety Cabinet. Class II cabinets have a front opening for access to the work space and for

introduction and removal of materials. Airborne contaminants in the cabinet are prevented from escaping across this opening by a curtain of air formed by (1) unfiltered air flowing from the room into the cabinet and (2) HEPA filtered air supplied from an overhead grille in the cabinet. This curtain of air also prevents airborne contaminants in the room from entering the work space of the cabinet across the front opening. The curtain of air is drawn through a grille at the forward edge of the work surface into a plenum below. Air from this plenum is HEPA filtered and recirculated through the overhead grille down into the cabinet. A portion of this filtered air is used to maintain the air curtain and the remainder passes down onto the work surface and is drawn out through grilles at the back edge of the work surface. The HEPA filtered air from the overhead grille flows in a uniform downward movement to minimize air turbulence. It is this air that provides and maintains a clean-air work environment. A percentage of air drawn through the front and back grilles of the work surface, which is equal to the flow of room air into the cabinet, is also filtered by HEPA filters and exhausted from the cabinet.

ii. The selection of utility services and materials of construction are similar to those for Class I cabinets.

iii. There are two types of Class II cabinets, A and B. These differ principally as to:
(1) Vertical dimension of the front opening
(2) Proportion of air recirculated
(3) Velocity of airflow to work surface
(4) Manner of discharge of exhaust air
(5) Whether contaminated air plenums are under positive pressure

iv. The Type A cabinet has a fixed front access opening. The inward face velocity through the front opening is at least 75 fpm. Contaminated air plenums are normally operated at positive pressure. The cabinet operates with a high percentage (approximately 70%) of recirculated air. The Type A cabinets can be operated with recirculation of the filtered exhaust air to the room in which they are located. This minimizes extra demand on supply and exhaust air systems unless the buildup of heat and odor from the recirculated exhaust air requires otherwise.

v. Type B cabinets do not recirculate their exhaust air to the room. They have a vertical sliding sash rather than the fixed opening of the type A. Inward air velocity of 100 fpm is attained at an 8″ sash opening. The cabinet operates with a low percentage (approximately 30%) of recirculated air.

vi. Type A and B cabinets are partial containment units with the same limitations as Class I cabinets. These cabinets provide protection to the user, environment, and product (experiment). Activities are accommodated that use pipetting aids, burettes, pH meters, sonicators, blenders, lyophilizers, and shielded centrifuges. The Type B cabinets can be used with dilute preparations of chemical carcinogens, of low-level radioactive materials, and of volatile solvents when the face velocity of 100 fpm is maintained. When these materials are used, however, a careful evaluation shall be made to determine that concentrations do not reach dangerous levels or cause problems of decontamination of the cabinets. The Type A cabinets cannot be used

with toxic, explosive, flammable, or radioactive substances because of the high percentage of recirculated air.

c. The Class III Biological Safety Cabinet
   i. The Class III cabinet is a totally enclosed ventilated cabinet of gas-tight construction. Operations within the Class III cabinet are conducted through attached rubber gloves. When in use, the Class III cabinet is maintained under negative air pressure of at least 0.5″ water gauge. Supply air is drawn into the cabinet through HEPA filters. The cabinet exhaust air is filtered by two HEPA filters installed in series or one HEPA filter and an incinerator. The exhaust fan for the Class III cabinet is generally separate from the exhaust fans of the facility ventilation system.
   ii. Materials are introduced and removed through attached double-door sterilizers and dunk baths with liquid disinfect- ants. The usual utility services can be provided, but not gas. Liquid wastes go to a holding tank for appropriate decontamination before release into “common” sewage lines. Stainless steel is the usual construction material. Modular designs provide for inclusion of refrigerator, incubator, deep freeze, centrifuge, animal holding, and other special cabinet units.
   iii. The Class III cabinet provides the highest level of personnel and environmental protection. Protection is also provided to the product (experiment). Most laboratory activities can be accommodated: the usual cultivation of microorganisms, fertile eggs, tissue cells; microscopy; serology; animal dissections and injections; experimental aerosol exposures; various physical measurements; and many others on a small-to-large scale. Selected gaseous atmospheres can be maintained at desired humidity and temperature conditions.
   iv. The Class III cabinet protection can be compromised by puncture of the gloves or accidents creating positive pressure in the cabinet. Flammable solvents shall not be used in the cabinets unless a careful evaluation has been made to deter- mine that concentrations do not reach dangerous levels. When required and determined safe, these materials shall only be introduced into the system in closed, non-breakable containers. These materials shall not be stored in the cabinet. Electric heaters are preferred over portable, canned-gas heaters. Flammable gas shall not be piped to the units.

d. Laminar Flow Clean Air Cabinet
   This cabinet is not suitable for work with biohazards. Personnel are exposed to contaminated air because the cabinet’s positive pressure allows air to flow out of the cabinet. Such units are suitable only for use with known “clean” materials where product protection is the only objective.

e. Certification Of Biological Safety Cabinets
   i. The capability of biological safety cabinets to protect personnel and the environment from exposures to potentially hazardous aerosols is dependent on both the ability of the laboratory worker to use the cabinet properly and the adequate functioning of the

cabinet itself. A biological safety cabinet shall never be used to contain hazardous materials unless it has been demonstrated to meet certain minimum safety specifications.

ii. Certification of the cabinets for minimum safety specifications is required whenever (1) a new cabinet has been purchased and installed, but before it is used, (2) after it has been moved or relocated, and (3) at least annually. This service is provided by outside companies. Please consult Environmental Health and Safety for names of companies.

BIOLOGICAL SAFETY CABINETS ARE NOT CHEMICAL FUME HOODS AND SHALL NOT BE USED AS SUCH.

6. Specialized Local Ventilation
   Some instruments such as atomic absorption spectrophotometers (AA's) or inductively coupled argon spectrometers (ICP's) emit small quantities of hazardous materials during use. To prevent excessive accumulations of these materials, each of these instruments should be provided with an individual ventilation exhaust duct (as required by the manufacturer and ASHRAE). Gas chromatography equipment using thermal conductivity detection should be kept in a hood or have a vent over the column outlets.

7. Flammable-Liquid Storage Cabinets
   Cabinets designed for the storage of flammable liquids should be properly used and maintained. Read and follow the manufacturer's information and also follow these safety practices:
   a. Store only compatible materials inside a cabinet.
   b. Do not store paper or cardboard or other combustible packaging material in a flammable-liquid cabinet.
   c. The manufacturer establishes quantity limits for various sizes of flammable-liquid storage cabinets; do not overload a cabinet.
   d. NFPA Guidelines and OSHA Standards on Flammable Liquids are utilized as standards for Worker/Fire Protection at Louisiana State University. In all laboratory work with flammable liquids the requirements of 29 CFR (H)-(L), NFPA 30, and NFPA 45 should be consulted and followed.

8. Safety Shield
   a. Safety shields should be used for protection against possible explosions, implosions or splash hazards. Laboratory equipment should be shielded on all sides so that there is no line-of-sight exposure of personnel.

b. Provided its opening is covered by closed doors, the conventional laboratory exhaust hood is a readily available built-in shield. However, a portable shield should also be used when manipulations are performed, particularly with hoods that have vertical-rising doors rather than horizontal-sliding sashes.
c. Portable shields can be used to protect against hazards of limited severity, e.g., small splashes, heat, and fires. A portable shield, however, provides no protection at the sides or back of the equipment and many such shields are not sufficiently weighted and may topple toward the worker when there is a blast (permitting exposure to flying objects). A fixed shield that completely surrounds the experimental apparatus can afford protection against minor blast damage.

C. COMPRESSED GAS SAFETY

Many laboratory operations require the use of compressed gases for analytical or instrument operations. Compressed gases present a unique hazard. Depending on the particular gas, there is a potential for simultaneous exposure to both mechanical and chemical hazards. Gases may be combustible, explosive, corrosive, poisonous, inert, or a combination of hazards. If the gas is flammable, flash points lower than room temperature compounded by high rates of diffusion (which allow for fast permeation throughout the laboratory) present a danger of fire or explosion. Additional hazards of reactivity and toxicity of the gas, as well as asphyxiation, can be caused by high concentrations of even "harmless" gases such as nitrogen. Since the gases are contained in heavy, highly pressurized metal containers, the large amount of potential energy resulting from compression of the gas makes the cylinder a potential rocket or fragmentation bomb. In summary, careful procedures are necessary for handling the various compressed gases, the cylinders containing the compressed gases, regulators or valves used to control gas glow, and the piping used to confine gases during flow. Addition details can be found in the Standard Operating Procedure for Use of Compressed Gases.

D. SAFETY PRACTICES FOR DISPOSAL OF BROKEN GLASSWARE

1. Inspect all glassware before use. Do not use broken, chipped, starred or badly scratched glassware. If it cannot be repaired, discard it in containers specifically designated for broken glass. All broken glass requires special handling and disposal procedures to prevent injury not only to lab personnel, but members of the janitorial staff as well.
2. All broken glass shall be disposed in rigid, puncture proof containers such as a cardboard box with taped seams, or a plastic bucket or metal can with a sealing lid. All broken

glass disposal containers shall be clearly marked "DANGER - BROKEN GLASS" Limit quantities to no more than approximately 15 to 20 pounds so that lifting of the container will not create a situation that could cause back injury.

3. Food, beverage, and uncontaminated glassware: Dispose in a rigid, puncture proof container such as a box with sealed or taped edges or a metal or thick plastic can or bucket with a sealing lid. Label container "DANGER - BROKEN GLASS".
4. Radioactive glassware: Contact the Radiological Safety Officer for specific instructions.
5. Glassware with biological contamination: Glassware that has been in contact with infectious agents may include: used slides, cover slips, test tubes, beakers, pipettes, etc. Contaminated glassware shall be disinfected before disposal. Dispose in a rigid, puncture proof container such as a box with sealed or taped edges or a metal or thick plastic can or bucket with a sealing lid. Label container "DANGER - BROKEN GLASS". Contact the Biological Safety Manager if you require further information.
6. Glassware with chemical contamination: Empty the contents of the glassware into a suitable container if safe to do so and rinse glassware before disposal. Contact the Chemical Safety Manager if you require further information.

E. CENTRIFUGE SAFETY

Rotors on high-speed centrifuge and ultracentrifuge units are subject to mechanical stress that can result in rotor failure. In addition, improper loading and balancing of rotors can cause the rotors to break loose while spinning. For these reasons, centrifuges must be properly used and maintained. Refer the Standard Operating Procedure for Use of high-speed centrifuges.

VII. CHEMICAL SAFETY

Working with potentially hazardous chemicals is an everyday occurrence in a laboratory setting. Hazardous situations can occur if employees are not educated in general chemical safety, toxicological information, and procedures for handling and storage for the chemicals they are using. The purpose of the chemical safety program is the protection of workers and property.

A. ELEMENTS OF THE CHEMICAL SAFETY PROGRAM

1. The Chemical Hygiene Plan
   a. Louisiana State University Policy Statement 19 (PS-19), “Environmental, Health, and Safety”, states that all University activities shall be conducted in accordance with

applicable safety codes, and governmental safety and environmental standards, including Occupational Safety and Health Administration (OSHA) standards. As such, PS-19 constitutes the basis of the Chemical Hygiene Plan (CHP) which is required by OSHA standard 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

b. The chemical hygiene plan is a written program which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting personnel from the health hazards presented by hazardous chemicals.

c. The major objectives of the plan are described in Appendix A of the OSHA Laboratory Standard based on the National Research Council's publication "Prudent Practices in the Laboratory".

i. Control all chemical exposures as necessary to protect worker health.

ii. Avoid underestimation of risk by assuming that all chemicals are hazardous and minimize exposure.

iii. Use engineering controls to provide adequate ventilation.

2. Introduction to Standard Operating Procedures

a. A standard operating procedure (SOP) is a written set of instructions or guidelines that detail the uniform procedures to be followed routinely, and safety precautions to take when carrying out a particular experiment or procedure. The development and implementation of standard operating procedures for critical activities is a core component of promoting excellence in a laboratory and for ensuring a safe, healthy, and environmentally sound workplace

b. Each lab needs to have Standard Operating Procedures that are clear, concise, and useful to lab personnel for training and safety purposes. SOP's may be developed according to a process or procedure, to classes of hazardous chemicals, individual hazardous chemicals, or any other reasonable approach that address health and safety concerns of an experimental protocol. SOP's need to be written that address specific processes of the lab. A copy of all SOP's developed must be located in the laboratory spaces and be available to all people in the laboratory.

c. However there are some basic SOP's that are generally applicable to all labs. These general safety procedures are designed to ensure basic levels of personnel health and safety in the laboratory, for routine and common practices, uses, and chemicals. These basic Standard Operating Procedures are provided at the EHS Website.

3. Chemical Inventory System

The Chemical Inventory Management System program from On-Site Systems is a commercial program that is user friendly and extremely powerful and provides a strong inventory program with compliance features. The key to a chemical safety program is knowing what chemicals can be found in the labs and having access to the relevant safety information. LSU is committed to the use of an on-line chemical inventory and laboratory personnel are responsible for maintenance of their inventory.

B. WORKING WITH CHEMICALS

Working with potentially hazardous chemicals is an everyday occurrence in a laboratory setting. Hazardous situations can occur if employees are not educated in general chemical safety, toxicological information, and procedures for handling and storage for the chemicals they are using. This section of the addresses these educational components and spells out specific protocols to minimize hazardous chemical exposures.

1. Modes of Entry
   There are four major modes of entry to chemicals: inhalation, skin absorption, injection, and ingestion. Inhalation and skin absorption are the predominant occupational exposures you may expect to encounter in the laboratory. Accidental injection of chemicals can be eliminated by good laboratory safety practices. All potential exposures, i.e., inhalation, skin absorption, injection, and ingestion, are discussed in the Material Safety Data Sheets available for each chemical or product. The hundreds of chemicals which employees are routinely exposed to during the course of their work in the laboratory can be divided into three main types: volatile solvents, corrosives, and toxic solids. The particular hazards associated with exposure to these materials, and ways to avoid them, are discussed in detail below.

2. Basic Chemical Classifications
   a. Volatile Solvents
      i. Organic solvents are perhaps the most ubiquitous chemicals found in the laboratory setting. The potential chronic health effects of some of these materials warrant special attention as one is likely to be exposed to more solvents than any other type of chemical. For safety purposes, these chemicals are generally subdivided into two categories: chlorinated and non-chlorinated. This is done mainly because the chlorinated solvents are, in general, not flammable while non-chlorinated solvents are often flammable.

ii. Keeping in mind the difference in flammability between these two classes of solvents, we can discuss the health effects common to both classes. The primary route of exposure to these materials is through inhalation. In general, high concentrations of the vapor, when inhaled, produce drowsiness, dizziness and headaches. This can occur quite quickly, since chemical vapors are rapidly absorbed. Most of the solvents will also act as upper respiratory and/or eye irritants. One physical property common to most solvents is odor. Unfortunately, the odor of a solvent offers little in the way of determining whether or not the environment is immediately hazardous. Solvent odor thresholds vary widely and acclimation or odor fatigue is often rapid. Odor is also not generally indicative of the degree of hazard that the material presents.

iii. Chronic effects of solvent exposure vary widely. Of most concern is the potential for lung, liver, and kidney damage posed by some solvents. This, in general, applies to solvents which are not water soluble. Instances of chronic disease caused by occupational exposure to these solvents have been documented. However, it must be kept in mind that everyone reacts differently and individual susceptibilities are quite variable.

iv. Skin absorption is an additional mode of entry for which an exposure to a solvent may occur. Most commonly, solvents act to de-fat the skin. This will cause drying and cracking of the skin, and may lead to chronic dermatitis with prolonged and repeated exposure. Some solvents can also act as corrosives. Most amines and phenols act in this manner.

v. In addition, many of the solvents will penetrate the skin and be absorbed into the body. In this case, the effects of exposure will be analogous to inhalation exposure. Most skin contact with solvents can be avoided by wearing gloves suitable for that chemical. It is important that the glove be resistant to the material being handled. Using the wrong glove can give a false sense of security and overexposure via the skin may result. If a solvent penetrates the glove, a prolonged contact will result due to slowed evaporation rates

vi. Direct liquid contact by solvents in the eyes can be very serious. The victim could easily panic. Get them to the eye wash immediately and flush the eyes for at least 15 to 30 minutes. Medical assistance should also be summoned.

vii. In summary, volatile solvents can pose inhalation, skin, and ingestion hazards. Some of the solvents may also be flammable, which could cause fire and/or explosion hazards. Whenever possible, use volatile solvents in a properly operating fume hood to eliminate inhalation hazards, use correct skin and eye

protection and use good laboratory and hygienic technique to eliminate any possible ingestion of volatile solvents.

b. Acid and Bases

Common to all acids and bases is their corrosive action on human tissues. Minor exposures are generally reversible, although often painful for a short period of time. The reversibility of the effects of acid or base exposure will depend on three factors: the duration of exposure, concentration of the material, and the first aid methods used.

i. Exposure can occur through skin absorption or inhalation. With inhalation exposure, remove the victim from the area (try to keep the victim from breathing too deeply, as this may exacerbate the effects) and summon medical help.

ii. Skin contact is the most common route of exposure. Here the concentration and type of acid are the most important factors. In concentrated forms, all types of corrosives may cause severe penetrating burns. Dilute solutions do not have the same warning properties as concentrated forms, so guard against exposure. One should be particularly careful with hydrofluoric acid. (See HF SOP).

iii. Neoprene gloves provide the best protection from skin exposure to both acids and bases, but in all cases, follow the recommendations in the MSDS. When using or dispensing concentrated acids or bases, a lab coat or apron and a full face shield is required.

iv. If there is skin or eye contact with acids or bases, make sure to flush the area with water for 15 to 30 minutes and summon medical assistance.

c. Toxic Solids

Many of the chemicals used in the laboratory that are solid and toxic are used in solution, so skin absorption can be of a concern. This is particularly true when a substance is dissolved in a solvent which can penetrate the skin. Also, an oxidizing material dissolved in water can act directly on the skin causing irritation where the solid alone would be relatively less irritating. It is therefore important that proper personal protective equipment be worn. In the solid form, the greatest risk of exposure is through inhalation. This risk can be lessened by working in a fume hood

d. Incompatible Chemicals

Certain hazardous chemicals cannot be mixed or stored safely with other chemicals due to potentially severe or extremely toxic reactions taking place. For example, keep oxidizing agents separated from reducing agents, initiators separated from monomers, and acids separated from alkalis, etc. The chemical label and Material Safety Data Sheet will contain information on incompatibilities. See the Chemical Storage SOP for a list of incompatible chemicals.

e. Chemical Stability

Stability refers to the susceptibility of the chemical to decomposition. Ethers, liquid paraffins, and olefins can form peroxides on exposure to air and light. Since these chemicals are packaged in an air atmosphere, peroxides can form even though the containers have remained sealed. Some inorganic chemicals also are unstable. Unless inhibitor was added by the manufacturer, closed containers of ethers shall be discarded after one year. Examples of potential peroxide forming materials in the Chemical Storage SOP.

f. Shock-Sensitive Chemicals
Shock-sensitive refers to the sensitivity of the chemical to decompose rapidly or explode when struck, vibrated, or otherwise agitated. The label and Material Safety Data Sheet will indicate if a chemical is shock-sensitive. Shock-sensitive chemicals should be procured as needed to minimize storage problems. Shock-sensitive materials should be considered individually and disposed of as soon as practical. Many chemicals become increasingly shock-sensitive with age. The date received and date opened shall be clearly marked on all containers of shock-sensitive chemicals.

C. CHEMICAL PROCUREMENT AND DISTRIBUTION

1. Procurement.
   a. Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved.
   b. The US Department of Transportation (DOT) requires that shippers furnish and attach DOT prescribed labels on all shipment of hazardous substances. These labels indicate the nature of the hazard(s) of the substance(s) shipped and thus provide some indication to receiving personnel of the type of hazard received. No container or cylinder should be accepted that does not have an identifying label. For chemicals, it is desirable that this label correspond to ANSI Z129.1, which requires, at a minimum, the following components:
      i. Identification of contents of container;
      ii. Signal word and summary description of any hazard(s);
      iii. Precautionary information - what to do to minimize hazard or prevent an accident from happening;
      iv. First aid in case of exposure;
      v. Spill and cleanup procedures; and
      vi. If appropriate, special instructions to physicians.

c. Every effort should be made to ensure that this label remains on the container and legible.
d. All substances should be received in a central location.
e. EHS has implemented an internet based chemical inventory management system. It is the responsibility of each lab to maintain the inventory by adding compounds upon receipt and deleting compound when gone. This enables EHS to provide support to the organization and emergency personnel in the event of an emergency. The system also promotes waste reduction by identifying excess chemicals for other departments prior to purchase.

2. Distribution

Many laboratory accidents occur through the simple operation of carrying chemicals from one place to another or transferring them from one container to another. The chemicals used in a laboratory are often corrosive, toxic, or flammable and any accident involving these has the potential for personal injury. Therefore, it is good practice to assume that all chemicals are potentially hazardous.

a. When large bottles of acids, solvents, or other liquids are transported within the laboratory without a cart, only one bottle should be carried at a time. The bottle should be carried with both hands, one on the neck of the bottle and the other underneath. Avoid the temptation to hook a finger through the glass ring on top of the bottle, allowing it to dangle while being transported. Never carry or attempt to pick up a bottle by the cap.
b. When transporting bottles within the laboratory, a wheeled cart may be used. Carts should be stable under load and have wheels large enough to negotiate uneven surfaces (such as expansion joints and floor drain depressions) without tipping or stopping suddenly. Do not place the bottles near the edge of the cart, nor should they be touching each other or other glassware during transport. Be cautious rolling the cart over door sills or other possible obstructions.
c. Incompatible chemicals should not be transported on the same cart. Freight-only elevators should be used, if possible, when transporting chemicals, to avoid exposure to persons on passenger elevators.
d. Special padded or rubber bottle carriers, pails, or carts should be used to prevent breakage by accidental striking against walls or floor, and to contain the material if breakage does occur.
e. Large quantities of concentrated mineral acids, e.g., sulfuric, nitric and hydrochloric acids, shall be kept in storage rooms, in cabinets for corrosive

substances, or chemical transfer rooms. Bottles of concentrated acids must be carried from the aforementioned areas in an approved acid bottle carrier.

f. Organic solvents shall also be stored in specialized flammable storage areas. These solvents shall be carried from storage areas in special rubber carriers. Organic solvents can present fire hazards as well as inhalation hazards.

D. CHEMICAL HANDLING AND STORAGE

The principle concerns in achieving proper storage are to maximize employee safety with regard to chemical compatibility, spill control, fire/explosion control, to provide security, identification, and provide a "user friendly" system with respect to point-of-use.

a. General Considerations
   i. Avoid storing equipment and material on top of cabinets.
   ii. Do not store materials on top of high cabinets where they will be difficult to reach.
   iii. Keep exits, passageways, areas under tables or benches, and emergency equipment areas free of stored equipment and materials.
   iv. Label all chemical containers appropriately.
   v. Place the users name and the date received on all purchased materials in order to facilitate inventory control of the materials.
   vi. Provide a definite storage place for each chemical and return the chemical to that location after each use.
   vii. Avoid storing chemicals on bench tops, except of those chemicals being used currently.
   viii. Avoid storing chemicals in laboratory hoods, except for those being used currently.
   ix. Store volatile toxins and odoriferous chemicals in a ventilated cabinet. Check with the institution's environmental health and safety officer.
   x. Provide ventilated storage near laboratory hoods.
   xi. If a chemical does not require a ventilated cabinet, store it inside a closable cabinet or on a shelf that has a lip to prevent containers from sliding off in the event of a fire, serious accident, or earthquake.
   xii. Do not expose stored chemicals to heat or direct sunlight.
   xiii. Observe all precautions regarding the storage of incompatible chemicals.
   xiv. Separate chemicals into compatible groups and store alphabetically within compatible groups.

xv. Store flammable liquids in approved flammable liquid storage cabinets.

b. Stockrooms/storerooms.
   i. Toxic substances should be segregated in a well-defined area with local exhaust ventilation.
   ii. Chemicals which are highly toxic or other chemicals whose containers have been opened should be in unbreakable secondary containers.
   iii. Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity.
   iv. Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person.

c. Laboratory storage
   i. Amounts permitted should be as small as practical.
   ii. Storage on bench tops and hoods is inadvisable. If hoods are used for storage, they must be labeled as such and not used for experiments.
   iii. Exposure to heat or direct sunlight should be avoided.
   iv. Periodic inventories should be conducted, with the items being discarded or returned to the storeroom/stockroom.
   v. All labels shall face front.

d. Containers and Equipment
   i. Use corrosion-resistant storage trays or secondary containers to retain materials if the primary container breaks or leaks.
   ii. Provide vented cabinets beneath laboratory hoods for storing hazardous materials. (This encourages the use of the hoods for transferring such materials.)
   iii. Use chemical storage refrigerators only for storing chemicals.
   iv. Label these refrigerators with the following signage: NO FOOD-CHEMICAL STORAGE
   v. Seal containers to minimize escape of corrosive, flammable, or toxic vapors.
   vi. Label all materials in the refrigerator with contents, owner, date of acquisition or preparation, and nature of any potential hazard.
   vii. Do not store flammable liquids in a refrigerator unless it is approved of such storage. Such refrigerators are designed not to spark inside the refrigerator. If refrigerated storage is needed inside a flammable-storage room, it is advisable to choose an explosion-proof refrigerator.

e. Storing Highly Reactive Substances

i. Consider the storage requirements of each highly reactive chemical prior to bringing it into the laboratory.

ii. Consult the MSDSs or other literature in making decisions about storage of highly reactive chemicals.

iii. Bring into the laboratory only the quantities of material you will need for your immediate purposes (less than 3- to 6-month supply, the length depending on the nature and sensitivity of the materials).

iv. Label, date, and inventory all highly reactive materials as soon as received. Make sure the label states, DANGER! HIGHLY REACTIVE MATERIAL!

v. Do not open a container of highly reactive material that is past its expiration date. Call your institution's hazardous waste coordinator for special institution's hazardous waste coordinator for special instructions.

vi. Do not open a liquid organic peroxide or peroxide former if crystals or a precipitate are present. Call your institution's hazardous waste coordinator for special instructions.

vii. Dispose of (or recycle) highly reactive material prior to expiration date.

viii. Segregate the following materials:

1) oxidizing agents from reducing agents and combustibles

2) powerful reducing agents from readily reducible substrates

pyrophoric compounds from flammables, and

4) perchloric acid from reducing agents.

ix. Store highly reactive liquids in trays large enough to hold the contents of the bottles.

x. Store percholric acid bottles in glass or ceramic trays.

xii. Store peroxidizable materials away from heat and light.

xiii. Store materials that react vigorously with water away from possible contact with water.

xiv. Store thermally unstable materials in a refrigerator. Use a refrigerator with these safety features:

1) all spark-producing controls on the outside,

2) a magnetic locked door, and

3) an alarm to warn when the temperature is too high.

xv. Store liquid organic peroxides at the lowest possible temperature consistent with

the solubility or freezing point. Liquid peroxides are particularly sensitive during phase changes.

xvi. Inspect and test-peroxide-forming chemicals periodically (these should be labeled with an acquisition or expiration date) and discard containers that have exceeded their safe storage lifetime.

xvii. Store particularly sensitive materials or larger amounts of explosive materials in explosive relief boxes.

xviii. Restrict access to the storage facility.

xix. Assign responsibility for the storage facility to one primary person and a backup person. Review this responsibility at least yearly.

f. Storing Toxic Substances

i. Store chemicals known to be highly toxic (including carcinogens) in ventilated storage in unbreakable, chemically resistant secondary containers.

ii. Keep quantities at a minimum working level.

iii. Label storage areas with appropriate warning signs, such as:

CAUTION! REPRODUCTIVE TOXIN STORAGE or

CAUTION! CANCER-SUSPECT AGENT STORAGE

VII. BIOLOGICAL SAFETY

This section presents certain safety requirements for handling specific hazardous microorganisms. These requirements are based on present knowledge and shall change as research continues and new standards are developed. All activities within labs where biohazards exist must operate under the CDC/NIH guidelines for biosafety. These guidelines are on the EHS web page. The operational requirements serve, in part, to indicate what facilities and resources should be made available to minimize hazards in work with specific microorganisms.

A. General Guidelines.

1. Authorized Personnel

Only authorized employees, students, and visitors shall be allowed to enter infectious disease laboratories or utility rooms.

2. Autoclaving

a. All infectious or toxic materials, equipment, or apparatus shall be autoclaved or otherwise disinfected before being washed or disposed of. Each individual working with infectious material shall be responsible for its disinfection before disposal.
b. Infectious or toxic materials shall not be placed in autoclaves overnight in anticipation of autoclaving the next day.
c. Autoclaves shall be checked for operating efficiency if spore formers are used.

3. Building Vacuum Line
When the building vacuum line is used, suitable traps or filters shall be interposed to insure that pathogens do not enter the fixed system.

4. Centrifuging, Sonication, Separation Aerosol Precautions
   a. Before centrifuging, inspect tubes for cracks; inspect the inside of the trunnion cup for rough walls caused by erosion of adhering matter; and carefully remove bits of glass from the rubber cushion. A germicidal solution added between the tube and trunnion cup not only disinfects the outer surface of both of these but also provides an excellent cushion against shocks that might otherwise break the tube.
   b. Avoid decanting centrifuge tubes. If you must do so, wipe off the outer rim with a disinfectant afterwards; otherwise, the infectious fluid will spin off as an aerosol. Avoid filling the tube to the point that the rim becomes wet with culture.
   c. A ventilated and filtered safety centrifuge cabinet is recommended to house and safeguard all centrifuging of infectious substances. Use a safety centrifuge cup. Centrifuging shall always be done in closed containers and, whenever possible, in closed centrifuge heads. When centrifuging is done in a ventilated glove box, the glove panel shall be in place with the glove ports covered. A centrifuge in operation creates reverse air currents that may cause escape of agent from an open cabinet.
   d. An aerosol containment hood or enclosure shall be provided for sonicators, cream separators, and similar aerosol producing apparatus.

5. Containers Protective
   a. Insure that all virulent fluid cultures or viable powdered infectious materials in glass vessels are transported, incubated, and stored in easily handled, non breakable, leak proof containers that are large enough to contain all fluid or powder in case of leakage or breakage of the glass vessel.
   b. All inoculated Petri plates or other inoculated solid media shall be transported and incubated in leak proof pans or other leak proof containers.

6. Emergencies
    a. No person shall work alone on an extremely hazardous operation. Use the "buddy system."
    b. Prepared solutions of suitable disinfectants, along with instructions for use, should be maintained in each laboratory in a conspicuous location. The location should be labeled "Disinfectants for Emergency Use."
    c. An Emergency Notification Sign, available from the Office of Occupational and Environmental Safety, shall be posted by the responsible researcher on the exterior door of each lab giving instructions to follow in the event of an emergency such as a fire or spill. Instructions shall emphasize precautionary measures. Biohazard signs must be posted on lab doors.

7. Floors and Other Surfaces
    a. Floors, laboratory benches, and other surfaces in the buildings in which infectious substances are handled shall be disinfected with a suitable germicide as often as deemed necessary by the supervisors or as directed by CDC/NIH guidelines. After completion of operations involving planting, pipetting, centrifuging, lyophilizing, and similar procedures with infectious agents, the surroundings shall be disinfected.
    b. Floor drains throughout the building shall be flooded with water, glycol, or a safe disinfectant at least once a week in order to fill traps and prevent backflow of sewer gases.
    c. Elimination of sweeping through use of vacuum cleaners utilizing absolute filters or through wet mopping only is recommended. If floors are swept, use push brooms only. The use of a floor sweeping compound is recommended because of its effectiveness in lowering the number of airborne organisms. Water used to mop floors shall contain suitable disinfectants. Custodial services in Biosafety Level 3 or 4 labs shall be performed by laboratory personnel only not by Facility Services or University contractors.

8. Hygiene
    a. Develop the habit of keeping your hands away from your mouth, nose, eyes, and face. This may prevent self inoculation.
    b. Deepfreeze and dry ice chests and refrigerators shall be checked and cleaned out periodically to remove broken ampules, tubes, etc., containing infectious material. A tray can be used to line the bottom of the refrigerator or freezer to catch and retain broken containers.

c. Library books and journals shall not be taken into rooms where work with infectious agents is in progress.
d. An effort shall be made to keep all other surplus materials and equipment out of these rooms.
e. According to the level of risk, the wearing of laboratory or protective clothing may be required for persons entering infectious disease laboratories. Likewise, showers with a germicidal soap may be required before exit.
f. Contaminated laboratory clothing shall not be worn in clean areas or outside the building.

9. Labeling
All laboratory rooms containing infectious sub-stances shall designate separate areas or shelters labeled: "INFECTIOUS TO BE AUTOCLAVED," or "NOT INFECTIOUS TO BE CLEANED." All infectious disease work areas including cabinetry shall be prominently marked with the Biohazard Warning Control symbol. Cultures shall be labeled with the name of the agent, researchers' names, and date.

10. Membrane Filters
Care shall be exercised in the use of membrane filters to obtain sterile filtrates of infectious materials. Because of the fragility of the membrane and other factors, such filtrates cannot be handled as noninfectious until culture or other tests have proven their sterility.

11. Personal Protective Equipment
a. A respirator or gas mask shall be worn when changing a glove or gloves attached to a safety cabinet if an infectious aerosol may possibly be present in the cabinet. See "Personal Protective Equipment."
b. Diagnostic serum specimens carrying a risk of serum hepatitis shall be handled with rubber gloves.

12. Pest Control
Pest and rodent control must be maintained. (See CDC/NIH Guidelines)All laboratories shall be sprayed with insecticides as often as necessary to control flies and other insects. Consult Physical Plant pesticide control personnel for spraying. Advise them of hazards in the laboratory before work begins and exercise adequate control of entry and activity as permitted under the lab classification.

13. Pipettes

a. No infectious materials shall be pipetted by mouth or blown out of a pipette. Do not use a pipette for mixing or for bubbling air through an infectious mixture. Hand pipetting devices shall be used to pipette all microorganisms, tissue, cell cultures, caustic or corrosive chemicals, poisons, organic solvents, radioactive materials, mutagens, carcinogens, or teratogens.
b. Contaminated pipettes shall be placed horizontally in a pan containing enough suitable disinfectant to allow complete immersion. They shall not be placed vertically in a cylinder. The pan and pipette shall be autoclaved as a unit and replaced by a clean pan with fresh disinfectant.

14. Syringes
    a. Only syringes of the Luer Lok type shall be used with infectious materials.
    b. 2) Use an alcohol soaked pledget around the stopper and needle when removing a syringe and needle from a rubber stoppered vaccine bottle.
    c. 3) Expel excess fluid and bubbles from a syringe vertically into a cotton pledget soaked with disinfectant or into a small bottle or cotton.
    d. 4) Syringes and needles shall be autoclaved and destroyed before disposal into special waste containers (not into the "trash"). Blunt needles (cannulas) shall be used wherever sharp needles are not required.

15. Shakers
    a. A safety box or safety shaker tray shall be used to house or safeguard all containers of infectious substances on shaking machines.
    b. Broth cultures shall be taken in a manner that avoids wetting the plug or cap.
16. Smoking, Eating, and Drinking
    a. Food, candy, gum, or beverages for human consumption shall not be taken into infectious disease or recombinant DNA research laboratories. Smoking shall not be permitted in any area in which work with infectious or toxic substances is performed. Employees who have been working with infectious materials shall wash and disinfect their hands thoroughly before smoking, eating, or drinking. See "Consumption of Food and Beverages."
    b. Industrial water from lab sinks shall not be used for human consumption.

17. Storage
    At the close of each workday, to minimize hazard to fireman, maintenance personnel, or emergency crews, all infectious or toxic material shall be:
    At the close of each workday, to minimize hazard to fireman, maintenance personnel, or emergency crews, all infectious or toxic material shall be:
    a. placed in the refrigerator,
    b. placed in the incubator, or
    c. autoclaved or otherwise disinfected before the building is closed.

18. Wastes
    a. No infectious substances shall be allowed to enter a building drainage or refuse disposal system without proper sterilization.
    b. Mechanical garbage disposal units shall not be installed for use in disposing of contaminated wastes. The units release considerable amounts of aerosol.
19. Water baths and warburg

Water Baths and Warburg Baths used to inactivate, incubate, or test infectious substances shall contain a suitable disinfectant. For cold water baths, 70% propylene glycol is recommended.

B. Sterilization and Disinfection Methods

General criteria for sterilization of typical materials are presented below. Supervisors are encouraged to review the type of materials being handled and to establish standard conditions for sterilization. Treatment conditions to achieve sterility will vary in relation to the volume of material treated, its contamination level, the moisture content, and other factors.

1. Steam Autoclave
    a. Laundry - 250 F (121 C) for 30 minutes with 15 minutes pre vacuum of 27" Hg.
    b. Trash - 250 F (121 C) for 1 hour with 15 minutes pre vacuum of 27" Hg.
    c. Glassware - 250 F (121C) for 1 hour with 15 minutes pre vacuum of 27" Hg for filled NTH Glassware can.
    d. Liquids - 250 F (121 C) for 1 hour for each gallon.
    e. Animals - 250 F (121 C) for 8 hours with 15 minutes pre vacuum of 27" Hg.
    f. Bedding - 250F (121C) for 8 hours with 15 minutes pre vacuum of 27" Hg.

2. Gas Sterilants
    a. Ethylene Oxide Gas - Sixteen hours exposure to a concentration of 750 mg/liter (approximately 5%) at 30 to 60% relative humidity and at ambient temperatures (> 70 F).
    b. Paraformaldehyde - 16 hours exposure to a concentration of 1.0 mg/liter at 40 to 60% relative humidity at ambient temperatures (> 70 F).

3. Disinfectants
    a. Mercurials are not recommended for general use because they have poor activity against vegetative bacteria and are useless as sporicides. Although the mercurials exhibit good activity against viruses (1:500 to 1:1000 concentration), they are toxic and not recommended.

b. Quaternary Ammonium Compounds are acceptable as general use disinfectants to control vegetative bacteria and non lipid containing viruses. However, they are not active against bacterial spores at the usual use concentrations (1.750).
c. Phenolic Compounds are recommended for killing vegetative bacteria, including Mycobacterium tuberculosis, fungi, and lipid containing viruses.
d. Chlorine Compounds are recommended for certain disinfecting procedures, provided the available chlorine needed is considered. Low concentrations of available chlorine (50 to 500 ppm) are active against vegetative bacteria and most viruses. For bacterial spores, concentrations of approximately 2500 ppm are needed. The corrosive nature of these compounds, their decay rates, and lack of residuals are such that they are recommended only in special situations.
e. Iodophors show poor activity against bacterial spores, but they are recommended for general use (75 to 150 ppm). They are effective against vegetative bacteria and viruses. Their advantages are:
    i. Iodophors possess a wide spectrum of antimicrobial and antiviral activity.
    ii. Iodophors have a built in indicator. If the solution is brown or yellow, it is still active.
    iii. Iodophors are relatively harmless to man.
    iv. Iodophors can be readily inactivated and iodophor stains can be readily removed with solutions of Na2S2O3 (Sodium Thiosulfate).
f. Alcohols, in concentrations of 70 to 95 percent, are good general use disinfectants, but they exhibit no activity against bacterial spores.
g. Formaldehyde Solutions, in concentrations of 8 percent, exhibit good activity against vegetative bacteria, spores, and viruses.
h. Activated Glutaraldehyde, in two percent solutions, exhibit good activity against vegetative bacteria, spores, and viruses. Its use, however, shall be limited and controlled because of its toxic properties and the damage to the eyes.
i. Formaldehyde Alcohol, in solutions of 8 percent in 70 percent alcohol is considered very good for disinfection purposes because of their effectiveness against vegetative bacteria, spores, and viruses. For many applications, this is the disinfectant of choice.

C. Factors Influencing Biological Safety Equipment Selection

1. Proposed Activity.
   Procedures which may cause aerosols to be of particular concern.
2. Risk of the Infective Agent.

All known characteristics of the agent shall be evaluated, i.e., potential for infection, history of known laboratory acquired human infections, concentration of the viable agent to be used, classification of the etiologic agent on the basis of hazard, etc.

3. Control Objectives.
   The control protection desired shall be determined from the proposed activity and the specific agent.
   a. Product protection only
   b. Personnel protection only
   c. Personnel and product protection

D. BIO-SAFETY LEVELS

Four bio-safety levels are described which consist of combinations of laboratory practices and techniques, safety equipment, and laboratory facilities appropriate for the operations performed and the hazard posed by the infectious agents and for the laboratory function or activity.

1. Bio-safety Level 1
   Practices, safety equipment, and facilities are appropriate for facilities in which work is done with defined and characterized strains of viable microorganisms not known to cause disease in healthy adult humans. Bacillus subtilis, Naegleria gruberi, and infectious canine hepatitis virus are representative of those microorganisms meeting these criteria. Many agents not ordinarily associated with disease processes in humans are, however, opportunistic pathogens and may cause infection in the young, the aged, immunodeficient or immunosuppressed individuals. Vaccine strains which have undergone multiple in-vivo passages should not be considered avirulent simply because they are vaccine strains.

2. Bio-safety Level 2
   Practices, equipment, and facilities are applicable to clinical facilities in which work is done with the broad spectrum of indigenous moderate-risk agents present in the community and associated with human disease of varying severity. With good microbiological techniques, these agents can be used safely in activities conducted on the open bench, provided the potential for producing aerosols is low. Hepatitis B virus, the Salmonellae, and Toxoplasma spp. are representative of microorganism assignment to this containment level. Primary hazards to personnel working with these agents may include accidental autoinnoculation, ingestion, and skin or mucous membrane exposure to infectious materials. Procedures with

high aerosol potential that may increase the risk of exposure to personnel, must be conducted in primary containment equipment or devices.

3. Bio-safety Level 3
   Practices, safety equipment, and facilities are applicable to facilities in which work is done with indigenous or exotic agents where the potential for infection by aerosols is real and the disease may have serious or lethal consequences. Autoinnoculation and ingestion also represent primary hazards to personnel working with these agents. Examples of such agents for which bio-safety Level 3 safeguards are generally recommended include Mycobacterium tuberculosis, St. Louis encephalitis virus and Coxiella burnetti.

4. Bio-safety Level 4
   Practices, safety equipment, and facilities are applicable to work with dangerous and exotic agents which pose a high individual risk of life threatening disease. All manipulations of potentially infectious diagnostic materials, isolates, and naturally or experimentally infected animals pose a high risk of exposure and infection to laboratory personnel. Lassa Fever virus is representative of the microorganisms assigned to Level 4.

5. Work with known agents shall be conducted at the bio-safety level recommended by the Centers for Disease Control (CDC) or the National Institute of Health (NIH), unless specific information is available to suggest the virulence, pathogenicity, antibiotic resistance patterns, and the other factors are significantly altered to require more stringent or allow less stringent practices to be used.
   a. Clinical laboratories, and especially those in health care facilities or disease diagnostic labs, receive clinical specimens with requests for clinical support services. Typically, clinical laboratories receive specimens without pertinent information such as patient history or clinical findings which may be suggestive of an infectious etiology. Furthermore, such specimens are often submitted with a broad request for microbiological examination for multiple agents (e.g., sputum samples submitted for "routine," acid fast, and fungal cultures).
   b. It is the responsibility of the laboratory supervisor to establish standard procedures in the laboratory which realistically address the issue of ineffective hazard of clinical specimens. Except in extraordinary circumstances (e.g., suspected hemorrhagic fever) the initial processing of clinical specimens and identification of isolates can be and are safely conducted using a combination of practices, facilities, and safety equipment described as bio-safety level 2. Biological safety cabinets (Class I or II) should be used for the initial processing of clinical specimens when the nature of the test is requested or

other information is suggestive that an agent readily transmissible by infectious aerosols is likely to be present. Class II biological safety cabinets are also used to protect the integrity of the specimens or cultures by preventing contamination from the laboratory environment.

c. Segregating clinical laboratory functions and limiting or restricting access to laboratory areas are the responsibility of the laboratory supervisor.
d. A specially designed suit area may be provided in the facility. Personnel who enter this area wear a one piece positive pressure suit that is ventilated by a life support system. The life support system includes alarms and emergency backup breathing air tanks. Entry to this area is through an airlock fitted with airtight doors. A chemical shower is provided to decontaminate the surface of the suit before the worker leaves the area. The exhaust air from suit area is filtered by two sets of HEPA filters installed in series. A duplicate filtration unit, exhaust fan, and an automatically starting emergency power source are provided. The air pressure within the suit area is lower than that of any adjacent area. Emergency lighting and communication systems are provided. All penetrations into the internal shell of the suit area are sealed. A double door autoclave is provided for decontaminating waste materials to be removed from the suite area.
e. The selection of an appropriate biosafety level for work with a particular agent or animal study is dependent upon a number of factors. The most important of these include: the virulence, pathogenicity, biological stability, communicability of the agent, the nature of function of the laboratory or function, the quantity and concentration of the agent, the endemicity of the agent, and the availability of effective vaccines or therapeutic measures.
f. The laboratory supervisor and/or principal investigator shall seek approval of the Department Head and the Institutional Biological and Recombinant DNA Safety Committee as well as other necessary administrative directors prior to initiation of experiments dealing with bio hazard materials. The principal criteria to be satisfied is the safety of University personnel and students. It is also necessary to comply with CDC/NIH guidelines.
g. If a combination of increasingly stringent primary and secondary containment procedures and facilities is used, laboratory studies and manipulations can be safely conducted on agents that are correspondingly more hazardous.

6. In general, the biosafety level used for activities using infectious agents or infected animals shall be commensurate with that required for the agent of highest virulence known or likely to be encountered in the course of contemplated work. For example: all diagnostic sera of human origin shall be considered potentially infectious for hepatitis and handled under

conditions which reasonably preclude cutaneous, oral, and parenteral exposure to personnel. Sputa shall be considered as potentially infectious for tuberculosis and should be handled under conditions which reasonably preclude the generation of aerosols, or which contain any aerosols generated. If, in the course of diagnostic or other laboratory examinations, there is evidence that the materials being studied contain only an agent of higher or lower risk than expected, the biosafety level shall be raised or lowered accordingly.

E. Laboratory Practice and Technique

The most important element of containment is strict adherence to standard microbiological practices and techniques. Persons working with infectious agents or infected materials must be aware of potential hazards and must be trained and proficient in the practices and techniques required for safely handling such material. The director or person in charge of the laboratory is responsible for providing or arranging for appropriate training of personnel.

When standard laboratory practices are not sufficient to control the hazard associated with a particular agent or laboratory procedure, additional measures may be needed. The laboratory supervisor is responsible for selecting additional safety practices, which must be in keeping with the hazard associated with the agent or procedure.

Each laboratory should develop or adopt a bio-safety or operations manual which identifies the hazards that will or may be encountered and which specifies practices and procedures designed to minimize or eliminate risks. Personnel shall be advised of special hazards and shall be required to read and follow the required practices and procedures. A scientist with training and knowledge in appropriate laboratory techniques, safety procedures, and hazards associated with handling infectious agents must direct laboratory activities.

Laboratory personnel, safety practices and techniques must be supplemented by appropriate facility design and engineering features, safety equipment and management practices.

1. Engineering controls shall be examined and maintained or replaced on a regular schedule to ensure their effectiveness.
2. Employees shall wash their hands immediately or as soon as possible after removal of gloves or other personal protective equipment and after hand contact with blood or other potentially infectious materials.
3. All personal protective equipment shall be removed immediately upon leaving the work area or as soon as possible if overtly contaminated and placed in an appropriately designated area or container for storage, washing, decontamination or disposal.

4. Used needles and other sharps shall not be sheared, bent, broken, recapped, or resheathed by hand. Used needles shall not be removed from disposable syringes.
5. Eating, drinking, smoking, applying cosmetics or lip balm, and handling contact lenses are prohibited in work areas where there is a potential for occupational exposure.
6. Food and drink shall not be stored in refrigerators, freezers, or cabinets where blood or other potentially infectious materials are stored or in other areas of possible contamination.
7. All procedures involving blood or other potentially infectious materials shall be performed in such a manner as to minimize splashing, spraying, and aerosolization of these substances, and shall comply with the Blood-Borne Pathogens Act.

F. EFFECTIVE USE OF BIOLOGICAL SAFETY CABINETS

Exposure to airborne microorganisms can result in infection of laboratory workers or contamination of research materials. Biomedical engineering and technology have provided safeguards, but these safeguards do not prevent mistakes or human errors. Danger to personnel and to the success of scientific investigation from carelessly or improperly used equipment cannot be overly emphasized.

The Laminar Flow Biological Safety Cabinet, designed to prevent escape of pathogens into the workers' environment and to bar contaminants from the research work zone, is a key element to safe, successful experimentation with biological materials. Escape of pathogens into the workers' area is prevented by an air barrier at the front opening and the cleaning action of the exhaust air filter. Inward flow of room air into the front air intake grill creates the air barrier. The amount of air drawn into the air intake grill and the amount of air exhausted through the exhaust filter are equal. The exhaust filter removes airborne biological contaminants which may be released in the cabinet. It does not remove chemical or radiological contaminant.

Contamination of the work area inside the cabinet is prevented by the cleaning action of the supply filters. Air flows through the cabinet work area in a downward direction at a uniform velocity. The air continues to be recirculated by the fan through the air flow plenum. Airborne biological contaminants are removed by the filters as the air is returned to the cabinet work area.

Certification and advance planning are of prime importance to safe operation. Only qualified personnel using approved test methods and equipment should provide

performance certification at initial installation, after maintenance, and on an annual basis thereafter. Certification is also necessary after the cabinet has been moved and after filters have been replaced. Many cabinets have gauges to indicate pressure differential across the supply filters. If the filters must be replaced, the cabinet MUST be decontaminated first. It is the responsibility of individual researchers and/or departments to insure this process is accomplished at least annually.

1. When planning is completed, start-up procedures may be initiated. There are three start-up steps:
   a. Turn on the lights
   b. Check the air intake and exhaust grill to make sure they are unobstructed
   c. Turn on the fan
2. Allow the fan to operate a minimum of five minutes before manipulations are begun in the cabinet. In addition, the following points should be considered:
   a. Some cabinets are equipped with ultraviolet light. These must be turned off during the day while laboratory personnel are occupying the room.
   b. Hands and arms should be washed well with germicidal soap before and after work in the cabinet.
   c. Technicians are encouraged to wear long-sleeve gowns with knit cuffs and rubber gloves. This minimizes the shedding of skin flora into the work area and protects the hands and arms from contamination by viable agents.
   d. Interior surfaces of the work area should be disinfected by wiping them thoroughly with 70% alcohol.
   e. The cabinets should not be overloaded. Everything needed for the complete procedure should be placed in the cabinet before starting so that nothing passes in or out through the air barrier until the procedure is completed.
   f. Do not place anything over the front intake or rear exhaust grill in units having a solid work surface. As a general rule, keep equipment at least four inches inside the cabinet window and perform transfer of viable materials as deeply into the cabinet as possible.
   g. After all materials have been placed in the cabinet, wait 2-3 minutes before beginning work. This will allow sufficient time for the cabinet air to purge airborne contamination from the work area.
   h. Hold the activity in the room to a minimum. Unnecessary activity may create disruptive air currents. The ideal location for a cabinet is in a quiet end of the laboratory, removed from doorways, air conditioning and heating vents.

Opening and closing laboratory doors can cause disruptive drafts that allow microorganisms to penetrate the air barrier.

i. Schedule uninterrupted work periods. The movement of objects including hands and arms causes turbulent air currents which disrupt the air barrier and allow escape and entrance of airborne contaminants.

j. Air turbulence caused by rotating laboratory equipment, such as a small clinical centrifuge, disrupt air flow within the cabinet and at the work opening. This is sufficient for contaminated air to escape to the laboratory environment. If a centrifuge must be used in the cabinet, do not perform other research activities in the cabinet while the centrifuge is operating.

k. Normal laboratory contamination control procedures and aseptic techniques are still necessary while working in the biological safety cabinet.

l. Equipment in direct contact with the biological agent should not be removed from the cabinet until enclosed or until the surface is decontaminated. Trays of discarded pipettes and glassware must be covered before removal from the cabinets.

m. If an accident occurs which spills or splatters the biological agent in the work area, all surfaces in the cabinet must be surface decontaminated before being removed.

n. Do not use a Bunsen Burner in a biological safety cabinet. The flame causes turbulence in the air stream and the heat generated may damage the HEPA filter. If a procedure requires the use of a flame, a burner with a pilot light should be used. It should be placed to the rear of the work space where resulting air turbulence will have a minimal effect.

o. Do not mouth pipette.

p. Following completion of the work, the following steps must be performed:

   i. Allow the cabinet to run 2-3 minutes with no activity. This will allow sufficient time for cabinet air flow to purge airborne contaminants from the work area;

   ii. Decontamination of the interior surfaces should be repeated after removal of all materials, cultures, apparatus, etc. A careful check of the work area should be made for spilled or splashed nutrients. They may support fungus growth and result in spore liberation that contaminates the protected work environment; and

   iii. Shut down by turning off the fan and lights. Use UV lights according to manufacturer's recommendations. Do not use the cabinet to store excess laboratory equipment

G. ANIMAL WORK

Plans for a biohazard program involving animals shall be submitted to the appropriate department head and reviewed and approved as necessary by the Animal Committee. All animals, equipment, and the animal room itself shall be treated as contaminated. Each animal shall be identified to indicate inoculation with infectious substances.

1. Animal Cages

   Cages used for infected animals shall be cared for in the following manner:

   a. Careful handling procedures shall be employed to minimize the dissemination of dust from cage refuse and animals.
   b. Cages shall be sterilized by autoclaving. Refuse bowls and watering devices shall remain in the cage during sterilization.
   c. All watering devices shall be of a non drip type.
   d. Each cage shall be examined each morning and at each feeding time so that dead animals can be removed.
   e. Animals in cages with shavings shall be transferred to clean cages as often as necessary. If cages have false screen platforms, the catch pan shall be replaced before it becomes full.
   f. The names of the investigators, a description of infectious agent, the date and method of administration, and an emergency telephone number shall be placed on each cage.
   g. If properly maintained, ultraviolet lamps and reflectors can prevent the airborne spread of infections between cages. Depending upon the location of the ultraviolet lamps, it may be necessary to shield the lamp to protect animals and personnel from eye damage. Protective goggles may be necessary. High efficiency spun glass filter materials used on the sides or top of a small animal cage will also prevent cross infection. Consult the Office of Environmental, Health, and Safety.
   h. Several types of ventilated cages are available and useful where airborne organisms are under investigation. Ventilated lids can be made to fit ordinary animal cages by use of air tight gaskets around the rim of the lid, which are connected to a central exhaust system through an absolute filter. Horsefall type cubicles of flexible film isolators may also be used.

2. Animal Rooms

a. Doors to animal rooms shall be kept closed at all times except for necessary entrance and exit. The doors shall be marked by a conspicuous sign, HAZARDOUS BIOLOGICAL MATERIALS. The conventional biohazard symbol shall be used.
b. Unauthorized persons shall not be permitted entry to animal rooms.
c. A container of suitable disinfectant shall be kept in each animal room for disinfecting gloves and boots and for general decontamination. Floors, walls, and cage racks shall be mop washed with a suitable disinfectant frequently.
d. Floor drains in animal rooms shall be flooded with water, glycol, or a suitable disinfectant periodically to prevent backing up of sewer gases.
e. Shavings or other refuse on floors shall not be washed down the floor drains.
f. Animal rooms shall have a licensed pest control service.
g. Special care shall be taken to prevent live animals, especially mice, from finding their way in disposable trash.
h. Animal rooms in infectious disease units shall be ventilated under negative pressure with respect to corridors or adjoining non infectious areas. Ten to fifteen changes of air per hour generally are sufficient, depending upon the species of animal. There shall be no recirculating of room air in infectious areas.
i. Use disinfectant vaporizers to decontaminate an animal room after experiments. No personnel or animals shall be in the room during this process.

3. Handling Infected Animals
   a. Special attention shall be given to the humane treatment of all laboratory animals in accordance with the Principles of Laboratory Animal Care as promulgated by the National Society for Medical Research and the National Institute of Health.
   b. Monkeys shall be tuberculin tested and examined for herpes lesions.
   c. Suitable masks and eye protection shall be worn when primates are being handled.
   d. Persons regularly handling monkeys shall receive periodic chest X ray examinations and other appropriate tuberculosis detection procedures.
   e. Heavy gloves shall be worn when feeding, watering, or removing infected animals. Under no circum-stances shall the bare hands be placed in the cage to move any object.
   f. When animals are to be injected with pathogenic material, the animal caretaker shall wear protective gloves and the laboratory workers should wear surgeon's gloves. Every effort shall be made to restrain the animal to avoid accidents that may result in disseminating infectious materials. Before and after injection of an animal, swab the site of the injection with a disinfectant.
   g. Ventilated biological safety cabinets or laminar flow biological hoods are recommended for the inoculation of animals with infectious organisms and for

necropsy of infected animals. They shall be equipped, as applicable, with viewing windows, glove ports, lights, ultraviolet lamps, an air exhaust absolute filter, and outlets for gas, air, water, and vacuum.

h. Infected animals to be transferred via public corridors shall be placed in aerosol proof containers.

4. Animal Bites
   a. If the handler receives a bite or scratch, the wound (even a superficial one) shall be scrubbed for three minutes with soap and water followed by a thorough rinsing with warm water, drying with absorbent cotton, and swabbing with 1% solution of Zephiran Chloride. The injured person shall seek medical attention promptly. If a fever develops, the handler shall report for medical attention promptly. If a fever develops, the handler shall report for medical aid and inform the doctor that he works with animals.
   b. Report any bite wounds to employees on an Employers Report of Occupational Injury or Disease Report. Students shall report bite wounds to their instructors and to the Student Health Center. Appropriate medical care shall be sought immediately.

5. Necropsy of Infected Animals
   a. Necropsy of infected animals shall be carried out in ventilated biological safety cabinets equipped with absolute exhaust filtration or special rooms with such ventilation control. The inside of the ventilated cabinet and other potentially contaminated surfaces shall be disinfected with a suitable germicide before and after the necropsy.
   b. Rubber gloves shall be worn when performing necropsies. Respiratory protection shall be used to prevent the inhalation of infectious agents.
   c. Surgeon's gowns shall be worn over laboratory clothing during necropsies.
   d. Fur of the animal shall be wet with a suitable disinfectant.
   e. Small animals shall be restrained and placed within a metal tray. Large animals shall be processed in an appropriate room designated for the purpose of necropsy.
   f. Upon completion of necropsy, all potentially contaminated material shall be placed in suitable disinfectant or left in the necropsy tray. The entire tray shall be autoclaved at the conclusion of the operation.
   g. Grossly contaminated rubber gloves shall be cleaned in disinfectant before removal from hands, preparatory to sterilization.
   h. Dead laboratory animals shall be placed in proper leak proof containers and thoroughly autoclaved before removal and incineration if zoonotic potential is present.

H. INSPECTION OF BIOSCIENCE LABORATORIES

1. Responsibilities.
   a. The assignment of inspection personnel depends upon the type of inspection and area to be covered. Safety of assigned areas is inherently the responsibility of the supervisor. To detect unsafe conditions, he/she may assign inspection duties to subordinates or use available staff inspection groups. In any event, the responsibility rests with the supervisor.
   b. Inspections of Biosafety Level 3 Recombinant DNA research labs must be performed by the Biosafety Officer. Such inspections are recommended for labs performing work with infectious agents.

2. Procedures.
   a. To help with the inspection process, an inspection report form has been developed that includes items construed to be important by the National Institute of Health, American Chemical Society, and the National Safety Council regarding safety in the bio science laboratory. (See Appendix.)
   b. Once finalized, the report shall be turned over to the department head/chairperson and a copy sent to the Office of Occupational and Environmental Safety.
   c. The department head/chairperson shall review the report and respond by taking measures necessary to comply with recommendations.
   d. It is important that the inspected area be identified by building name, department (botany, zoology, physiology, etc.), floor on which it is located, and room number. Furthermore, the area shall be identified as used for teaching, research, both, or neither as would be the case in chemical storage and/or hazardous waste holding areas.

3. Inspection Form.

a. Biological Safety: include such items as training, authorization, written emergency procedures, infectious agents, recombinant DNA procedures, accident investigations, NIH/CDC guidelines, and laboratory ventilation.
b. Fire and Explosion Safety: are items related compliance the National Fire Protection Association (NFPA) guidelines, including storage and handling of flammable chemicals, sprinkler systems, means of egress, and compressed gas cylinders.
c. General Safety Considerations: included are questions regarding the administration of the laboratory safety program, hazard communication, personal protective equipment, and electrical safety.

I. SHIPPING REQUIREMENTS AND LIMITATIONS FOR INFECTIOUS SUBSTANCES AND DIAGNOSTIC SPECIMENS

The World Health Organization document, "Guidelines for the Safe Transport of Infectious Substances and Diagnostic Specimens" is available at the EHS web site. These guidelines are applicable to the transport of infectious substances and diagnostic specimens both nationally and internationally. They provide information for identifying and classifying the material to be transported and for its safe packaging and transport. The guidelines stress the importance of developing a working relationship between the groups involved – the sender, the carrier and the receiver – in order to provide for the safe and expeditious transport of this material.

1. Definitions

For the purpose of describing transport safety measures the terms "infectious substances" and "infectious materials" are considered synonymous. The term "infectious substances" will be used in this document.

a. Infectious substances - An infectious substance is defined as a substance containing a viable microorganism, such as a bacterium, virus, rickettsia, parasite or fungus, that is known or reasonably believed to cause disease in humans or animals (This definition is taken from the current UN Recommendations on the Transport of Dangerous Goods. Prions are not included in this definition although they are considered to be infectious agents.) With respect to packaging and transport situations, infectious substances include:
   i. all cultures containing or suspected of containing an agent which may cause infection; human or animal samples that contain such an agent in quantities sufficient to cause infection, should an exposure to them occur due to a transport mishap;
   ii. sample(s) from a patient with a serious disease of unknown cause;
   iii. other specimens not included above and designated as infectious by a qualified person, e.g. a physician, scientist, nurse, etc.

b. Diagnostic specimens - A diagnostic specimen is defined as any human or animal material including, but not limited to, excreta, blood and its components, tissue and tissue fluids collected for the purposes of diagnosis, but excluding live infected animals. Diagnostic specimens resulting from medical practice and research are considered a negligible threat to the public health. Diagnostic specimens obtained from patients with suspected infectious diseases may contain limited quantities of an infectious agent. There are very few agents which may be the source of an infection

as a result of a transport mishap. If exposure to the specimen due to transport mishap could result in an infection, the diagnostic specimen must be packaged, labeled and transported as an infectious substance. Diagnostic specimens collected during an investigation of an outbreak of a serious disease of unknown cause must be handled as infectious substances.

2. Packaging, Labeling and Documentation for Transport
Because of the distinction of risks between infectious substances and diagnostic specimens, there are variations to the packaging, labeling and documentation requirements. The packaging requirements are determined by the UN and are contained in ICAO and IATA regulations in the form of Packaging Instructions (PI) 602 and 650. The requirements are subject to change and upgrade by these organizations. The current packaging requirements are described in the WHO document. UN-approved packaging systems are available commercially.

VIII. INDUSTRIAL HYGIENE

A. HAZARDOUS MATERIAL

1. Hazardous Material Information

Development, Preparedness, and Response Rules
(Act 435 of the 1985 Louisiana Legislative Regular Session)

The purpose of the Act is to insure that the hazards of all chemicals produced, imported, consumed, applied, transported, stored, or emitted in Louisiana are communicated to appropriate emergency response organizations, local information repositories, and to the general public upon request.

2. <u>HAZARD COMMUNICATION PROGRAM</u>

a. General Program Information
The purpose of this program is to make employees aware of the hazards of chemicals and provide them information on how to protect themselves. The LSU written Hazard Communication Plan can be found in the Appendix. This plan has been developed based on the OSHA Hazard Communication Standard and addresses hazardous material identification, use of material safety data sheets, employee training, and labeling.

b. Responsibilities

i. Deans, Directors, Department Chairs, Principal Investigators, Managers and Supervisors shall:

1) Comply with the specific requirements of the program.

2) Maintain a current list of chemicals in the work place. Update the list on an ongoing basis via the Internet.

3) Ensure that minimum amounts of chemicals are maintained in the workplace.

4) Ensure that MSDSs are readily available to employees.

5) Ensure that necessary physical or toxic warning signs are posted in those areas where special notices are required.

6) Ensure that each work area requiring specific personal protective equipment is posted with appropriate warning signs. Department Heads/Supervisors shall make appropriate personal protective equipment available as needed.

7) Inform any contractor working in their area of chemicals to which their employees are exposed. Contractors must reciprocate on chemicals used in their work. MSDS information shall be exchanged.

8) Train their employees regarding the chemicals in the workplace, the location and operation of controls, procedures used to protect themselves and other workers, emergency plans and location of MSDS or information related to chemicals in the workplace. (Note: Much of the above can be handled in safety meetings.)

ii. The Environmental, Health, and Safety Office is responsible for:

1) Establishment of an MSDS library/access system via the Internet.

2) Assisting departments in determining proper use, storage and labeling of chemicals.

3) Assisting departments with employee training. This shall be coordinated through the Safety and Environmental Training Officer.

4) Assessing chemical inventories provided by LSU departments and ensure that MSDSs are available via the Internet.

iii. University Stores shall:

1) Ensure that each container of a chemical received is properly labeled.

2) Ensure that each container of a chemical shipped to departments is properly labeled.

3) Ensure employees are properly trained in handling chemicals and in spill response.

iv. Employees shall:

1) Learn about the chemical and physical hazards of chemicals in their workplace and how to protect themselves.
2) Comply with the chemical safety requirements of LSU's hazard communication program and the MSDS sheets for a particular chemical.
3) Immediately report spills or suspected spills of chemicals.
4) Report any problems with storage or use of chemicals.
5) Use only those chemicals for which they have received training.
6) Use chemicals only for the tasks designated and covered in standard operating procedures, and protect other employees from these hazards.
7) Inform their supervisors of changes in operations that could affect the safety and health of the job site or work area.
8) Use personal protective equipment as specified by the MSDS.

v. Contractors' responsibilities:

1) Comply with all aspects of LSU's Hazard Communication Program and OSHA's Hazard Communication Standard, 29 CFR 1910.1200.
2) Ensure Contractor employees are properly trained.
3) Monitor and ensure proper storage and use of chemicals by Contractor employees.
4) Properly dispose of chemicals and hazardous waste.

c. Training Program

Department Heads/Supervisors shall provide training to affected employees annually, or when changes in operations warrant. Environmental, Health, and Safety can assist in this effort. The training shall include the following points:

i. Physical and health hazards of the chemicals or materials in the workplace and all information on the MSDS that may affect employees.
ii. Methods that may be used to detect the presence of a chemical or material by visual appearance, odor, irritation (skin, headaches, coughing).
iii. Measures used to protect the employee (engineering design, barriers, ventilation, operating procedures, special training, etc.).
iv. Measures employees can take to protect themselves from exposure (work practices, respiratory equipment, eye protection, other personal protective equipment, special training, etc.).
v. Details of the Hazard Communication Program.

An outline of a hazard communication training program is contained in the appendix.

B. INDOOR AIR QUALITY AND SANITATION

1. Indoor Air Quality Rules

Staff, faculty and students can assist in controlling indoor air quality by following the guideline below:

a. Cap chemical containers when not in use.

b. Clean up spills of chemical or waste products immediately.

c. Report need for repairs to facilities and equipment which introduce mold/mildew into the building, such as a leaking roofs, pipes, drains, etc.

d. Conduct experiments which pollute the indoor air either inside hoods, or outside the building.

e. Prevent outdoor air contamination from entering buildings. (Example: during roofing operations, close vents and windows.)

f. Maintain rooms, especially carpets and floors, in clean, sanitary condition at all times.

g. Assure trash is collected and emptied frequently.

h. Report problems with air quality to supervisor/EHS.

Warn occupants and work out necessary arrangement to prevent exposure before painting, treating, or demolition which may affect indoor air quality.

2. HOUSEKEEPING

Inadequate housekeeping can cause indoor air quality problems -- buildings should be kept clean. Also, cleaning materials themselves may be pollutant sources that produce odors and emit a variety of chemicals. Select cleaning methods that are effective for the given need. Read product labels and Material Safety Data Sheets (MSDS) on all cleaning products used in buildings. The housekeeping staff will be the most highly exposed to the chemicals in cleaning products. Buy products with the least adverse impact on human health.

a. Housekeeping Specific Steps

   i. Prepare and follow written housekeeping procedures that detail the proper use, storage and purchase of cleaning materials.

   ii. Be aware of the housekeeping products and equipment used in buildings, particularly those that are potential irritants or have other IAQ impacts.

iii. Purchase the safest available housekeeping products that meet cleaning needs.

iv. Educate housekeeping staff or contractors about proper use of cleaning materials, cleaning schedules, purchasing, materials storage and trash disposal.

b. Training

It is important that the housekeeping staff, whether they are in-house staff or contractors, be trained on how your housekeeping procedures and products may affect IAQ. In fact, OSHA's Hazard Communication Standard (29 CFR 1910.1200) requires employers to explain the labels and MSDSs of all hazardous chemicals used, even infrequently, by an employee, and to train those employees in how to protect themselves from emergencies.

3. HVAC Preventive Maintenance

A written preventive maintenance program is an effective tool for improving IAQ. The plan should include monitoring, inspecting and cleaning HVAC components such as outside air intakes, outside air dampers, air filters, drain pans, heating and cooling coils, the interior of air handling units, fan motors and belts, air humidification, controls and cooling towers.

a. Preventive Maintenance Specific Steps

   i. Develop and follow a preventive maintenance plan that includes maintenance schedules. Activities in the plan should include:

      1) Inspect outside air dampers for nearby sources of contamination,
      2) Ensure that air dampers are clear of obstruction and operating properly,
      3) Regularly replace or clean air filters,
      4) Clean and inspect drain pans,
      5) Inspect and clean heating and cooling coils,
      6) Inspect and clean as warranted interior of air handling units,
      7) Inspect fan motors and belts,
      8) Regularly inspect and clean air humidification equipment and controls,
      9) Inspect, clean and treat cooling towers, and
      10) Inspect and clean as needed air distribution pathways and variable air volume (VAV) boxes.

   ii. Update your maintenance plan when equipment is added, removed or replaced.

b. The frequency of maintenance activities may vary from building to building. It is important to develop a maintenance schedule based on the needs of the equipment and building. However, the schedule should ensure that all equipment is in good, sanitary condition and is operating as close to design set points as possible.

4. Basics for Handling Food Safely

Safe steps in food handling, cooking, and storage are essential to avoiding foodborne illness. You can't see, smell, or taste bacteria which may be on any food. Follow these food safety guidelines to keep pathogens away.

a. Safe Shopping
   i. Buy cold food last; get it home fast.
   ii. Never choose packages which are torn or leaking.
   iii. Don't buy foods past "sell-by" or expiration dates.
   iv. Put raw meat and poultry into a plastic bag so meat juices won't cross- contaminate cooked foods or those eaten raw, such as vegetables or fruit.
   v. Place refrigerated or frozen items in the shopping cart last, right before heading for the checkout counter.
   vi. When loading the car, keep perishable items inside the air- conditioned car -- not in the trunk.
   vii. Drive immediately home from the grocery. If you live farther away than 30 minutes, bring a cooler with ice from home; place perishables in it.

b. Safe Storage of Foods
   i. Keep it safe; refrigerate.
   ii. Unload perishable foods from the car first and immediately refrigerate them. Place securely wrapped packages of raw meat, poultry, or fish in the meat drawer or coldest section of your refrigerator.
   iii. Check the temperature of your unit with an appliance thermometer. To slow bacterial growth, the refrigerator should be at 40 °F; the freezer, 0 °F.
   iv. Cook or freeze fresh poultry, fish, ground meats, and variety meats within 2 days; other beef, veal, lamb, or pork, within 3 to 5 days.

c. Safe Food Preparation
   i. Keep everything clean!
   ii. Wash hands before and after handling raw meat and poultry.
   iii. Sanitize cutting boards often in a solution of 1 teaspoon chlorine bleach in 1 quart of water. Wash kitchen towels and cloths often in hot water in washing machine.
   iv. Don't cross-contaminate. Keep raw meat, poultry, fish, and their juices away from other food. After cutting raw meats, wash hands, cutting board, knife, and counter tops with hot, soapy water.
   v. Marinate meat and poultry in a covered dish in the refrigerator.

d. Thaw Food Safely
   i. Refrigerator: Allows slow, safe thawing. Make sure thawing juices do not drip on other foods.
   ii. Cold Water: For faster thawing, place food in a leak-proof plastic bag and submerge in cold tap water.
   iii. Microwave: Cook meat and poultry immediately after microwave thawing.

e. Safe Cooking

Cook ground meats to 160 °F; ground poultry to 165 °F. Beef, veal and lamb steaks, roasts, and chops may be cooked to 145 °F; all cuts of fresh pork, 160 °F. Whole poultry should reach 180 °F in the thigh; breasts, 170 °F.

f. Serving Food Safely

i. Never leave it out over 2 hours. (1 hour in temperatures above 90 °F)

ii. Bacteria that cause foodborne illness grow rapidly at room temperature.

iii. Keep hot food hot! Cold food cold!

iv. When serving food at a buffet, keep hot food over a heat source and keep cold food on ice. Keep platters of food refrigerated until time to serve or heat them.

v. Carry perishable picnic food in a cooler with a cold pack or ice. Set the cooler in the shade and open the lid as little as possible.

g. Handling Leftovers Safely

i. Divide foods into shallow containers for rapid cooling. Put food directly in the refrigerator or freezer.

ii. Cut turkey off the bone and refrigerate. Slice breast meat; legs and wings may be left whole.

iii. Use cooked leftovers within 4 days.

h. Refreezing Food

Meat and poultry defrosted in the refrigerator may be refrozen before OR after cooking. If thawed by other methods, cook before refreezing.

E. ILLUMINATION FOR OCCUPATIONAL TASKS

1. BACKGROUND

Glare, diffusion, direction, uniformity, brightness, color, and brightness ratios affect visibility and the ability to see easily, accurately, and quickly. Poor lighting is uncomfortable and possibly hazardous. The desirable quantity of light for any particular installation depends primarily upon the work that is being done. As the illumination of the task is increased, the ease, speed, and accuracy of accomplishing it are also increased. Following are two tables of levels of illumination for industrial areas as recommended by the American National Standard A11.1 "Practice for Industrial Lighting." The Office of Environmental, Health, and Safety will perform lighting measurements upon request.

RECOMMENDED MAXIMUM LUMINANCE RATIOS				
		Environmental Classification		
		A	**B**	**C**
1	Between task and adjacent darker surroundings	3 to 1	3 to 1	5 to 1
2	Between tasks and adjacent lighter surroundings	1 to 3	1 to 3	1 to 5
3	Between tasks and more remote darker surfaces	10 to 1	20 to 1	*
4	Between tasks and more remote lighter surfaces	1 to 10	1 to 20	*
5	Between luminaires (or windows, skylights, etc.) and surfaces adjacent to them	20 to 1	*	*
6	Anywhere within normal field of view	40 to 1	*	*

*

Brightness Ratio control not practical.

A -- Interior Areas where reflectances of entire space can be controlled in line with recommendations for optimum seeing conditions.

B -- Areas where reflectances of immediate work area can be controlled, but control of remote surroundings is limited.

C -- Areas (indoor and outdoor) where it is completely impractical to control reflectances and difficult to alter environmental conditions.

NOTE: From the normal view point, brightness ratios of areas of appreciable size in industrial areas shall not exceed those in the above table.

Recommended Reflectance Values Applying to Environmental Classifications A and B	

	Reflectance (%)**
Ceiling	80 to 90
Walls	40 to 60
Desk and bench tops, machines and equipment	25 to 50
Floors	not less than 20

** Reflectance should be maintained as near as practical to recommended values.

LEVELS OF ILLUMINATION RECOMMENDED FOR SAMPLE OCCUPATIONAL TASKS

Area	Foot-Candles
Assembly-rough, easy seeing	30
Assembly-medium	100
Building construction-general	10
Corridors	20
Drafting Rooms-detailed	200
Electrical equipment, testing	100
Elevators	20
Garages-repair areas	100
Garages-traffic areas	20
Inspection, ordinary	50
Inspection, highly difficult	200
Loading platforms	20
Machine shops-medium work	100
Materials-loading, trucking	20
Offices-general areas	100
Paint dipping, spraying	50
Service spaces-wash rooms, etc.	30

Sheet metal-presses, shears	50
Storage rooms-inactive	5
Storage rooms-active, medium	20
Welding-general	50
Woodworking-rough sawing	30

1 foot-candle=10.76 lux.

From: A132.1-1973, Office Lighting.

2. Definitions

Footcandle - A unit of illuminance on a surface that is everywhere 1 foot from a point source of light of one candle and equal to one lumen per square foot.

Illumination Level - The quantity or amount of light falling on a surface usually expressed in foot candles.

Intensity (Luminous Intensity) - The quantity of light a source gives off in a given direction expressed in candela (formerly "candle").

Lamp - any man-made light source.

Lumen - The flux falling on a surface of one square foot in area, every part of which is one foot from a point source having a luminous intensity of one candela (candlepower) in all directions.

Luminaire - A complete lighting device consisting of lamps and parts to distribute the light.

Luminance (Photometric Brightness) - The amount of light emitted and reflected from an area of a surface measured in footlamberts. A surface emitting one lumen per square foot has a luminance of one footlambert.

Reflectance - A measure of how much light is reflected from a surface. It is the ratio of luminance to illumination.

F. HOT ENVIRONMENTS

When the rate of heat transfer from the body by convection, radiation, and sweat evaporation is not adequate, then warming of the body occurs. Excessive warming of the body can lead to heat stroke which can be fatal unless treated promptly and properly. Other consequences of heat stress include heat exhaustion, heat cramps, and heat rashes. All employees who work in hot environments shall be trained in the recognition of heat stress warning signs and the appropriate emergency treatments should symptoms occur.

1. HEAT CRAMPS

Heat cramps are the least severe of the three heat-related illnesses. They are often the first signal that the body is having trouble with the heat. Heat cramps are painful muscle spasms that usually occur in the legs and abdomen. If a person has heat cramps, take them to a cool place, loosen clothing, and give cool water or a commercial sports drink. Allow the person to drink about one glass of liquid every 15 minutes. With rest and fluids, the person should recover quickly and be able to resume activity. Keep the person drinking fluids and watch for any further signs of heat-related illness.

2. HEAT EXHAUSTION

Heat exhaustion is more serious than heat cramps. Symptoms include cool, moist, pale or flushed skin, headache, nausea, dizziness, weakness and exhaustion. As with heat cramps, get the person to a cool place and loosen the victim's clothing. Give plenty of fluids to a heat exhaustion victim. Apply cool, wet compresses to cool the person.

3. HEAT STROKE

Heat stroke is the most severe heat condition. It develops when the body systems become overwhelmed by heat and begin to stop functioning. Heat stroke is a serious medical emergency. The signals include red, hot, dry skin; changes in consciousness; rapid, weak pulse; and rapid, shallow breathing. Work to cool the person, as in the other two heat-related illness, but also call for medical help. Refusing water, vomiting and changes in consciousness indicate the person's condition is worsening. Get medical attention immediately. If the person vomits, do not give any more fluids and put him on his side. This prevents the possibility of the person choking on his vomit. Watch for breathing problems and keep the victim lying down. Cool the body as much as possible. Place cool, wet cloths or ice packs on the victim's wrists, ankles, on the groin area, armpits and neck to cool the large blood vessels. Do not apply rubbing alcohol.

4. HEAT RASHES

Heat rashes are the most common problem in hot work environments. Prickly heat is manifested as red papules and usually appears in areas where the clothing is restrictive. As sweating increases, these papules give rise to a prickling sensation. Prickly heat occurs in skin that is persistently wetted by sweat, and heat rash papules may become infected if they are not treated. In most cases, heat rashes will disappear when the affected individual returns to a cool environment.

G. ERGONOMICS

Preventing Work-Related Musculoskeletal Disorders (WMSDs)

1. <u>WHY ARE WMSDS A PROBLEM?</u>

Work-related musculoskeletal disorders occur when there is a mismatch between the physical requirements of the job and the physical capacity of the human body. More than 100 different injuries can result from repetitive motions that produce wear and tear on the body. Back pain, wrist tendinitis and carpal tunnel syndrome may all stem from work-related overuse. Specific risk factors associated with WMSDs include repetitive motion, heavy lifting, forceful exertion, contact stress, vibration, awkward posture and rapid hand and wrist movement.

2. RULES TO PREVENT WMSDS

a. Look at injury and illness records to find jobs where problems have occurred.
b. Talk with workers to identify specific tasks that contribute to pain and lost workdays.
c. Ask workers what changes they think will make a difference.
d. Encourage workers to report WMSD symptoms and establish a medical management system to detect problems early.
e. Find ways to reduce repeated motions, forceful hand exertions, prolonged bending or working above shoulder height.
f. Reduce or eliminate vibration and sharp edges or handles that dig into the skin.
g. Rely on equipment-not backs-for heavy or repetitive lifting.
h. Keep physically fit, maintain good muscle tone. Exercise at desk or work station.

3. SIMPLE SOLUTIONS OFTEN WORK BEST

Workplace changes to reduce pain and cut the risk of disability need not cost a fortune. For example:

a. Change the height or orientation of the product, such as using knives with curved handles to prevent bending wrists unnaturally for a particular task.
b. Provide lifting equipment to prevent back strain when working alone.
c. Offer workers involved in intensive keyboarding more frequent short breaks to rest muscles.
d. Vary tasks to avoid repeated stress for the same muscles.

4. CONTACT EHS FOR ASSISTANCE

EHS can review a particular task or operation that may be troublesome upon request.

I. RESPIRATORY PROTECTION PROGRAM

1. GENERAL

Where engineering controls are not feasible in completely controlling exposure to dusts, mists, or chemical agents, Louisiana State University encourages the use of respirators for protection from inhalation of these products. In some instances OSHA regulations may require the use of a respirator due to potential overexposure to a particular agent. In most instances, however, the use may be recommended to provide comfort or added protection to the individual. This added protection is the choice of the individual and constitutes "voluntary" protection.

2. GENERAL PROGRAM MANAGEMENT - RESPONSIBILITIES

The respiratory protection program is provided in the appendix. In general, EHS provided technical support, departmental managers and directors are responsible for implementation of the program, and employees are responsible for following the requirements of the program.

3. VOLUNTARY USE

Voluntary respirator use applies if the employees are not exposed to hazardous agents above the permissible exposure limits, or they are not emergency responders. Voluntary use of respirators is encouraged by Louisiana State University to prevent inhalation of small amounts of potentially harmful agents that are not considered to be at hazardous levels as defined by OSHA. If the responsible person decides that respirator use is permitted, that person must ensure that the voluntary user is given the information in Appendix D of this program ("Information for Employees Using Respirators When Not Required Under the Standard"). EHS also recommends that a medical evaluation is accomplished, and that the respirator is cleaned, stored, and maintained so that its use does not present a health hazard to the employee. If employees use filtering facepiece respirators (dust masks), a medical evaluation is not required.

4. RESPIRATOR SELECTION

Respirator use is work place specific. Respirators shall be assigned to individuals based upon the following their job requirements and the hazards to which the individual is exposed. Contact EHS for assistance in respirator selection. More details of respirator selection requirements are contained in the appendix.

5. MEDICAL EVALUATION

A medical evaluation is required of those individuals required to wear a respirator, and recommended for those individuals using a respirator on a voluntary basis. Those wearing a filtering facepiece respirator (dust mask) do not need an evaluation. The evaluation consists

primarily of filling out a questionnaire for review by a medical practitioner. Details are in the appendix.

J. NOISE

1. TECHNICAL INFORMATION

   a. OSHA permits noise exposures up 90 decibels, averaged over an 8-hour period. Noise levels are measured on the A scale of a standard sound level meter and are expressed as dBA.

   b. Paragraph 1910.95(c) of the 1983 Hearing Conservation Amendment to the Occupational Noise Exposure Standard requires employers to administer a continuing, effective hearing conservation program for all employees whose noise exposures equal or exceed an 8-hour TWA (time-weighted average) of 85 dBA or, equivalently, a noise dose that is equal to 50 percent of the PEL. The standard requires that all continuous, intermittent, and impulsive sound levels from 80 dB to 130 dB be included in the measurement of dose. In other words, the threshold level for noise measurement purposes is 80 dB.

   c. Dosimeters can be used to calculate both the continuous equivalent A-weighted sound level (L_A) and the 8-hour TWA for the time period sampled.

2. EFFECTS

   a. Auditory Effects

      i. Chronic noise-induced hearing loss is a permanent sensorineural condition that cannot be treated medically. It is initially characterized by a declining sensitivity to high-frequency sounds, usually at frequencies above 2,000 Hz.

      ii. Exposure of a person with normal hearing to workplace noise at levels equal to or exceeding the PEL may cause a shift in the worker's hearing threshold. Such a shift is called a standard (or significant) threshold shift and is defined as a change in hearing thresholds of an average 10 dB or more at 2,000, 3,000, and 4,000 Hz in either ear. Workers experiencing significant threshold shifts are required by 29 CFR 1910.95(g)(8) to be fitted with hearing protectors and to be trained in their use.

   b. Extra-auditory Effects. In addition to effects on hearing, noise:

      Interferes with speech;

      Causes a stress reaction;

      Interferes with sleep;

      Lowers morale;

      Reduces efficiency;

      Causes annoyance;

Interferes with concentration; and

Causes fatigue.

c. Noise/Hearing Loss

Noise-induced loss of hearing is an irreversible, sensorineural condition that progresses with exposure. Although hearing ability declines with age (presbycusis) in all populations, exposure to noise produces hearing loss greater than that resulting from the natural aging process. This noise induced loss is caused by damage to nerve cells of the inner ear (cochlea) and, unlike some conductive hearing disorders, cannot be treated medically.

3. STANDARDS

a. Time-weighted average (TWA) noise limits as a function of exposure duration are shown on the following table.

b. The OSHA regulation has an additional action level of 85 dB(A) which stipulates that an employer shall administer a continuing, effective hearing conservation program when the TWA value exceeds the action level. The program must include monitoring, employee notification, observation, an audiometric testing program, hearing protectors, training programs, and recordkeeping requirements.

c. The OSHA noise standard also states that when workers are exposed to noise levels in excess of the OSHA PEL of 90 dB(A), feasible engineering or administrative controls shall be implemented to reduce the workers' exposure levels. Also, a continuing, effective hearing conservation program shall be implemented.

Duration of Exposure (hrs/day)	**Sound Level - dB(A)**		
	ACGIH	**NIOSH**	**OSHA**
16	82	82	85
8	85	85	90
4	88	88	95
2	91	91	100
1	94	94	105

1/2	97	97	110
1/4	100	100	115*
1/8	103	103	---

* No exposure to continuous or intermittent noise in excess of 115 dB(A).

** Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

*** No exposure to continuous, intermittent, or impact noise in excess of a peak C-weighted level of 140 dB.

4. PROGRAM REQUIREMENTS FOR OCCUPATIONAL NOISE EXPOSURE

a. Monitoring

The hearing conservation program requires employers to monitor noise exposure levels in a manner that will accurately identify employees who are exposed to noise at or above 85 decibels (dB) averaged over 8 working hours, or an 8-hour time-weighted average (TWA.) Under this program, employees are entitled to observe monitoring procedures and they must be notified of the results of exposure monitoring. Instruments used for monitoring employee exposures must be carefully checked or calibrated to ensure that the measurements are accurate.

b. Noise - Training Information

Supervisors and exposed workers must become aware of and understand about the adverse effects of noise and how to prevent noise-induced hearing loss. People exposed to hazardous noise must take positive action, if progressive permanent hearing loss is to be prevented. Each exposed worker and supervisor should know the following.

i. Noise exposure may result in permanent damage to the auditory system and there is no medical or surgical treatment for this type of hearing loss.

ii. Each person should know how to recognize hazardous noise even if a noise survey has not been conducted an/or warning signs posted.

iii. Preventing noise-induced hearing loss is accomplished by reducing both the time and intensity of exposure. Reducing exposure time is accomplished by avoiding any unnecessary exposure to loud sound. Reducing intensity is usually accomplished by wearing personal hearing protection. Each person must be able to properly wear and care for the particular type of hearing protection selected.

iv. Each person must know how to tell if they have been overexposed to loud sound. Overexposure may occur even while wearing hearing protection. Earplugs and/or earmuffs alone may not be enough protection. Each time a temporary threshold shift (TSS) occurs, a certain degree of permanent loss results. The recognizable symptoms of overexposure are described as "dullness in hearing or ringing in the ears."

c. General Program Management

i. Deans, Directors, Department Chairs, Principal Investigators, Managers and Supervisors are responsible for ensuring that noise hazards which may contribute to occupational hearing loss in there areas are evaluated.

ii. Occupational & Environmental Safety is responsible for:

1) Monitoring and evaluating noise sources upon request.

2) Providing training for potentially noise exposed individuals upon request.

iii. Workers responsibilities include the following:

1) Learn about the potential hazards of noise exposure and follow the rules when around or operating noisy equipment.

2) Wear or use prescribed protective equipment.

3) Refrain from operating equipment without proper training or equipment that has

safety defects.

4) Attended training sessions for hazardous noise exposures.

5) Be aware of the noise producing capabilities of equipment they are around or use.

IV. PERSONAL PROTECTION PROGRAM

This section applies to employees and students on campus construed to be in need of personal protective equipment by virtue of their exposure to hazards in the working, teaching, or research environment. Protective equipment shall be used and maintained in sanitary and reliable condition. Under no circumstances shall a person knowingly be subjected to a hazardous condition without appropriate personal protective equipment. Persons who are exposed to hazards requiring personal protective equipment shall be properly instructed in the use of such equipment by the individual in charge of the activity or his/her designee. It is the responsibility of the individual in charge of the activity to assure that safety practices are adhered to. If those individuals required to wear personal protective equipment fail to do so, they will be subject to disciplinary action.

A. EYE PROTECTION

1. GENERAL

a. Persons working in or studying occupations such as painting, carpentry, construction, labor, landscape, general maintenance, metal trades, chemistry, other sciences and engineering, or any work/study activity which involves hazards such as flying objects, dust and/or vapors, hot metals, chemicals, or light radiation shall wear approved safety eyewear/goggles at all times while exposed.

b. Custodial workers shall wear approved safety eyewear/goggles when cleaning bathroom appliances or mopping floors with caustic or abrasive cleaners.

c. Management level employees, students, or visitors who make occasional visits to machine, welding, and carpentry shops, boiler rooms, equipment rooms, power houses, construction areas, chemistry labs, or other areas in which eye injury is a possibility shall wear approved eyewear.

2. PRESCRIPTION LENS WEARERS

If required to wear eye protection, such persons shall wear an approved face shield, goggles that fit over glasses, prescription glasses with protective optical lenses fitted with side shields, or goggles that incorporate prescription lenses.

3. CONTACT LENS WEARERS

Contact lenses shall never be considered as a substitute for eye protection; eye protection shall be worn over them.

4. APPROVAL AND SELECTION:

a. Eye protection shall meet the ANSI Z87.1-1989 standard and the eyewear shall indicate such on the lens or the frame.

b. Visitors to hazardous areas shall be provided protective eyewear meeting ANSI Z87.1 protection factors for visitor's eyewear.

c. Selection chart for eye and face protectors:

This selection chart offers general recommendations only. Final selection of eye and face protective devices is the responsibility of management and safety specialists. (For laser protection, refer to American National Standard for Safe Use of Lasers, ANSI Z136.1-1976.)

SELECTION CHART FOR EYE AND FACE PROTECTORS FOR USE IN INDUSTRY, SCHOOLS, AND COLLEGES

1. GOGGLES--Flexible fitting, regular ventilation.

2. GOGGLES--Flexible fitting, hooded ventilation.

3. GOGGLES--Cushioned fitting, rigid body.

4. SPECTACLES*--Without side shields.

5. SPECTACLES--Eyecup type side shields.

6. SPECTACLES--Semi-/Flat-fold side shields.

7. WELDING GOGGLES--Eyecup type, tinted lenses (illustrated).

7A. CHIPPING GOGGLES--Eyecup type, clear safety lenses (not illustrated).

8. WELDING GOGGLES--Cover spec type, tinted lenses (illustrated).

8A. CHIPPING GOGGLES--Cover spec type, clear safety lenses (not illustrated).

9. WELDING GOGGLES--Cover spec type, tinted plate lens.

10. FACE SHIELD--Plastic or mesh window (see caution note).

11. WELDING HELMET*

*Non-side shield spectacles are available for limited hazard use requiring only frontal protection.

Operation	**Hazards**	**Protection**
Acetylene-Burning	Sparks, harmful rays, molten metal, flying particles	7,8,9
Acetylene-Cutting		
Acetylene-Welding		
Chemical Handling	Splash, acid burns, fumes	2 (for severe exposure, add 10)
Chipping	Flying particles	1,3,4,5,6,7A,8A
Electric (Arc) - Welding	Sparks, intense rays, molten metal	11 (in combination with 4,5,6 in tinted lenses, advisable)
Furnace Operations	Glare, heat, molten metal	7,8,9 (for severe exposure, add 10)
Grinding-Light	Flying particles	1,3,5,6 (for severe exposure, add 10)
Grinding-Heavy	Flying particles	1,3,7A,8A (for severe exposure, add 10)
Laboratory	Chemical splash, glass breakage	2 (10 when in combination with 5,6)
Machining	Flying particles	1,3,5,6 (for severe exposure, add 10)

Molten Metals	Heat, glare, sparks,	7,8 (10 in combination with 5,6, in tinted lenses)
Spot Welding	Flying particles	1,3,4,5,6 (tinted sparks lenses advisable; for severe exposure add 10)

CAUTION:
* Face shields alone do not provide adequate protection.
* Plastic lenses are advised for protection against molten metal splash.
* Contact lenses, of themselves, do not provide eye protection in the industrial sense and shall not be worn in a hazardous environment without appropriate covering safety eyewear.

5. INSPECTION AND MAINTENANCE

All eye and face protection shall be kept clean and inspected daily before each use. Badly scratched or damaged items are to be replaced immediately.

6. OTHER

It is recommended that all employees required to wear eye and face protection shall have their own and be required to inspect and maintain them in accordance with this section.

B. HEARING PROTECTION

1. EMPLOYEES/STUDENTS COVERED

Hearing protection shall be worn by employees/students when noise exposure is above that of the 90dB when measured on the A-scale of the standard sound level meter at slow response. An employees/students may also be required to wear hearing protection if hearing loss is demonstrated during audiometric testing. Audiometric testing is required at 85dBA of noise exposure and the employees/students is placed in the hearing conservation program.

2. APPROVAL AND SELECTION

a. Personal hearing protection devices shall meet ANSI 53.19.

b. Selection of hearing protection shall take into consideration durability, ease of fit, noise calculations in area, and length of time to be worn.

c. There are many types of disposable and permanent hearing protection. Listed below are three:

i. *Earmuffs*: fluid or foam-filled cushions connected by a plastic or metal band that fits over the head. They reduce noise levels by 35-40dB depending on type and fit. In order for them to be effective, a perfect seal must be formed. Glasses, long side burns, and facial movements can reduce protection.

ii. *Ear Plugs*: the most commonly used ear protection device. They come in many different shapes, sizes, and materials. Ear plugs can be purchased as disposables, preformed, or molded (professionally fitted). They reduce noise levels by 25-30dB depending on type and fit. Cotton is ineffective as ear plugs.

iii. *Ear Caps*: a cross between ear muffs and ear plugs--ear plugs connected to a plastic (usually) band which can be worn under the chin, over the top of the head, or behind the neck. They reduce noise levels by 25-35dB depending on type and fit.

NOTE: Combinations or ear plugs and ear muffs can reduce noise level be an additional 3-5dB depending on type and fit.

3. FITTING

Preformed ear plugs have to be professionally fitted. All others are fitted according to need in accordance with LSU's hearing conservation and evaluation program.

4. INSPECTION AND MAINTENANCE

All ear protection, if not disposable, shall be inspected and cleaned before each use. All damaged ear protection shall be discarded and replaced. No unauthorized modifications shall be allowed.

5. OTHER

Noise measurements shall be performed by the Office of Occupational and Environmental Safety personnel. Noise studies shall be authorized by the Office of Occupational and Environmental Safety.

C. HAND PROTECTION

1. EMPLOYEES/STUDENTS COVERED

Hand protection shall be worn by employees when handling hot work, chemicals, electrical, material handling of rough and/or sharp items, doing landscaping work, welding, and "wherever it is necessary by reason of hazards of processes of environmental, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment." (OSHA 1910 Standards)

Hand protection shall not be worn while working on moving machinery such as drill saws, grinders, or other rotating and moving equipment that might catch the hand protection and pull the worker's hand into a hazardous area.

2. APPROVAL AND SELECTION

Hand protection used will meet the criteria for its particular use. Consult with EHS for assistance in selection as required. The EHS web site contains chemical resistance charts for glove selection. Other factors such as durability, dexterity, and frequency and ease of donning and removing gloves are also important factors in glove selection.

3. FITTING

Gloves shall be selected to fit comfortably and snugly.

4. INSPECTION AND MAINTENANCE

All hand protection shall be kept clean and inspected daily before each use. Badly worn or damaged items are to be replaced.

5.. GLOVE MATERIALS

NOTE: For Glove selection, consult the Environmental, Health, and Safety Web Page or contact EHS.

To assure resistance to a particular chemical, the user should rely upon chemical permeation and resistance data conducted by the manufacturer. Manufacturers may show different data for the same glove material.

a. Liquid Proof Styles

i. *Butyl (cement**) Highest resistance to permeation by most gases and water vapor.

ii. *Viton (cement**) Exceptional performance when subjected to chlorinated and aromatic solvents, coupled with excellent resistance to permeation by many vapors.

iii. *Nitrile (latex**) Superior puncture and abrasion resistance. Recommended as a general duty glove. Excellent resistance to the degrading effects of fats, petroleum products, and a wide array of chemicals.

iv. *Natural Rubber* Excellent resistance to the degrading (cement*) effects of alcohols and caustics. Ideal for use in sand blasting.

v. *PVC Coated* Excellent abrasion resistance in a liquid-proof glove. Also provides cushioning.

* Cement and Latex refer to two basic manufacturing processes of unsupported liquid proof gloves. As a general rule, cement dip gloves exhibit greater resistance to liquid

and vapor permeation than do Latex dipped gloves. Therefore, where a permeation barrier is required, a cement dip glove shall be selected.

a. General Purpose: Fabrics And Coatings

i. Worknit® Combines the toughness of a nitrile coating with the softness and stretchy comfort of jersey.

ii. Worknit HD™ Developed and designed to replace leather and/or heavy cotton gloves, the HD fabric has a heavier cotton liner than the regular Worknit. This glove is best used where a tough job requires a product which provides protection, excellent wear, comfort, and value.

iii. Coated Machine Knits

Unique, economical answer to the general purpose glove. Offers comfort and long wear. Four wearing surfaces instead of two. Superior grip and abrasion resistance.

1) *Grip-N®, Grip-N® Hot Mill, Double™ Grip-N® (1.)Reversibility (2.)N-tread PVC coating.*

2) *Clean Grip™ (1.)Reversible (2.)Large. Soft PVC Dots*

iv. Impregnated Wovens and Jerseys

1) *Newtex* Woven cloth for strength. Coating for abrasion resistance.

2) *PVC Dotted Canton and Jersey*. The original coated glove. Cool, comfortable cotton, permanently "dotted" for longer wear and better grip.

v. Uncoated Knit Fabrics Machine Knit (string glove). 100% cotton. They are cool, comfortable, and the lowest-priced glove on the market.

vi. General Purpose: Leather

1) *Side Split Leather* Superior combination of strength, thickness and suppleness in split cowhide leather. A minimum of flaws, scars, and weaknesses, provides longer wear and comfort.

2) *Shoulder Split Leather* Provides cushioning and abrasion resistance in a more economical grade of leather.

3) *Grain Leather* Better flexibility, finger dexterity and fit than split leather. Generally more comfortable, but less durable than split leather.

D. RESPIRATORY PROTECTION PROGRAM

1. GENERAL PROGRAM REQUIREMENTS

See Industrial Hygiene Section and appendix for details of the program.

2. RULES FOR RESPIRATOR PROGRAM

a. If a respirator is required by an OSHA standard or due to overexposure to a contaminant in the workplace, all of the requirements of the respirator program must be met, including medical evaluation, fit testing, maintenance, and program management.

b. If a respirator is required by the organization (i.e., director, manager, supervisor, principle investigator), all of the requirements of the respirator program must be met, including medical evaluation, fit testing, maintenance, and program management.

c. If respirator use is voluntary, EHS recommends having a medical evaluation, fit testing, and maintenance. Dust masks do not require a medical evaluation or fit testing.

   Note: Voluntary respirator use applies if the employees are not exposed to hazardous agents above the permissible exposure limits, they are not emergency responders, or they are not required by the organization. Voluntary use of respirators is encouraged by Louisiana State University to prevent inhalation of small amounts of potentially harmful agents that are not considered to be at hazardous levels as defined by OSHA.

d. If a respirator is required use as a member of an emergency team, all of the requirements of the respirator program must be met, including medical evaluation, fit testing, maintenance, and program management.

3. FIT TESTING

a. Before using a respirator an employee must be fit tested with the same make, model, style, and size of respirator that they will be wearing.

b. A qualitative fit test (QLFT) or quantitative fit test (QNFT) according to Appendix A of the attachment must be used.

c. Air supplied or powered air purifying (PAPR) respirators must also use the fit test techniques of Appendix A of the attachment by adapting the facepieces to negative air respirators or using an identical negative air respirator as a surrogate.

4. RULES FOR MAINTENANCE, CARE AND USE OF RESPIRATORS

(Does not apply to dust masks)

a. Change filter cartridges or dispose of respirator in accordance with breakthrough times recommended by the manufacturer.

b. Clean facepieces periodically to maintain hygienic conditions using the manufacturer's recommended cleaning product (or isopropyl alcohol, or suitable disinfectant). Emergency use respirators, respirators used by more than one person, and fit test respirators are to be cleaned after each use.

c. Perform field fit check before each use (see appendix for procedure).

d. Facial hair and glasses shall not interfere with respirator fit.

e. Inspect respirators before each use and replace if defective.

f. Store respirators to prevent contamination, moisture, or damage.

5. BREATHING AIR QUALITY AND USE.

a. Compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration shall comply with the following specifications:

   i. Compressed and liquid oxygen shall meet the United States Pharmacopoeia requirements for medical or breathing oxygen; and

   ii. Compressed breathing air shall meet at least the requirements for Type 1-Grade D breathing air described in ANSI/Compressed Gas Association Commodity Specification for Air, G– 7.1–1989, to include:

      1) Oxygen content (v/v) of 19.5– 23.5%;

      2) Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;

      3) Carbon monoxide (CO) content of 10 ppm or less;

      4) Carbon dioxide content of 1,000 ppm or less; and

      5) Lack of noticeable odor.

b. Cylinders used to supply breathing air to respirators shall meet the following requirements:

   i. Cylinders are tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR part 173 and part 178);

ii. Cylinders of purchased breathing air have a certificate of analysis from the supplier that the breathing air meets the requirements for Type 1—Grade D breathing air; and

iii. The moisture content in the cylinder does not exceed a dew point of ´50 °F (´45.6 °C) at 1 atmosphere pressure.

c. Do not use oil-lubricated compressors.

d. Breathing gas containers marked in accordance with the NIOSH respirator certification standard, 42 CFR part 84, shall be used.

6. IDENTIFICATION OF FILTERS, CARTRIDGES, AND CANISTERS.

All filters, cartridges and canisters used in the workplace shall be labeled and color coded with the NIOSH approval label and that the label is not removed and remains legible.

7. TRAINING AND INFORMATION

Effective training must be provided to employees who are required to use respirators. The training must be comprehensive, understandable, and recur annually, and more often if necessary. Employees who wear respirators when not required by this section or by the employer to do so must be provided the basic information on respirators in Appendix D of the attachment. Consult the appendix for training procedures.

E. FALL PROTECTION

1. EMPLOYEES/STUDENTS COVERED

Fall protection shall be utilized by those employees/students for the specific purpose of securing, suspending, or retrieving the employee/student in or from a hazardous work area, and/or when work exposes them to the risk of falling more than 6' whether outdoors or inside buildings.

2. APPROVAL AND SELECTION

Fall protection and devices and equipment shall meet ANSI A 10.14.

Selection of fall protection shall be based on the attached, "Classification of Safety Belts, Harnesses, and Lanyards."

3. FITTING

The appropriate safety belt shall be chosen for the hazard. It shall be securely buckled and worn tightly enough to prevent any possibility of the wearer slipping out.

4. INSPECTION AND MAINTENANCE

Safety belts and associated equipment shall be inspected before each use. Every one to three months they shall be inspected by a trained inspector. Cut, worn, or damaged belts, lifelines,

lanyards, etc., shall be discarded and replaced. Safety belts in service shall not be tested for maximum impact loading.

NOTE: After an accidental freefall, the safety belt and lanyard shall be discarded.

5. CLASSIFICATION OF SAFETY BELTS AND HARNESSES

Class I: Body belt (work belts), used to restrain a person in a hazardous work position and to reduce the probability of falls and to avert falls from bucket trucks.

Class II: Chest harness, used where there are only limited fall hazards (no vertical free-fall hazard) and for retrieval purposes, such as removal of a person from a tank, bin, or other enclosed place.

Class III: Body harness, used to arrest the most severe free-falls. This harness is ideal for workers on elevated sites. During a fall, it distributes the fall impact over the body.

Class IV: Suspension belts, independent work supports used to suspend or support the worker.

Lifeline: A horizontal line between two fixed anchorages.

Support capacity: 5400 lbs.

Line diameter: ½ inch.

Personal Lifeline: This system is usually a rope system that provides flexibility for worker freedom of movement, yet will arrest a fall and help absorb the shock. These systems always have some type of belt or harness that is worn around the waist to which a lanyard or rope-grabbing device is attached.

Lanyard: A short piece of flexible line used to secure wearer of safety belt to a lifeline or dropline, or fixed anchorage, such as on the boom of a bucket truck.

Support capacity: 5400 lbs.

F. FOOT PROTECTION

1. EMPLOYEES/STUDENTS COVERED

For all non-office personnel, "Footwear such as sandals, open-toed shoes, platforms, high heels, cloth-bodied tennis shoes, or sneakers is not considered safe and is prohibited for use as a good work shoe. Well-built safety shoes, leather-bodied shoes, or boots in good condition with low heels and hard soles are to be used." (Physical Plant Operations Manual)

2. APPROVAL AND SELECTION

Foot protection used shall meet ANSI Z41.1 "Men's Safety-Toe Footwear."

FOOT PROTECTION CLASSIFICATION AND PROTECTION FACTORS

Classification of Safety Shoes

a. Safety-toe Shoes: Steel toes and metal reinforced sole.

Usage: Areas where heavy, protruding on falling objects presents a threat.

b. Conductive Shoes: Reduces the possibility of generating a spark.

Usage: Areas where fire and explosive hazards exist.

c. Foundry Shoes: Contains no fasteners and is easily removed.

Usage: Areas where exposure to splashes of molten metal is likely.

d. Explosive Operation Shoes: A shoe with non-conductive and grounding properties.

Usage: Areas where explosive compounds are present when cleaning tanks with volatile hydrocarbons.

e. Electrical Hazard Shoes: A shoe which minimizes the hazard of conducting electricity (no metal in shoes).

Usage: Areas where electrical hazards exist.

3. INSPECTION AND MAINTENANCE

All foot protection shall be kept reasonably clean and in good repair. Shoes shall be repaired or replaced periodically.

F. HEAD PROTECTION

1. EMPLOYEES/STUDENTS COVERED

Employees/students in areas such as visiting construction sites, tree trimmers, and any work where a potential for head hazard may exist.

2. APPROVAL AND SELECTION

Head protection used shall bear the ANSI Z89.1 or Z89.2 approval, manufacturer's name, and ANSI class designation (A, B, C, or D). Employees shall only be allowed to purchase or receive them through an authorized department representative to insure compliance. Refer to the attached "Selection Chart for Head Protection for University Employees" to determine appropriate head protection.

3. FITTING

Each employee shall be individually fitted. The hard hat shall fit firmly but comfortably on the employee's head.

4. INSPECTION AND MAINTENANCE

a. Painting: If the hard hat is to be painted, the manufacturer shall be contacted to see if the paint will affect the properties of the hat.

b. Cleaning: Hard hats shall be washed every thirty days. If worn by more than one employee, it shall be washed daily.

c. Inspection: Before each wearing of the hard hat, it shall be checked for wear and damages, especially the suspension system.

d. Other: Hard hats shall not be stored or carried on the rear window shelf of a vehicle. Sunlight and extreme heat can affect the degree of protection offered. Also, the hard hat can become a projectile in an accident.

5. SELECTION CHART FOR HEAD PROTECTION FOR UNIVERSITY EMPLOYEES

a. Hard Hat: A rigid head gear of varying materials used to protect the worker's head from impact, penetration, electrical shock, or a combination of these.

b. Composition: Special plastics, fiberglass and plastics combination, cloth and resin, and aluminum alloy.

c. Types:

   i. Type 1: Helmet (hard hat), full brim. Allows for complete protection of head, face, and back of neck.

   ii. Type 2: Helmet (hard hat), brimless with beak. This type is most commonly used and can accommodate various types of face shields and ear protection.

d. Classes: There are four different voltage classes of head protection. University personnel covered under this section shall only be allowed to wear class A and B.

   i. Class A: Limited voltage protection. Used by employees or students in general service (non-electrical) occupations. i.e., construction, landscape, etc.

   ii. Class B: High voltage protection. Used by employees in electrical occupations, i.e., electricians.

   iii. Class C: Metal helmets. Under no circumstances shall metal helmets be used by University employees or students.

   iv. Class D: Firefighters' helmet.

e. Other Forms of Protective Head Gear:

   i. Bump Hats: Shall not be used unless approved by the Office of Occupational and Environmental Safety.

   ii. Hair Protection: All employees/students with long hair or beards who work around chains, belts, or other machines with moving parts shall be required to wear protective hair coverings. Hair nets, bandannas, and turbans shall not be considered

satisfactory. Contact local vendors for information on the type of protective hair coverings available. Those who work around sparks, hot metals, flames, etc., shall use flame-resistant protective hair coverings.

H. PROTECTIVE AND PREVENTIVE CLOTHING

1. EMPLOYEE/STUDENTS COVERED

Protective clothing shall be worn by employees/students when the potential of an employee/student being exposed or coming in contact with harmful substance is evident. i.e., chemicals, high heat (radiant), dust, open flame, etc.

2. APPROVAL AND SELECTION

There are many different standards for approval of protective clothing (ANSI, ASTM, etc.). Protective clothing shall be selected for specified hazard, degree of protection, comfort, and ease of use.

Once the specific or multi-hazards have been identified, contact a reputable vendor or Occupational and Environmental Safety personnel for recommendation of proper protective clothing and/or equipment needed.

3. FITTING

Protective clothing shall fit the wearer comfortably and shall not be too loose or baggy.

4. INSPECTION AND MAINTENANCE

Protective clothing shall be routinely cleaned unless disposable. Disposable clothing shall be disposed of after use. Damaged, torn, ripped, etc., clothing shall be replaced before use.

5. PREVENTIVE CLOTHING

Employees in occupations which expose them to arcs, flames, and explosions shall wear clothes which will not melt, drip, or burn in the presence of one of these hazards. Heavy cotton of flame resistant fabrics shall be worn.

I. EMERGENCY SHOWERS AND EYE WASH STATIONS

Since it has been conclusively proven that immediate washing of the skin and eye with a generous amount of water is the most effective first aid treatment for chemical burns, all chemistry laboratories and areas where faculty, staff, students, or visitors are exposed to harmful chemicals shall be provided with safety showers and eyewash fountains. These facilities shall be conveniently located and tested frequently, readily available, operable, and known to persons concerned.

The valve handle of safety showers and eyewash fountains shall be rigidly fixed and plainly labeled. The valve shall open readily in either direction and remain open until intentionally closed. Water flow pressure shall be sufficient to drench the subject rapidly or gently flow in the case of eyewash fountains. The shower and eyewash fountain area shall be kept clear of obstructions. Water of drinking purity only shall be used in safety showers and eyewash fountains. The showers and eyewash stations shall be in the immediate vicinity. Eyewash stations should be located close to the safety shower so that the eyes can be washed while the body is showered if necessary.

Emergency eyewash fountains shall deliver a gentle flow of clean, aerated water. A hand-held eyewash spray with a five foot hose is more adaptable to unusual situations including head and body splashes, but shall not be located where it can be contaminated by waste materials. It shall be understood by all that eye protection is infinitely more important than eye washes. For chemical splashes, very complete irrigation is indicated. (A 15 minute flush is recommended.) Immediately flush the eye with copious amount of water under gentle pressure, checking for and removing contact lenses at once. An eyewash fountain shall be used if available. Forcibly hold the eye open to wash thoroughly behind the eyelids. In the absence of an eyewash fountain, the injured shall be placed on his back and water gently poured into the eye. The injured eye shall be held open. The injured shall be given prompt medical attention, regardless of the severity of the injury. Keep the eye immobilized with clean, wet, cold pads while transporting the injured to medical attention.

Neutralizing agents shall not be used for chemical burns to the eye. Experiments have indicated that this type of treatment is likely to increase the eye damage.

The emergency shower and eyewash fountains shall be tested on a regular basis and a record kept of such tests. The tests shall concern the operation of the unit to determine sufficient water flow and valve operation. The physical condition of the unit shall be noted and whether the unit is kept clear of obstructions.

Portable Eye Wash Stations

Periodically inspect each station to make sure it is properly filled and ready to use. Check to see if the unit is full. Change the water once a month with water of drinking purity. Test the unit's operation monthly.

Also, be sure the unit is always clearly visible and there are no obstructions to interfere with its use.