DEPARTMENT OF CHEMISTRY & LIFE SCIENCE

CHEMICAL HYGIENE PLAN (CHP)

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Table of Contents

SECTION	PAGE
Section I – Introduction	4
1.1 References	4
1.2 Purpose, Policy, and Scope	4
Section II – Responsibilities	6
2.1 Head of Department	6
2.2 Course Directors, Researchers, and Instructors	6
2.3 Chemical Hygiene Officer	7
2.4 Laboratory Supervisors	7
2.5 Laboratory Workers	8
2.6 Cadets	8
2.7 Safety Committee	9
Section III – General Chemical Hygiene Practices and Laboratory Facilities	10
3.1 Information	10
3.2 Training	11
3.3 General Principles of Chemical Safety	12
3.4 Equipment	13
3.5 Maintenance	13
3.6 Visitors, Minors, Tours, and Pets	14
Section IV – Chemical Hygiene Plan	15
4.1 Definitions and Warning Labels	15
4.2 Risk Management and Mitigation	17
4.3 Procurement and Receipt of Chemicals	17
4.4 Laboratory Housekeeping	18
4.5 Storage of Chemicals	21
4.6 General Rules for Chemical Laboratories	22
4.7 Rules for Corrosive, Flammable, and Moderately Toxic Chemicals	24
4.8 Rules for Work with Chemicals that are Water-Reactive	26
4.9 Rules for Working with Chemicals That Are Explosive, Highly Reactive or Shock Sensitive	27
4.10 Rules for Use of Toxic Chemicals	30
4.11 Medical Program	31
4.12 Records	33
4.13 Waste Disposal	33
4.14 Physical, Electrical, and Mechanical Safety	34
4.15 Radiation	34
4.16 Working With Compressed Gases	34
4.17 Laboratory Hoods	35
4.18 Cryogenic Liquids Precautions and Safe Handling Procedures	36

Annex A – Pre-Accident Plan

SECTION I – INTRODUCTION

1.1 REFERENCES

a. OSHA Standard 29 CFR Part 1910 *Occupational and Health Safety Standards*.
b. OSHA Standard 29 CFR § 1910.120, *Hazardous Waste Operations and Emergency Response.*
c. OSHA Standard 29 CFR § 1910.1200, *Hazard Communication*.
d. OSHA Standard 29 CFR § 1910.1450, *Occupational Exposures to Hazardous Chemicals in Laboratories.*
e. DOD Instruction 6050.5, *Hazardous Material Information System*.
f. AR 385-10, *The Army Safety Program.*
g. USMA Reg 385-10, *Safety Program.*
h. USACHPPM Technical Guide 190, *Guide to Managing Occupational Exposure to Blood-borne Pathogens*
i. *Prudent Practices in the Laboratory, Handling and Management of Chemical Hazards, updated version*. 2011. National Research Council of the National Academies, 337 pp.

1.2 PURPOSE, POLICY, AND SCOPE

Purpose

This document constitutes the Chemical Hygiene Plan (CHP) required by the U.S. Occupational Safety and Health Act (OSHA) of 1970 Safety and Health Act (OSHA) of 1970, regulations of the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard"), the Department of Defense and Department of the Army regulations. The CHP is a written program developed and implemented by the Department which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting all occupants of Bartlett Hall from the health hazards presented by hazardous chemicals used within the Department. The purpose of the CHP is to describe the proper use and handling practices and procedures to be followed by employees, cadets, visitors, and other personnel working in the Department of Chemistry and Life Science to minimize exposure to hazardous chemicals and physical hazards in the laboratory and to set forth guidelines for personnel (faculty, staff, cadets, visitors, etc.). The CHP is the foundation of the Department laboratory safety program and will be reviewed and updated, as needed, on an annual basis to reflect changes in policies and personnel.

While the CHP establishes work practices to promote safety in the laboratory, each individual has the first responsibility for ensuring good health and safety practices.

Policy and Scope

It is the policy of the Department of Chemistry and Life Science to provide a safe and healthy workplace in compliance with OSHA regulations including the “Laboratory Standard” referenced above, and DoD and DA regulations. Ensuring a safe laboratory environment is the combined responsibility of all personnel within the Department. A sound safety plan and safe laboratory environment that is respected by all requires

participation and support by everyone working in the Department. The Chemical Hygiene Officer (CHO) and the Chairman of the Department Safety Committee have direct responsibility for the management of the laboratory safety program. The ultimate responsibility for creating a safe environment and for encouraging a culture of safety lies with the Head of the Department.

This plan applies to all laboratories in the Department of Chemistry and Life Science, and all personnel who supervise or work in these labs. The CHP provides guidelines for maintaining the health and safety of departmental personnel and cadets. Although this CHP primarily concerns chemical safety in the laboratory, it also contains sections on other safety matters. Each member of the Department of Chemistry and Life Science will be thoroughly familiar with the contents of this CHP.

SECTION II – RESPONSIBILITIES AND TRAINING

An essential component of any chemical hygiene program is clear communication of the different roles and responsibilities of all stakeholders who work in or visit areas where chemicals are present. Clarifying roles and responsibilities for implementing the Chemical Hygiene Plan (CHP) will establish accountability, streamline processes, enhance safety, and avoid confusion in meeting the CHP's objectives.

2.1 HEAD OF DEPARTMENT

He/She has ultimate responsibility for chemical hygiene in the Department of Chemistry and Life Science:

a. Ensure that an effective chemical hygiene program is in place and updated annually.
b. Appoint a Chemical Hygiene Officer (CHO). The individual selected must be qualified by training or experience to provide technical guidance in the development and implementation of this written CHP. This individual must have appropriate authority to assist with implementation and administration of the CHP.
c. Appoint a chairperson and members of the Department Safety Committee. These individuals will meet at least quarterly to review safety rules and conditions with the Department and provide the head of the department with information and recommendations to maintain safety.
d. Provide or obtain administrative and financial support, as needed, for implementing and maintaining the CHP and the requirements of the plan.
e. Ensure that the CHP is fully supported by everyone in the department.
f. Review the results of laboratory inspections and share them with the Department to ensure awareness and compliance.

2.2 COURSE DIRECTORS, RESEARCHERS, AND INSTRUCTORS

a. Be familiar with the CHP and ensure that all work is conducted in accordance with requirements of this Plan. They should contact the CHO for advice and assistance regarding this plan and implementing the provisions of this plan when needed. Each member of the Department is responsible for working safely. Instructors are responsible for informing cadets of safety precautions and for **directly** supervising cadets to ensure they work safely in the laboratory.
b. Assess all chemicals in the teaching and research laboratories under their purview, and ensure measures are established for safe use, storage, and disposal of the hazardous chemicals within the laboratory. Such measures include:

    (1) Preparing Risk Assessments for all demonstrations, laboratories, and research activities involving hazardous chemicals. (See DD2977)
    (2) Providing personal protective equipment needed for safe handling of the chemicals.
    (3) Providing proper containers, containment, and cabinetry for safe storage of chemicals.
    (4) Defining the location and processes where particularly hazardous substances will be used, ensuring these areas are labeled, and ensuring that a list of these substances is maintained.

c. Before leaving the Department of Chemistry and Life Science permanently, each instructor is responsible for cleaning out any laboratory space under their responsibility and for the disposal of unused or waste chemicals.

2.3 CHEMICAL HYGIENE OFFICER

The Chemical Hygiene Officer (CHO) for the department shall be the Lab Program Director (LPD).

a. Know and understand the requirements of the OSHA Laboratory Standard regulation (29CFR 1910.1450), applicable DoD and DA regulations, and the Department of Chemistry and Life Science CHP.
b. Oversee the development and implementation of the CHP in the Department, Lab, or Center and assist Principal Investigators or Course Supervisors (PI/Supervisors) with implementing the CHP within their laboratory.
c. Ensure the CHP is distributed or made available to all personnel in the Department of Chemistry and Life Science.
d. Supervise an annual inventory of the chemicals in all areas of the Department, to include storage, classroom, teaching, and research laboratories in compliance with state, federal, Department of the Army, Department of Defense, safety, and fire code requirements.
e. Seek ways to continually improve the CHP.
f. Ensure that the CHP and training courses are reviewed annually.
g. Monitor procurement, use, and disposal of all chemicals used in the department.
h. Maintain all records required by the CHP.
i. Advise course directors, researchers, instructors, and workers of how the CHP applies to them.
j. Maintain an up-to-date safety library that is available to all.
k. Ensure training of laboratory workers in Hazard Communication and Chemical Hygiene.
l. Assist PI/Supervisors, as needed, with obtaining services or supplies and equipment for correcting chemical hygiene problems or addressing chemical hygiene needs.
m. Attend periodic meetings conducted by the Installation Safety Office.
n. Review proposed experiments for significant environment, health, and safety issues, and/or contact the Installation Safety Office to address concerns.
o. Investigate all chemical accidents and near misses to determine the cause and take appropriate corrective action to prevent similar accidents. Contact the Department Head immediately to arrange for assistance with investigations, assessment, and recommendations for corrective action.

2.4 LABORATORY SUPERVISORS:

a. Be familiar with this CHP and ensure that all workers and cadets understand and follow the CHP and are current on all safety-related training as it pertains to the specific research conducted under the supervisor’s purview.

b. Assess all chemicals in the teaching and research laboratories under their purview, and ensure measures are established for safe use, storage, and disposal of the hazardous chemicals within the laboratory.
c. Ensure new processes (including demonstrations) or experiments involving hazardous materials are planned carefully and appropriate hazard information, safety equipment, and risk assessments are available prior to commencing work. Always seek to minimize the amount of hazardous chemicals purchased and used for experiments or processes.
d. Ensure that all necessary personal protective equipment (PPE) is available, in working order, properly sized, and used.
e. Develop good personal chemical hygiene habits and ensure that housekeeping and maintenance of all lab areas are up to standard.
f. Ensure that storage of chemicals in the laboratories or classrooms for which you are responsible is in compliance with applicable chemical compatibility requirements.
g. Plan for accidents and ensure that appropriate supplies are in place and procedures are established for responding to an accident, including cleaning up chemical spills.
h. Monitor the safety performance of the staff to ensure that the required safety equipment, practices and techniques are understood and are being employed and ensure that action is taken to correct work practices that may lead to chemical exposures or releases.
i. Ensure laboratory inspections are conducted routinely. Take action to correct conditions that may lead to accidents or exposure to hazardous chemicals, and to correct problems identified during inspections.
j. Ensure employees and cadets who suspect they may have received an excessive exposure to a hazardous chemical report to the Medical Treatment Facility for assessment. Such exposures may occur through accidental inoculation, ingestion, or inhalation of the chemical.
k. Promptly report all accidents involving an employee's or cadet's chemical exposure or involving a chemical spill that may constitute a danger of environmental contamination to the CHO, Safety Officer, and Department Head immediately. (See pre-accident plan-Annex A)
l. Ensure unwanted or excess hazardous chemicals and materials are properly disposed according to all USMA, state, and federal procedures.
m. Ensure that cadets, staff, or faculty NEVER work alone in laboratories.

2.5 LABORATORY WORKERS (Faculty and Laboratory Staff):

a. Have a working knowledge of the CHP as it applies to their normal duties.
b. Develop and sustain good personal chemical hygiene habits.
c. Observe all safety policies, rules and procedures at all times while working in laboratories.

2.6 CADETS

a. **Cadets will never work alone in teaching or research laboratories.** Both, the American Chemical Society (ACS) and Occupational Safety and Health Administration (OSHA) laboratory standards states "do not work alone in a laboratory…" Accidents are expected by definition, and if a cadet is working alone when one occurs, his or her ability to respond appropriately could be severely impaired, which could result in personal injury or death and catastrophic facility

damage. If no one can accompany a cadet in the laboratory, **do not proceed with the work.**

b. Cadets must read, understand, and sign the CHP before working in any research laboratory. It is your duty to prevent accidents whenever you are in the laboratory.

2.7 SAFETY COMMITTEE

a. Membership:
   (1) Deputy Head of the Department (Chair)
   (2) Lab Program Director, - CHO and Safety Officer
   (3) Building Commandant
   (4) General Chemistry Physical Science Technician
   (5) Microbiology Technician
   (6) Course Director CH 489/490
   (7) Organic Chemist
   (8) Chemical Engineering Technician
   (9) Instrumental Technician

b. Duties shall include:
   (1) Conduct walk-throughs of the laboratories and document quarterly hygiene and safety inspections of all laboratory areas.
   (2) Conduct an annual review of the Chemical Hygiene Plan and provide comments to the CHO as necessary.

SECTION III - LABORATORY FACILITIES

Section III contains information on laboratory facilities to include information that must be available to laboratory personnel, general principles of chemical safety, equipment, and maintenance.

3.1 INFORMATION – Information that must be available to laboratory personnel includes:

a. A **copy of the OSHA Laboratory Standard** and its Appendices. These are available from the LPD or on the OSHA website via http://www.osha.gov and searching under the regulation number "1910.1450".
b. The **Permissible Exposure Limits (PELs)** for OSHA-regulated substances and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) for hazardous substances not given OSHA PELs.
c. See the LPD for the location and availability of **known reference materials** on hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory.
d. **Safety Data Sheets (SDSs)** are documents prepared by chemical manufacturers, that provide information about the chemical's physical and chemical hazards and recommended exposure limits, and list the means for controlling those hazards. SDSs also provide information about first aid, emergency procedures, and waste disposal. An SDS should be reviewed before beginning work with a chemical to determine proper use and safety precautions. Once a chemical is present in the lab, the SDS should be either book marked electronically or a hard copy kept on hand for reference, or in case of emergencies. Specific information required by OSHA to be on an SDS includes:

    (1) Product Identity
    (2) Reactivity Hazards
    (3) Hazardous Ingredients
    (4) Spill Clean-Up
    (5) Physical/Chemical Properties
    (6) Protective Equipment
    (7) Fire and Explosion Hazards
    (8) Special Precautions
    (9) Health Hazards and Exposure Limits

SDSs and additional chemical hazard information can be obtained from a variety of sources as outlined below:

(1) **Laboratory Binder** in each laboratory for all chemicals used/stored in that laboratory.
(2) **The Internet.** SDSs are available on the internet from a variety of sources.
(3) **Chemical Manufacturer.** A request may be made directly to the chemical manufacturer or supplier. This is often the best source for products or mixtures to determine what hazardous ingredients are contained in the formulation and is usually provided with the package.

(4) **Chemical Container Labels** – these are a good resource for information on chemical hazards. All containers of hazardous chemicals must have labels attached. Labels on purchased chemicals must include:

(a) The common name of the chemical
(b) The name, address and telephone number of the company responsible for the product
(c) Appropriate hazard warning(s)

(5) **Risk Assessments** – Each experiment, lab exercise, or research thread will mitigate risks and post risk assessments in the laboratory in which the activities occur in accordance with Section 2.2. (See DD 2977)

e. Laboratory personnel are responsible for:

(1) Inspecting incoming containers to be sure that labels are attached, are in good condition, and contain the information outlined above.
(2) Reading the container label each time a newly purchased chemical is used. It is possible that the manufacturer may have added new hazard information or reformulated the product since the last purchase.
(3) Ensuring that chemical container labels are not removed or defaced, except when containers are empty.
(4) Labeling any secondary containers used in the laboratory, to prevent unknown chemicals or inadvertent reaction.
(5) Verifying that chemical waste containers have complete and accurate chemical waste labels.

3.2 TRAINING

The Department of Chemistry and Life Science has established systems to ensure you are provided with OSHA, DOD, and DA required training to inform you of the hazards and precautions for work with chemicals. The process begins when you complete initial entry training during Faculty Development Workshop (FDW) for faculty or during initial lab training for laboratory technicians. Chemical hygiene training requirements are detailed below. The following four components are required if you will potentially use hazardous chemicals in a laboratory or if you are a supervisor for those who use potentially hazardous chemicals in the laboratory:

a. **General Chemical Hygiene and Hazardous Communication (HAZCOM) Training** – This training will be provided during FDW for all new faculty and by the LPD for all new laboratory technicians and other personnel working in the laboratories. This training is required before beginning work with potentially hazardous chemicals in the laboratory and periodic updates will be provided as needed.
b. **Read the Chemical Hygiene Plan** – Confirm that you have read and understand the CHP by signing the signature page of the CHP Update Memo annually.
c. **Lab-Specific Chemical Hygiene Training** – provided by the lab or course supervisor or his/her designee on lab-specific chemical or Blood-borne pathogen hazards. This training is required before beginning work with potentially hazardous chemicals or Blood-borne pathogens in a laboratory including chemicals developed

for use exclusively in the lab. Training is done initially before starting work in the laboratory and annually thereafter. The topics covered will depend, in part, on the nature of the lab and research being done.

d. **Department Safety Seminar** – The Department conducts an annual safety seminar at the beginning of the academic year. Topics covered at the seminar are varied and they may include reviews of safety procedures, discussion of recent incidents, or results of recent Safety Committee inspections. All personnel who work in Department laboratories are required to attend.

3.3 GENERAL PRINCIPLES OF CHEMICAL SAFETY

a. **Avoiding eye injury.** Eye protection is required for all personnel and visitors in all locations where laboratory chemicals are stored or used, whether or not one is actually performing a chemical operation.

   (1) Safety glasses with side shields (American National Standards Institute standard Z87.1-2003) provide the minimum protection acceptable for regular use.
   (2) Chemical splash goggles will be worn to protect against hazards such as projectiles, as well as when working with glassware under reduced or elevated pressures (e.g., sealed tube reactions), when handling potentially explosive compounds (particularly during distillations), and when using glassware in high-temperature operations.
   (3) Chemical splash goggles or face shields will be worn when there is a risk of splashing hazardous materials or flying particles.
   (4) Full-face shields (to protect the face and neck) will be worn in addition to safety glasses or goggles when conducting particularly hazardous laboratory operations (e.g., working with glassware under vacuum or handling potentially explosive compounds). In addition, glassblowing and the use of laser or ultraviolet light sources require special glasses or goggles.
   (5) Operations at risk of explosion or that present the possibility of projectiles must have engineering controls as a first line of protection. For instance, in addition to chemical splash goggles or full-face shields, those operations must be conducted behind blast shields, in rubber-coated or taped glassware.

b. **Minimize all chemical exposures.** Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be followed. Avoid skin exposure, inhalation, and ingestion of all hazardous chemicals.
c. **Avoid underestimating the risk.** Even for chemicals of no known significant hazard, exposure should be minimized. All work on unfamiliar compounds should be preceded by a literature search for hazards. Procedures to be used in the lab should be based on the hazards found. One should assume that any mixture is more toxic than its most toxic component, and that all substances of unknown toxicity are toxic.
d. **Provide adequate ventilation.** The best way to prevent overexposure to chemicals is to prevent their escape into the working atmosphere by use of hoods and ventilation controls.

e. **Observe the PELs and TLVs.** Permissible Exposure Limits (PELs) of OSHA and the Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists should not be exceeded. The actual values are provided on the material safety data sheets (SDS).
f. **Laboratory Housekeeping.** In compliance with applicable safety regulations, all laboratory areas, whether under the supervision of a researcher, instructor, or course director, shall be kept clean, and orderly. Bench tops, hoods, drawers, shelves, floors, and cabinets will be free of broken glassware, chemical spills, trash, exposed needles, exacto or razor blades, and all containers not empty will be labeled as to content.

3.4 EQUIPMENT

The Department of Chemistry and Life Science equipment will be maintained in a condition to provide the following:

a. General ventilation system for each lab that ensures 4 to 12 air changes per hour to prevent the buildup of chemical vapors.
b. Stockrooms with continuous ventilation, automatic fire suppression systems, fire alarms, and spill control material. NFPA hazardous warning labels shall be posted outside stockroom doors.
c. Individual local exhaust ventilation at each work position and hoods for use with volatile chemicals that is toxic, flammable, or corrosive. Each hood will have a simple airflow meter attached that indicates whether the hood is working properly or not.
d. Eyewash fountains and drench showers in each lab. Signs for eyewashes and drench showers will be prominently displayed.
e. Properly labeled bottles and jars for collection of chemical waste.
f. Fire extinguishers accessible to each area to include storerooms.
g. Spill control material for all chemicals in each lab and in each storeroom.
h. Personal protective equipment (PPE) such as gloves, aprons, goggles, and lab coats.
i. A telephone and a list of emergency numbers such as fire, spill control (DPW), hospital, supervisor, etc.
j. Signs to mark areas where special chemical hazards are present.

3.5 MAINTENANCE (General)

a. Personnel shall ensure ventilation systems are turned on at the beginning of any day the lab is in use.
b. Storeroom ventilation shall be checked whenever the rooms are entered.
c. Hoods shall be checked at each use with the simple in-hood meters.
d. Eyewashes and safety showers will be tested weekly, and results recorded.
e. Waste bottles and jars shall be collected and transported to the satellite accumulation point whenever they are full, with the proper local use Hazardous Waste Label filled out for content only and attached (leave “accumulation start date” blank). Laboratory technicians will collect chemical waste generated in teaching labs and from classroom demonstrations; individual researchers will

deliver waste to the satellite accumulation point themselves. Waste will be combined and reduced in volume where possible. The CHO or his designate will submit on a weekly basis a Hazardous Waste Inventory Report and a "RCRA Hazardous Waste Satellite Accumulation Report" to DHPW. Electronic copies of these reports will be maintained by the CHO.

f. Fire extinguisher condition will be checked monthly, documented and discrepancies reported to the Fire Department.
g. Spill control kits will be checked monthly and replaced when depleted.
h. The supply of PPE will be checked monthly and reordered as necessary.
i. All safety signs will be checked monthly for visibility and telephone numbers updated.

3.6 VISITORS, MINORS, TOURS, AND PETS

a. All visitors, including minors, taking tours of the laboratory facilities must be accompanied at all times by a faculty member or a laboratory technician. Prior approval of the Department Head is required. All personnel taking tours must wear all required personal protective equipment appropriate to the lab being visited.
b. Pets are prohibited from all laboratories, except for service dogs and police dogs.

SECTION IV - CHEMICAL HYGIENE PLAN

Section IV contains the minimum required precautions and standard operating procedures for working with laboratory chemicals in Department of Chemistry and Life Science laboratories. These precautions address broad classes of chemicals. This section contains chemical hazard and risk assessment information, and general procedures for safe chemical management addressing the purchase, use, labeling, storage, disposal and shipping of chemicals. This section also discusses common controls for safe use of chemicals including administrative and engineering controls, such as fume hoods, personal protective equipment, and designated areas.

Hazardous chemicals can cause harm when they enter the body in sufficient amounts via inhalation, ingestion, injection or skin absorption. Harmful effects can also occur by eye or skin contact alone. The nature of the hazardous chemical and the routes

by which it enters or contacts the body determine the type of controls that are needed. The Occupational Safety and Health Administration (OSHA) and other organizations have set occupational exposure limits on airborne chemical exposure. Keeping exposures below these limits is generally believed to protect employees and students. Permissible Exposure Limits (PELs) set by OSHA are contained in Appendix II-A. Threshold Limit Values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) are contained in Appendix II-B. For many laboratory chemicals, exposure limits have not been established. In addition, little is known about the effects of combined exposures. Therefore, all laboratory workers should take steps to minimize chemical exposure via all routes of entry.

OSHA recognizes that some classes of chemical substances pose a greater health and safety risk than others. To differentiate this different risk characteristic, OSHA identifies two categories of hazardous chemicals: hazardous chemicals and particularly hazardous substances. Particularly hazardous substances (PHSs) is a subset of hazardous chemicals that is regulated more stringently because they have been deemed to pose a substantially greater risk. Because of this, OSHA requires additional precautions and procedures be undertaken when particularly hazardous substances are used in the laboratory.

4.1 DEFINITIONS AND WARNING LABELS

a. **Definition of chemical hazards**

(1) Explosives-Chemicals that cause a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature. (Example: fireworks, nitrogen triiodide, gunpowder)
(2) Flammable liquid--Any liquid having a flash point below 100°F (38°C). This class is further subdivided into:
  (a) Flash point below 73°F (23°C); boiling point below 100°F (38°C). (Examples: pentane, tetrahydrofuran, diethyl ether, carbon disulfide)
  (b) Flash point below 73°F (23°C); boiling point at or above 100°F (38°C) (Examples: acetone, ethyl acetate, ethanol, triethylamine, toluene)

(c) Flash point 73°F (23°C) to 100°F (38°C) (Examples: xylene, butanol, turpentine)

(3) Combustible liquid -- Flash point 100°F (38°C) to 200°F (93°C) Examples: acetic acid, kerosene)

(4) Flammable solid--solid other than an explosive that is liable to cause fire through absorption of moisture or chemical change, or which can easily be ignited and burns vigorously and persistently. (Examples: benzoyl peroxide, calcium carbide, picric acid)

(5) Toxic Chemical--Any chemical that has been shown to cause acute toxicity or severe chronic health effects in exposed workers. This would include acute toxins, suspected carcinogens, and mutagens. (Examples: bromine, hydrofluoric acid, phosgene, nicotine)

(6) Select Carcinogen--Any chemical which is regulated by OSHA as a carcinogen, or listed under “Known Carcinogen” by the National Toxicology Program (NTP), or is listed under human carcinogens by the International Agency for Research on Cancer (IARC). (Examples: asbestos, vinyl chloride, benzidine)

(7) Etiologic Agent--A viable microorganism or toxin which causes or may cause human disease.

(8) Radioactive Material--Any material or combination of material which spontaneously emits ionizing radiation having specific activity greater than 0.002 microcuries per gram. (Example: Uranium 235)

(9) Permissible Exposure Limits (PELs)--The average amount of any chemical vapor that workers can be exposed to during an eight hour day. (Example: the PEL for benzene is 30 mg/cubic meter.)

(10) Threshold Limit Values (TLVs)--The time weighted average concentrations for a normal 8-hour workday and a 40 hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effects.

b. **Warning Labels**

(1) All chemicals will have their manufacturer's original container warning label about hazards. When chemicals are transferred from their original containers, the new container will be labeled with, at a minimum, the chemical name and appropriate hazard wording.

(2) DOT labeling system. Department of Transportation (DOT) labels that are used on external packaging of all shipments of chemicals should be understood by all employees. DOT labels use color-coded diamonds with picture and word warnings to convey their messages. They are largely self-explanatory.

(3) Private labeling systems. Many private chemical companies use their own warning label systems, but most include the NFPA 704 symbol in addition to their own. Most company systems use pictures to convey easily understood warnings. In addition to the types of warnings given by the NFPA system, the private systems often give additional warnings as to protective equipment to use and how to store the chemical.

4.2 RISK MANAGEMENT AND MITIGATION

All work involving chemicals in Department of Chemistry and Life Science laboratories must be conducted using the procedures outlined in this CHP. All responsible researchers and course directors must conduct a thorough risk assessment of all laboratory procedures and complete a Risk Management Form (DD 2977) approved by the appropriate program director for all research and teaching laboratory experiments before work begins. These approved risk management forms must be kept by the researcher or course director and are subject to inspection.

For all accidents requiring emergency police, fire, or medical response, contact Military Police at 911.

4.3 PROCUREMENT AND RECEIPT OF CHEMICALS

a. **Before ordering chemicals.** When preparing to order a chemical for any reason, several questions must be asked:

   (1) What is the minimum amount of this chemical needed?
   (2) Is the chemical available elsewhere within the Department?
   (3) Has the purchase been approved by the CHO?
   (4) Is the proper PPE available in the laboratory to handle this chemical?
   (5) What are the special handling precautions?
   (6) Where will the chemical be stored in the laboratory?
   (7) Does the laboratory chemical hood provide proper ventilation?
   (8) Are there special containment considerations in the event of a spill, fire, or flood?
   (9) Will there be additional costs or considerations related to the disposal of this chemical?

b. **Incoming chemicals:** All requisitions for chemicals are initiated by the course director or principal investigator with program director oversight, who will be aware of any hazards involved. Receipt of a chemical shipment occurs when a member of the department receives it from the delivery personnel or from a private carrier, if direct shipped. Normally, shipments are made to the loading dock, but may be made to any door. The person picking up the shipment should use a cart for large packages to minimize the risk of dropping and spilling chemicals.

c. **Check-out and labeling:** When a shipment arrives in the department, the LPD, lab technician, or supply technician will inspect it to ensure that it is in fact the material ordered, is in good condition, and that an SDS is on file. He or she will mark each container with the date of receipt. The material will then be stored in the appropriate storeroom and all paperwork turned in to the supply technician. Throughout this handling, appropriate protective gear will be utilized.

4.4 LABORATORY HOUSEKEEPING

Attend to housekeeping by establishing and following routine cleaning procedures as part of the work you do. There is a definite relationship between safety and orderliness in the laboratory.

a. **The following housekeeping rules should be adhered to in all laboratories:**

(1) Clean bench tops and other work areas and equipment regularly. Do not allow dirty glassware, expired or unneeded samples or chemicals, and trash or boxes to accumulate. When floors require cleaning, notify the Building Commandant.
(2) Maintain ready access to exits and safety equipment such as fire extinguishers, eyewashes, and safety showers. Do not store materials in a way that will block access to exits or safety equipment.
(3) Ensure all compressed gas tanks are properly secured to walls or benches.
(4) Chemical storage refrigerators should be defrosted periodically and should not be overcrowded.
(5) Ensure that all chemical containers are properly labeled.
(6) Power cords or extension cords will never be ran across walkways or in aisles of labs or classrooms.

b. **Properly use, maintain, and dispose of laboratory glassware and other sharps.**

(1) Careful handling and storage procedures should be used to avoid damaging glassware. Always carefully inspect glassware for flaws and cracks before use. Damaged items should be discarded or repaired.
(2) Adequate hand protection should be used when inserting glass tubing into rubber stoppers or corks or when placing rubber tubing on glass hose connections. Tubing should be fire polished or rounded and lubricated, and hands should be held close together to limit movement of glass should fracture occur. The use of plastic or metal connectors should be considered.
(3) Improper use of glassware is a frequent cause of injuries and accidents in the laboratory. Glass-blowing operations should not be attempted unless proper annealing facilities are available.
(4) Vacuum-jacketed glass apparatus should be handled with extreme care to prevent implosions. Equipment such as Dewar flasks should be taped or shielded. Only glassware designed for vacuum work should be used for that purpose.
(5) Hand protection should be used when picking up broken glass. (Small pieces should be swept up with a brush into a dustpan).
(6) Broken glassware, syringes, and other "sharp objects" must be disposed of properly. Such waste should be separated from other trash and stored for pickup in clearly marked containers labeled "sharps".
    (a) Needles, lancets, scalpel blades, sharp pipettes, slides, broken/contaminated glass, surgical staples, orthodontic wires, wooden applicator sticks, or any other item likely to puncture a bag are considered sharps and must be disposed of in an approved sharps container.

Everyone is personally responsible for the proper disposal of sharps that they have used. Sharps are never to be discarded into trash bags or cardboard glass waste containers.

(b) Bending, shearing or breaking of used needles is strictly prohibited.
(c) Needles are not to be recapped or disassembled from syringes before disposal.
(d) Sharps containers must be closable, puncture-resistant, leak proof on sides and bottoms, and labeled or color-coded appropriately. Sharps disposal containers are available in BH426 and BH427.
(e) Sharps containers that contain biohazard material, either actual or suspected, must either be labeled with the universal biohazard symbol and the word "biohazard" or be color-coded red. Sharps containers shall be maintained upright throughout use, replaced routinely, and not be allowed to overfill.
(f) Sharps containers must be easily accessible and as close as feasible to the immediate area where sharps are used.

c. **Establish and follow safe chemical storage procedures for your laboratory.** Researchers should consult this CHP or the LPD for instructions on procedures for storing chemicals in laboratories. All procedures employed must comply with OSHA, flammable material, and building code regulations. The following minimum guidelines must be adhered to:

(1) Access to all hazardous chemicals, including toxic and corrosive substances, should be restricted at all times. Specifically, good practice would dictate that these materials be stored in laboratories or storerooms that are kept locked at all times when laboratory personnel are not present. In the case of unusually toxic or hazardous materials, additional precautions are advisable and likely required, such as keeping the materials in locked storage cabinets. Contact the LPD to determine the appropriate controls.
(2) To avoid the accumulation of excess chemicals, it is recommended that you maintain a list of chemicals in your lab and check this list prior to purchasing new chemicals. When purchasing new chemicals, purchase the minimum quantities of commercial chemicals necessary for your research.
(3) Make sure all containers of chemicals are in serviceable condition.
(4) Make sure all containers of chemicals, (including research samples), are properly labeled. When appropriate, special hazards should be indicated on the label. For certain classes of compounds, (e.g. ethers), the date the container was opened should be written on the label.
(5) Store incompatible materials in separate cabinets. If they must be stored together due to space limitations, provide secondary containment to separate incompatible materials.
(6) Do not store liquids above eye-level. Particularly, large containers (more than 1 liter) should be stored below eye-level on low shelves. Avoid storage of hazardous chemicals on the floor. If such storage is required, provide secondary containment for liquids stored on the floor.
(7) For refrigerated storage of chemicals, ensure refrigeration equipment is selected properly for the types of materials to be stored. For flammable or explosive chemicals, special refrigerators are required. See flammables and

explosives section below. Food should never be kept in refrigerators used for chemical storage.
(8) Do not store items in the working space of fume hoods.

d. **Precautions for handling flammable substances:**

(1) Flammable substances should be handled only in areas free of ignition sources. Besides open flames, ignition sources include electrical equipment (especially motors), static electricity, and for some materials, (e.g. carbon disulfide), even hot surfaces.
(2) Never heat a flammable substance with an open flame.
(3) When transferring flammable liquids in metal equipment, static-generated sparks should be avoided by bonding and the use of ground straps.
(4) Ventilation is one of the most effective ways to prevent the formation of flammable mixtures. A laboratory hood should be used whenever appreciable quantities of flammable substances are transferred from one container to another, allowed to stand or be heated in open containers, or handled in any other way. Be sure that the hood is free of all ignition sources including, in particular, variable transformers.
(5) Generally, only small quantities of flammable liquids should be kept at work benches. Larger quantities should be stored away from ignition sources in flammable storage cabinets. It is advisable to purchase highly flammable solvents (e.g., acetone, hexane, diethyl ether, ethyl acetate, tetrahydrofuran) only in metal or break-resistant (e.g., plastic or plastic-coated), containers.
(6) Refrigerators used for storage of chemicals must be explosion-proof or flame proof. Storage trays or secondary containers should be used to minimize the distribution of material in the event a container should leak or break.

e. **Precautions for handling corrosive substances**

Corrosivity is a complex hazard. Corrosives can be solids, liquids, and gases and includes acids, bases, oxidizers, as well as other chemical classes. Corrosives may belong to more than one chemical class. What is at risk varies, as well. Elemental mercury is considered a toxic substance, but it is shipped as a corrosive substance because it can deteriorate some metals. For purposes of these standard operating procedures, a corrosive is any chemical that can rapidly damage human tissue, metals, and other compounds, such as wood or concrete by chemical action. Store by compatibility. Segregate acids from bases. Segregate oxidizing acids, such as nitric acid from organic acids, such as acetic acid.

(1) Store corrosives on a lower shelf or in ventilated corrosive storage cabinets.
(2) Make sure containers and equipment, such as tubing, etc. used with corrosive materials is compatible with those materials.
(3) Personal protective equipment is important for work with corrosives. Neoprene or rubber gloves, goggles and face shield, rubber apron, and rubber boots should be considered .
(4) Always add acid to water, never water to acid.

(5) Wherever corrosives are used or stored, be sure there is a working, readily accessible eyewash and safety shower.
(6) Seek medical attention immediately in the event of a potentially injurious exposure.

4.5 STORAGE OF CHEMICALS

a. General storage conditions

(1) No smoking or flames of any kind in chemical storerooms.
(2) All storerooms shall have continuous ventilation, but this must not be taken for granted and shall be checked if any buildup of odors is noticed.
(3) Annually inspect all containers for seal, label integrity, warning labels, quantity on hand, and any sign of decomposition. This inspection may be accomplished during the conduct of the annual chemical inventory.
(4) Storage of chemicals in hoods and on lab benches is discouraged and all such containers shall be returned to the appropriate storerooms whenever the experiment is complete. All areas outside the storerooms shall be inspected for such containers annually.
(5) Aisles in storerooms shall not be blocked.
(6) Keep chemicals away from heaters and sunlight.
(7) Ensure storerooms do not have floor drains in order to prevent contamination of water supplies.
(8) All storerooms shall be clearly posted for the type of hazards inside.
(9) All refrigerators used for the storage of flammables shall be explosion proof. Clearly label all materials placed in refrigerators. Label all non-explosion proof refrigerators with the following: DO NOT STORE FLAMMABLES IN THIS REFRIGERATOR. Another sign will state: DO NOT STORE EDIBLES IN THIS REFRIGERATOR.

b. Flammable chemical storage

(1) Containers of chemicals with flashpoints less than 200^{o}F and one gallon (or larger) containers shall be normally stored in the storage shed in the courtyard of Bartlett Hall. An exception to this is that containers up to 5 gallons that are actively being used in a laboratory may also be stored in a Bartlett Hall

laboratory flammable locker or designated flammable storage area. No transfer of chemicals from a container to a smaller vessel will be performed in or near the storage shed. Containers will be brought to the laboratory where the chemical is needed and decanted into another vessel, and the container returned to the shed.
(2) All containers of chemicals with flash points less than 100^{o}F shall be stored in flammable storage cabinet or fully equipped storerooms. The size and number of such containers will be kept to a minimum. Only chemicals with compatible storage characteristics will be stored in the same cabinet.
(3) Isolate all flammables from:
-strong oxidizers

-explosives
-water reactives
-compressed gases and cryogenic liquids

(4) Spill control material will be available in marked containers.
(5) Four inch dikes will close each flammable storeroom doorway to prevent the escape of spills.
(6) Potential peroxide formers such as: diethyl ether, cyclohexene, cyclooctene, p-dioxane, tetrahydrofuran, and tetralin will be tested annually for peroxide formation with test strips and disposed of or freed of such contamination, if peroxides are detected. Diethyl ether will not be kept for more than two years in any case.

c. **Corrosive Chemical Storage**

(1) Inorganic corrosives will be stored by themselves and in a clearly labeled area.
(2) Organic corrosives will be stored in a separate area of the organic storeroom and clearly labeled as such.
(3) Keep storage areas dry, well ventilated and cool, but not cold, as acetic acid freezes at 60 ^{o}F (16 ^{o}C).
(4) Isolate corrosives from all other nearby chemicals.
(5) Whenever possible, store corrosives in their original shipping containers.
(6) Acid spill control material will be readily available.
(7) Store corrosives four feet or less above the floor.
(8) Recognize that some acids, such as perchloric and fuming nitric, must be treated as strong oxidizers rather than acids.
(9) Separate corrosives that will react with other corrosives, such as hydrochloric acid and ammonium hydroxide.

d. **Water Reactive Chemical Storage**

(1) Isolate from other chemicals, especially flammable ones, and label clearly.
(2) Store in a dry place.

e. **Compressed Gas Storage**

(1) All extra gas cylinders will be located in the gas cylinder storage cage near BH SB09.
(2) Cylinders will be transported on gas cylinder carts, with caps in place.
(3) All cylinders outside of the storage cage must be securely attached to walls or benches with chains or straps.

4.6 GENERAL RULES FOR CHEMICAL LABORATORIES

a. **Minor Spills and Accidents**

(1) Eye contact--If a chemical is splashed in the eye(s), the eye(s) must be flushed IMMEDIATELY with water. (Some reagents, strong NaOH solutions for example, damage the eye(s) within 10 seconds.) Flush the eye(s) gently with water using the emergency eyewash for 15 minutes, have the victim roll his/her

eye(s) to ensure that all areas under the eyelid is cleaned. It is critical for co-workers to pull the victim's eyelid open all the way to ensure full irrigation. Seek medical treatment.

(2) Skin contact--For spills on the skin, wash with plenty of soap and water. Toxic or corrosive spills on clothing are to be flushed with plenty of water, as the cloth may retain the chemical and cause injury to the skin beneath it by releasing it slowly. In the event of a large spill on clothing immediately move the victim to the safety shower and pull the chain. Remove contaminated clothing to ensure thorough cleaning of the skin. Seek medical treatment.

(3) Minor inorganic spills **of known materials** on desk tops or floors are to be wiped up with a wet sponge, rinsed and wiped again. Wear proper protective gear to protect hands and clothes. If a spill is a concentrated acid, pour sodium bicarbonate over the area first to neutralize it before wiping it up. If a spill is a base, pour citric acid over the area to neutralize it before cleaning the area. Organic spills should be absorbed with dry powder from the spill control kit, swept up, and disposed of properly. **For minor inorganic spills of unknown materials See Section 4.16.**

b. Avoid routine exposures by developing and encouraging safe work habits that limit chemical exposures by any route. These include wearing safety apparel appropriate for the task (goggles, aprons, gloves etc), not smelling or tasting chemicals, not pipetting by mouth, clamping all apparatus securely, and thinking safety at all times.
c. Plan your experiment ahead of time so that you have the necessary chemicals, equipment, and safety apparatus on hand. Check literature sources to determine the hazards possible and utilize the proper amount of ventilation. As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm. See SDS for TLVs.
d. No eating, drinking, gum chewing, or application of makeup is allowed in areas where chemicals are present. Food and drink may be consumed in only office areas. Do not use chemical glassware to hold food or drinks. Do not store food or drink in laboratory areas. Wash hands thoroughly after working in a chemical environment, and especially before any activity listed above.
e. No practical jokes, “horseplay,” or other behavior which might confuse, startle, or distract others is allowed in the laboratory.
f. Confine long hair and loose clothing while in the lab. Wear shoes covering the whole foot at all times; no sandals, cloth sneakers, high heels or perforated shoes. Long pants are required. All workers will wear lab coats or aprons at all times.
g. Keep work areas clear and uncluttered. Clean up the work area upon completion of an operation or at the end of the day. Label all containers awaiting further work.
h. All personnel in the lab, including visitors, will wear goggles or safety glasses, during experiments. <u>No employee, cadet, or instructor may wear contact lenses while chemicals are in use.</u> Use the correct type of gloves whenever handling toxic chemicals. Inspect before use for holes, replace gloves as needed, and wash hands after use.
i. <u>All</u> research cadets/students will be thoroughly briefed by their instructors on all hazards and required safety procedures associated with their specific research project(s). All cadets involved in a research project will read and acknowledge they understand the provisions of the CHP. The Research Course Director will ensure compliance with this requirement. Instructors must be aware of the research

schedule for all of their research students during non-duty hours, and inform the Research Course Director.

j. Faculty members desiring to work alone during non-duty hours must inform their supervisor. The intent here is to ensure supervisory knowledge of laboratory work performed in solitary conditions.
k. Correct all unsafe conditions immediately or report them to someone who can correct them. Post warning signs if immediate correction is not possible.
l. Before any operation is left running unattended, secure all water lines with wire or clamps, leave lights on in the area, and post signs on the door listing who and where to call if problems develop.
m. Dispose of all waste in accordance with the procedures in the Installation Hazardous Waste Management Plan (**West Point Supplement 1 to AR 200-1**) and the CHP.
n. Wash exposed hands and arms before leaving the lab.
o. Shaded eyewear used for recovery from medical procedures is not a substitute for protective eyewear; if shaded eyewear is required for medical reasons, protective eyewear must be worn as an addition to the shaded eyewear provided.

4.7 RULES FOR CORROSIVE, FLAMMABLE, AND MODERATELY TOXIC CHEMICALS

a. **Laboratory Supervision**--The greatest potential for injury is in cadet lab attendances. Injury prevention during labs requires that instructors brief cadets on safety hazards and frequently check their equipment set-ups and experimental procedures during the lab periods. In addition, cadets must read the comments on safety in the Chemistry Laboratory Instructions contained in their lab guidance or risk assessments.

    (1) Initial Lab Briefing--In each chemistry course, during the first lab attendance, instructors shall stress the importance of working safely in the lab. They shall briefly review the safety comments included in the Chemistry Laboratory Instructions in the laboratory manual for the course. Any cadet not present for the first lab period shall be briefed before he/she attends any subsequent lab period. S tudents and officers doing research will be briefed on safety by the research advisor.
    (2) Briefing for Individual Experiments-- “Notes for Instruction” will include safety information appropriate to each specific lab exercise. Instructors then include these items in their briefing at the beginning (and end, sometimes) of the lab period. Instructors screen the experiment for safety hazards and inform cadets of these hazards before the experiment begins. In every course, any cadet who arrives after the briefing should be individually briefed on safety hazards.
    (3) In doing demonstrations, instructors must follow the same safety procedures to be followed by the cadets; for example, wearing goggles and gloves to handle strong corrosives.
    (4) Where appropriate, instructors must also brief cadets on cleanup and disposal of spent chemicals.

(5) Supervision--At frequent intervals throughout the lab period, each instructor will circulate through the section to ensure that cadets are working safely: i.e., that equipment is safely assembled, experimental techniques are safe, protective equipment (goggles, aprons, etc) is used, reactions emitting hazardous gases are run under the hood vents, etc.
(6) Clean-up and Waste Disposal - Standard clean-up procedures followed in the lab requires that glassware used in the experiments is washed, removing chemical hazards which might injure others using the same glassware later.
(7) **Chemical waste will never be poured down the sink.** Always ensure that cadets follow the disposal instructions given in the briefing. Waste generation points set up at instructor positions or in waste hoods will be collected by laboratory personnel for transporting to the Satellite Accumulation Point(SAP) in BH 115. Researchers will transport their own chemical waste (and that of their research cadets), once properly labeled, from their laboratories to the SAP.

b. **Corrosives**

(1) Characteristics--Corrosives are those materials that actively attack tissue and often metals as well. Dilute corrosive materials are irritating and cause local inflammation. Corrosives include acids, bases, and such chemicals as phenol, bromine, thionyl chloride, etc. Concentrated corrosives can cause serious skin burns and even char the skin. Severe damage can be done to the respiratory tract, in particular the lungs. If swallowed, corrosive materials can cause serious burns of the gastrointestinal tract.
(2) In addition to their corrosive properties, acids have a number of other hazardous properties. For example, nitric acid is also a strong oxidizing agent and a poison. Some acids, such as sulfuric acid, react with many other compounds to produce heat and toxic fumes. Sometimes the reaction can be explosive. The combination of an acid and an organic compound can produce a fire.
(3) A number of corrosive materials, in addition to attacking the skin mucous membranes, eyes, or penetrate the skin. Phenol, for example, causes severe burns rapidly, penetrates through the skin, and acts as a systemic stomach poison. Corrosive materials in the gas phase, or in the gaseous form, are particularly dangerous because of the potential of pulmonary edema resulting from the attack on the lung tissue.
(4) Never use corrosives in locations where there is not an eyewash and chemical shower immediately available.

c. **Flammables**

(1) Characteristics--Flammables can be solids, liquids, or gases. Liquids and gases are more hazardous because they can be ignited by a

flame or heat source several feet or yards away from the vessel containing the liquid or gas. Flammable vapors are usually heavier than air, and thus are more apt to be found near the floor or benchtop. Ignition of flammables may cause an explosion.

(2) Handling Procedures
   (a) Large volume lab work with flammable liquids and gases should be done in a hood.
   (b) Open flames will not be used in any work area in which flammable liquids or gases are being handled. In labs with different chemistry courses present at the same time, instructors will ensure that no flames are being used in the other courses if flammables are to be used in theirs. Electric heating mantles or hot plates will be used for heating all flammable liquids.

d. **Moderately Toxic Chemicals**

(1) Characteristics--A toxic substance is anything that causes damage to the body when ingested, inhaled, or on skin contact. An individual chemical may be hazardous in one, two or all three ways. Moderately toxic means any chemical NOT listed as water reactive, shock sensitive, or carcinogenic in the appendices.

(2) Personal Protection--Wear gloves, goggles, and lab coats. If toxic vapors are involved, ensure adequate ventilation via fume hoods, bench hoods, or exhaust fans.

(3) Handling Procedures - Keep the quantity of toxic material handled to a minimum and dispose of properly. Follow all general rules for laboratory behavior.

4.8 RULES FOR WORK WITH CHEMICALS THAT ARE WATER-REACTIVE

a. Characteristics—Water-reactive chemicals when exposed to water present a fire or explosion hazard, generate enough heat to boil water, or cause burns to the skin. They may also generate flammable gases with enough heat to ignite the gases. Examples are: strong acids and bases, acid anhydrides, alkali metals (Li, Na, K), alkaline metals (Ca), hydrides, nitrides, carbides.

b. Personal Protection--Always avoid skin contact by use of proper gloves, lab coats, aprons and goggles. Always wash hands and arms immediately after working with these compounds.

c. Handling Procedures--When diluting strong acid or bases, always add the acid/base to the water not vice versa. Pouring water into concentrated acid can cause the formation of pockets of steam which could cause splashing of hot acid. Add the acid/base to the water slowly, in small quantities, to prevent heat buildup. This heat can crack non-Pyrex containers. These chemicals must be used in clean, dry locations and in/on a tray or in a containment area. Signs or warnings must be posted at unattended work areas indicating water reactivity.

d. Location and Storage--Store these chemicals in a cool, dry location with warning signs and adequate ventilation. All containers must be tightly sealed.
e. Spills and Accidents--Be prepared for accidents and spills by thinking ahead and having spill cleanup material nearby and a plan for cleanup ready. Follow the procedures specified on the material safety data sheet. Contaminated clothing should be removed prior to using a safety shower, if possible.
f. Waste--Store contaminated waste in a clearly labeled, closed container. Contaminated clothing shall be sealed in a plastic bag/container, labeled, and disposed of immediately. Dispose of all waste chemicals in the proper manner by containerizing, labeling, and storing in the satellite accumulation point.

4.9 RULES FOR WORKING WITH CHEMICALS THAT ARE EXPLOSIVE, HIGHLY REACTIVE OR SHOCK SENSITIVE

a. **Explosive chemicals** may detonate unexpectedly when handled, jarred, or subjected to high temperatures. Occasionally, it may be necessary to handle materials that are known to be explosive (examples are ammonium perchlorate and nitrogen triiodide) or that may contain explosive impurities such as peroxides. Unexpected detonation of even a small amount of explosive can cause blindness, maiming, and even death. Additionally, such a detonation may start fires which cause major damage. Frequently, chemicals which are not explosive can react explosively or react to form compounds which might explode. For example, isopropyl ether and diethyl ether combines with oxygen in the air to form highly shock-sensitive peroxides, and ammonium hydroxide reacts with iodine to form very shock sensitive nitrogen triiodide.

Any person desiring to work with known explosive materials must seek and gain Department Head approval in writing before any materials are procured or work commences.

(1) Personal Protection-- Work with explosive materials requires the use of special protective apparel (e.g., face shields, special protective gloves, and laboratory coats) and protective devices such as explosive shields, barriers or even enclosed barricades in an isolated room.
(2) Handling Procedures--The proper handling of highly energetic substances without injury demands attention to the most minute detail. The unusual nature of work involving such substances requires special safety measures and handling techniques that must be understood thoroughly and followed by all persons involved. Explosive materials should be brought into the laboratory only as required and in the smallest quantities adequate for the experiment. Insofar as possible, direct handling should be minimized. Always follow general laboratory safety rules. These materials will not be transported when in an unstable state. Closed containers will not be used for storage of unstable materials nor shall they be kept in a contained area. These materials shall be conspicuously marked/placarded. Keep away from heat sources.

(3) Location and Storage--Store these chemicals in designated storerooms approved by the Lab Program Director, segregated and isolated from other chemicals, and conspicuously marked with appropriate signs/placards. The storeroom must be cool, dry, and well ventilated. These chemicals should never be stored in a shock sensitive state, their physical condition frequently checked, and must be handled with care.
(4) Spills and Accidents--Be prepared for accidents and spills by anticipating problems, having clean-up material available, and a spill response plan. Follow procedures specified on the SDS. Clean up all spills immediately. Alert the Fire Department and evacuate the area if a large material spill occurs **or minor spill of an unknown.** Contaminated clothing must be neutralized with an inactivator/stabilizer, sealed in a labeled container and disposed of immediately.
(5) Waste--Store contaminated waste in a clearly labeled, closed container (do not use glass). Do not store in a shock sensitive state.

b. **Highly reactive or shock sensitive chemicals**

Special precautions are required for the safe use of highly reactive materials. It is the responsibility of the researcher or instructor to evaluate the reactive hazards involved in their work and to consult with their supervisor to develop detailed standard operating procedures for any work involving highly reactive substances. Work with highly reactive materials will generally require the use of special protective apparel (face shields, gloves, lab coats) and protective devices such as explosion shields and barriers.

Shock sensitive chemicals are a special class of compounds with unusually low stability that makes them among the most hazardous substances commonly handled in laboratories. Examples of shock-sensitive materials include many acetylides, azides, organic nitrates, nitro compounds, azo compounds, perchlorates, and peroxides. Although they are low-power explosives, they are hazardous because of their extreme sensitivity to shock, sparks, and other forms of accidental detonation. Many peroxides that are used in laboratories are far more sensitive to shock than most primary explosives such as TNT. Whenever possible, use a safer alternative.

(1) **Perchlorates will not be used within the Department of Chemistry and Life Science at any time**. Perchlorate salts of organic, organometallic, and inorganic cations are potentially explosive and may detonate by heat or shock. Safe alternatives should be used, such as fluoroborate, fluorophosphates, and trifluoromethanesulfonate. Work with perchlorates requires specially designed percholoric acid ($HCLO_4$) hoods that are not available within the Department.
(2) Organic peroxides are among the most hazardous substances handled in laboratories. As a class, they are low-power explosives, hazardous because of their sensitivity to shock, sparks, and even friction (as in a

cap being twisted open). Many peroxides that are routinely handled in laboratories are far more sensitive to shock and heat than high explosives such as Dynamite or trinitrotoluene (TNT), and may detonate rather than burn. All organic peroxides are highly flammable, and most are sensitive to heat, friction, impact, light, as well as strong oxidizing and reducing agents.

(3) Some peroxides in use in the Department are commercial compounds such as m- chloroperoxybenzoic acid, benzoyl peroxide, hydrogen peroxide, and t-butyl hydroperoxide. However, many common solvents and reagents are known to form peroxides on exposure to air, and these chemicals often become contaminated with sufficient peroxides to pose a serious hazard. Classes of compounds that form peroxides by autoxidation include: aldehydes including acetaldehyde and benzaldehyde, Ethers with primary and/or secondary alkyl groups, including acyclic and cyclic ethers, acetals, and ketals. Examples include diethyl ether, diisopropyl ether (especially dangerous!), dioxane, dimethoxyethane, tetrahydrofuran, ethyl vinyl ether and alcohols protected as tetrahydropyranyl ethers. Isopropyl alcohol also frequently forms peroxides upon storage. Hydrocarbons with allylic, benzylic, or propargylic hydrogens. Conjugated dienes, enynes, and diynes, among which divinylacetylene is particularly hazardous. Saturated hydrocarbons with exposed tertiary hydrogens; common peroxide-formers include decalin (decahydronaphthalene) and 2,5- dimethylhexane.

(4) **Precautions for work with peroxide forming materials**

(a) Personal Protection-- Work with explosive materials requires the use of special protective apparel (e.g., face shields, special protective gloves, and laboratory coats) and protective devices such as explosive shields, barriers or even enclosed barricades in an isolated room.

(b) Handling Procedures--The proper handling of highly reactive or shock sensitive chemicals without injury demands attention to the most minute detail. The unusual nature of work involving such substances requires special safety measures and handling techniques that must be understood thoroughly and followed by all persons involved. Highly reactive or shock sensitive chemicals should be brought into the laboratory only as required and in the smallest quantities adequate for the experiment. Insofar as possible, direct handling should be minimized. Protect peroxidizable compounds from physical damage, heat, and light. Always follow general laboratory safety rules. These materials will not be transported when in an unstable state. Closed containers will not be used for storage of unstable materials nor shall they be kept in a contained area. These materials shall be conspicuously marked/placarded. Keep away from heat sources.

(c) Location and Storage--Store these chemicals in designated storerooms approved by the Lab Program Director, segregated and

isolated from other chemicals, and conspicuously marked with appropriate signs/placards. The storeroom must be cool, dry, and well ventilated. Store peroxide forming materials away from heat and light. These chemicals should never be stored in a shock sensitive state, their physical condition frequently checked, and must be handled with care. Date peroxidizable containers with date of receipt and date of opening. Affixing a label stating "Warning, Peroxide Former" can also be helpful to alert others regarding these materials.

(d) Spills and Accidents--Be prepared for accidents and spills by anticipating problems, having clean-up material available, and a spill response plan. Follow procedures specified on the SDS. Clean up all spills immediately. Most solutions can be absorbed on vermiculite or other absorbing material and disposed of harmlessly according to Department procedures (see the Supervisory Chemist for assistance). Alert the Fire Department and evacuate the area if a large material spill occurs **or minor spill of an unknown.** Contaminated clothing must be neutralized with an inactivator/stabilizer, sealed in a labeled container and disposed of immediately.

(e) Waste--Store contaminated waste in a clearly labeled, closed container (do not use glass). Do not store in a shock sensitive state. Use or dispose of peroxides within time limits recommended on the label or SDS. Test for peroxidizables before distilling or evaporating peroxidizable solvents for research purposes. Do not distill for research purposes without treating to remove peroxides. It is illegal to evaporate or treat a regulated waste to avoid disposal of that material. All waste material should be disposed of properly as outlined in this CHP. If crystals are visibly present on the container or lid, or if the container is open but has not been tested, do not open. Contact the EHS Office (x5837) to arrange for disposal. Immediately rinse empty containers that once held peroxidizables. Do not let residues evaporate.

4.10 RULES FOR USE OF TOXIC CHEMICALS

a. Characteristics--Toxic chemicals cause damage to the body when ingested, inhaled, or by skin contact. Because of their very hazardous properties special precautions must be taken in their use, storage and disposal. A list of these compounds is located in Annex C and D. The list of OSHA Schedule Z, Toxic and Hazardous Substances, can be found on line at http://www.osha.gov under Regulations (Standards-29 CFR) Air contaminants – 1910.1000 Table Z-1, Limits for Air Contaminants; Table Z-2, and Table Z-3, Mineral Dusts.

b. Compounds with a High Degree of Acute Toxicity **--** Compounds that have a high degree of acute toxicity comprise a third category of particularly hazardous substances as defined by the OSHA Laboratory Standard. Acutely toxic agents include certain corrosive compounds, irritants, sensitizers (allergens), hepatotoxins, nephrotoxins, neurotoxins, agents that act on the hematopoietic

systems, and agents which damage the lungs, skins, eyes, or mucous membranes. Substances that have a high degree of acute toxicity are interpreted by OSHA as being substances that "may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration".

c. Toxic and Highly Toxic Agents - OSHA regulations (29 CFR 1910.1200 Appendix A) define toxic and highly toxic agents as substances with median lethal dose (LD50) values.

(1) It is important to note that the above classification does not take into consideration chronic toxicity (e.g. carcinogenicity and reproductive toxicity). Also, note that LD50 values vary significantly between different species, and the human toxicity for a substance may be greater or less than that measured in test animals. OSHA considers substances that are either toxic or highly toxic, as defined above, to be particularly hazardous substances.
(2) In evaluating the acute toxicity of chemical substances, the HMIS (Hazardous Materials Identification System) rating criteria developed by the National Paint and Coatings Association may be helpful. HMIS numbers can often be found in SDSs. LD_{50} values can be found in SDSs.
(3) Personal Protection--Wear gloves, lab coats, and goggles. ALL work must be accomplished in a hood. Hands must be washed immediately after working with these chemicals.
(4) Handling Procedures--The general rules for laboratory safety must be followed exactly. Hood must be used for these chemicals and work areas posted with warning signs if left unattended. SDSs should be consulted for precautions for each chemical used.
(5) Location and Storage--Store these chemicals in a cool dry location with warning signs and adequate ventilation. A sign-out sheet shall be used for any removal of chemicals from storage.
(6) Spills and Accidents--Be prepared for accidents and spills by anticipating problems, knowing the location of spill cleanup agents, and have a plan formed around the recommendations of the SDSs.
(7) Waste--Waste shall be stored in clearly labeled containers in the satellite accumulation point. Dispose of materials in accordance with all regulations.

4.11 MEDICAL PROGRAM

a. Laboratory workers and other exposed personnel with chemical exposure that the Occupational Health Department determines are significant enough to warrant medical surveillance will undergo periodic medical surveillance conducted by Occupational Health in accordance with AR 40-5 (Preventive Medicine) and USMA AR 40-5 (Medical Services Occupational Health Program).
b. Whenever an employee exhibits signs or symptoms related to exposure to a hazardous chemical, if exposure monitoring reveals a level above an action level, PEL or TLV, or if an employee is subjected to events such as spills,

leaks, or explosions or other unexpected occurrences where there is a likelihood of exposure to hazardous chemicals, they should be examined by Occupational Health.

c. Medical Attention--For any serious injury call the hospital for immediate assistance at extension 911. The number is posted at each phone. In less serious cases the patient can be assisted to the hospital or Occupational Health by co-workers or instructors. Proper paperwork must follow the patient to either place. (See Appendix D for sample paperwork. Reporting procedures are on the safety offices web site http://www-internal.usma.edu/safety/).

(1) Chemicals in the Eye--IMMEDIATELY begin flushing with water from the eyewash fountain and continue for a minimum of 15 minutes. Anyone nearby should assist by helping to hold the injured individual's eyelids open. In some cases, the eyelid may have to be forced open to allow proper flushing. Eyewash fountains must remain on after activation. Ensure eyewash fountains do not have spring loaded valves.

(2) Call the hospital to alert them that the injured party is on the way and describe the injury and type of chemical involved. ALWAYS ASSUME THAT AN INJURY HAS OCCURRED.

(3) Chemicals on the Body--IMMEDIATELY flush with plenty of water, using the safety shower if large areas are involved, for 15 minutes. All affected clothing shall be removed including shoes and socks. Do not allow these clothes to be put back on as they may be contaminated.

(4) Base burns can be more serious than acid burns. They do not precipitate protein like acids, thus they will penetrate deeper and do not usually cause pain as quickly as acids. Neutralizers, buffers and solvents should never be used as emergency treatment for chemical burns. The seconds lost looking for them can cause disaster. The use of solvents, such as alcohol for chemical burns, can spread the corrosive material and result in a more severe injury.

(5) Inhalation of Chemicals--Never assume that even short exposure to corrosive chemicals or high concentrations of any chemical dust, mist or vapor has not produced lung damage. Pulmonary edema can develop hours after exposure. Anyone over-exposed to corrosive vapor or dust should be immediately removed to fresh air and transported to the hospital.

(6) Ingestion of Chemicals--If someone has swallowed a hazardous chemical, determine conclusively what it was. Have someone call the hospital emergency room (number at each phone) and report the chemical ingestion. Follow their advice on treatment until help arrives. Always seek medical help for any hazardous chemical ingestion.

(7) Non-chemical Accidents (cuts, falls)--Whenever an accident occurs the protection of personnel is the primary concern. Keep calm and collect information. Call for help from the hospital or Occupational Health if necessary.

4.12 RECORDS

a. Every accident involving injury to cadets, staff, or faculty must be recorded on the proper forms. DA Form 285 AB must be completed by the victim's supervisor and submitted to the safety officer, who will then submit to the USMA Safety Office.
b. All monitoring records will be retained and reviewed annually by the Safety Committee.

4.13 WASTE DISPOSAL

a. General. The Department of Chemistry is required to comply with state, federal, OSHA, RCRA, EPA, HAZMAT, and EPCRA requirements and Army Environmental Command regulations with respect to the disposal of chemical waste. Fulfilling all of these requirements dictates strict adherence to the procedures described below.
b. Chemical waste is classified on the basis of its risk to the environment and the class of hazardous chemicals to which it belonged before being declared waste.
c. Nonhazardous inorganics. Certain nonhazardous inorganics can be flushed down the drain. These chemicals, which are found in abundance in the environment, pose no threat to it, especially in the minor quantities used in the chemistry labs; e.g., sodium chloride, potassium bicarbonate, iron (III) nitrate, etc. In addition, non-hazardous acids and bases (those with pHs between 2 and 12) can be flushed down the drain. More hazardous acids and bases (those with pHs outside 2 to 12) must be collected and treated with acid or base until the resultant pH is between 4 and 10, as determined by wide range pH paper. The resultant solution can then be disposed of down the drain and the quantity recorded for inclusion in the annual report to DHPW of treated wastes. Instructors in the teaching labs will follow the disposal directions of the Assistant Course Director (Laboratory) or the Course Director.
d. Insoluble inorganics. Nonhazardous chemicals which are not water-soluble can be disposed of in waste containers to be emptied by the building custodians; e.g., calcium oxalate, ferric hydroxide, and zinc sulfide.
e. Hazardous chemicals. Hazardous chemicals, whether solid or liquid, will NOT be disposed of in the drains or in the trash. Waste will be placed in glass or plastic containers in the lab and labeled for content using only the local use Hazardous Waste Label. DO NOT indicate a start date for waste accumulation; this is filled out by Hazardous Materials Branch personnel only. After labeling, transport the satellite accumulation point for storage with the appropriate documentation (see the waste accumulation point of contact for details). Examples of hazardous chemicals are mercury, chromium, lead, cadmium, and organics.

4.14 PHYSICAL, ELECTRICAL, AND MECHANICAL SAFETY

a. Any mechanical equipment with exposed moving parts present***s*** a hazard. Anyone working with such machinery (copiers, stirring motors, etc) should remove bracelets, dangling necklaces, etc. Loose fitting sleeves, etc. should be tied back or covered with a lab coat. Long hair should be gathered together and tied at the back of the neck.
b. Whenever possible, exposed moving parts should be covered by a protective shield to minimize the chance of accidental injury. Do not use equipment with protective shields removed.
c. Any reactions involving vacuum or pressure should be conducted behind a safety shield to protect from glass fragments in case of accidents. All evacuated vessels should be wrapped in tape to minimize hazards from breakage.
d. Ultraviolet light can cause considerable damage to the eyes. The absorption of this radiation by the outer layers of the eye (cornea and conjunctiva) produces conjunctivitis (sensation of “sand in the eyes”). When using UV lights for TLC analysis and other purposes, do not look directly at the lights, limit reflected light off the desktops, and limit time spent looking under lamps. Use of enclosed lights is best for long periods of time spent examining objects under UV light as it does not penetrate regular glass.
e. Electrical energy has potential for grave injury. Most people are aware of this and know how to avoid electrical shocks. The major problem in the Department of Chemistry is with high voltage. There are several demonstrations that utilize high voltage generated by a coil box to provide the energy for cathode ray tubes, and smoke precipitators. Great care must be taken in setting up such apparatus to prevent accidental contact with the high voltage.

4.15 RADIATION

The department currently has only one piece of equipment with a radiation source, the GC with an Electron Capture detector. This GC detector is under the license of the Physics Department and is wipe tested semi-annually by them for any leakage. In addition, the Chemistry Department borrows radioactive sources from the Physics Department once each year. When radioactive sources are in the department they will be kept secured until they are conveyed to the instructor who is responsible for them until they are returned to the lab personnel. Sources will be kept in a container displaying the radiation warning label.

4.16 WORKING WITH COMPRESSED GASES

a. Compressed gases expose laboratory personnel to both chemical and physical hazards. Additional hazards arise from the reactivity and toxicity of gases. Asphyxiation can be caused by high concentrations of even inert gases such as nitrogen. An additional risk of simple asphyxiants is head injury from falls due to rapid loss of oxygen to the brain. Death can also occur if oxygen levels

remain too low to sustain life. Also, the large amount of potential energy stored in a compressed gas cylinder makes the cylinder a potential rocket or fragmentation bomb.

b. Precautions are necessary for handling the various types of compressed gases, the cylinders that contain them, the regulators used to control their delivery pressure, the piping used to confine them during flow, and the vessels in which they are ultimately used. Prudent procedures for the use of compressed gas cylinders in the laboratory include attention to appropriate purchase, proper transportation and storage, identification of contents, handling and use, and marking and return of the empty cylinder to the supply company.
c. All compressed gas cylinders must be clearly labeled so they can be easily, quickly, and completely identified by all laboratory personnel. Clearly label all gas lines leading from a compressed gas supply to identify the gas, the laboratory served, and relevant emergency telephone numbers.
d. Secure compressed gas cylinders firmly at all times. A clamp and belt or chain, holding the cylinder between waist and shoulder height to a wall or bench top. Locate cylinders in well ventilated areas. Place cylinders so that the rotary cylinder valve handle at the top is accessible at all times. Valves should be either completely open or completely closed. Never leave the cylinder valve open when the equipment is not in use. Check cylinders, connections, and hoses regularly for leaks.

4.17 LABORATORY HOODS

a. Laboratory hoods control exposures to toxic, offensive, or flammable vapors. They protect users from implosions but *not* from explosions. If it is necessary to perform a procedure that could result in an explosion, conduct such work behind sturdy barriers that are designed and built for the purpose. Ordinary laboratory hoods are not strong enough to withstand the forces released in any but the mildest of explosions.
b. Before each use, ensure that the hood is working properly. If you have questions, ask the technician or the Lab Program Director. A properly operating laboratory hood requires both an adequate airflow and the absence of excessive air turbulence.
c. Never block, even partially, exhaust ports or slots in the rear wall and ceiling of the hood. Never alter the supply air vents to the room, especially air vents in the ceiling of the room that are near the hood. When using a hood, keep the sash closed, or open it only the minimum amount necessary.
d. Keep your face outside the plane of the hood sash. Place your equipment and do your work within the hood, at least 15 cm. (6 inches) from the front edge of the fume hood. That is, work as far back in the hood as practical, but do not block the rear vent openings.
e. Laboratory hoods are not storage cabinets. Chemicals stored in a hood can interfere with efficient hood operation, and, in the event of an accident or fire, every item in the hood may be involved.

4.18 CRYOGENIC LIQUIDS PRECAUTIONS AND SAFE HANDLING PROCEDURES

a. **Physical Properties**

Cryogenic liquids are extremely cold liquids that at normal temperature and pressure would be a gas. These very cold liquids provide a fluid media that is useful for researchers to preserve their sample materials and for laboratory experimental processes. This fact sheet provides a summary of the hazards and safe work practices for users of cryogens and can be referenced in the laboratory Chemical Hygiene Plan. The most common cryogens are nitrogen and helium.

b. **Hazards**

(1) Burns - Direct contact of skin and cryogenic liquids can cause cold burns and frost- bite. Prolonged contact may result in blood clots.
(2) Adhesion - The cold surface of equipment and piping containing cryogenic liquid can cause the skin to stick to the surface, which will then tear as you attempt to remove it. Even non-metallic materials are dangerous to touch at such low temperatures.
(3) Boiling and Splashing - Cryogenic liquids can boil and splash when first added to a warm container.
(4) Oxygen Deficiency and Asphyxiation - Cryogenic liquids have the potential to create an oxygen deficient environment because of their large liquid-to-gas volume displacement ratios, typically about 700:1.
(5) Pressure and Explosions - Large liquid-to-gas ratios can lead to rapid pressure changes as cryogenic liquids vaporize. All cryogens can condense sufficient moisture from the air subsequently freezing and blocking the opening of storage vessels. This can lead to an explosion from the buildup of trapped gases in the container; for instance, cryotubes stored in liquid nitrogen may explode when removed from the Dewar.
(6) Flammability and Explosions - Nitrogen and helium are considered non-reactive and non-flammable; however, liquid nitrogen and liquid helium can condense oxygen out of air. Liquid oxygen is VERY reactive and hazardous. Combustible substances exposed to liquid oxygen become more likely to ignite, will burn more vigorously, and may potentially explode. Materials usually considered non-flammable can burn vigorously in an oxygen enriched environment. Organic materials that can react violently with liquid oxygen include oil, grease, kerosene, tar, cloth, and asphalt. Any planned use with liquid oxygen should be reviewed by the Department of Environmental Health and Safety.

c. **Safe Handling Procedures**

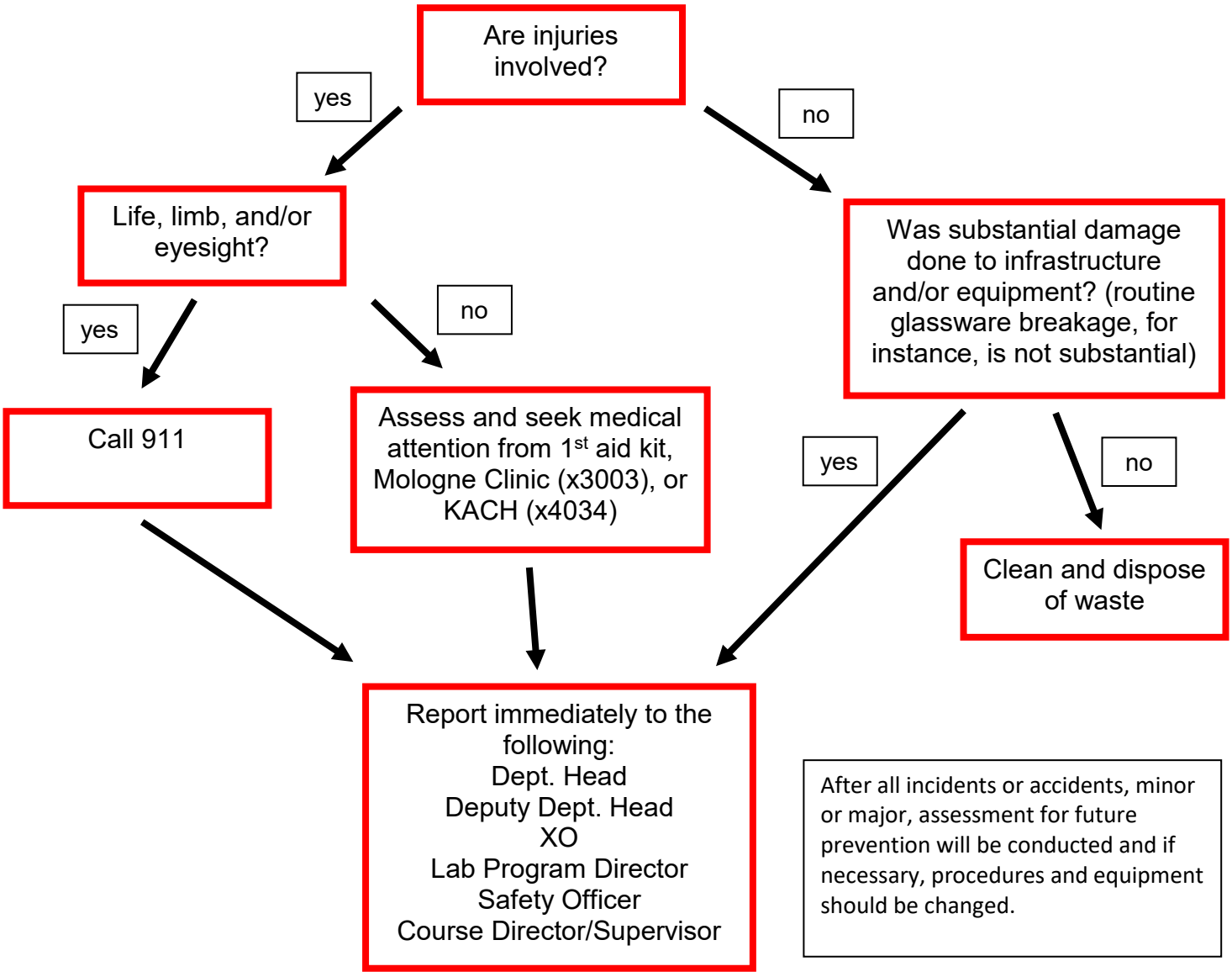
(1) Be familiar with hazards associated with cryogen use.
(2) Work in an open, well-ventilated location. Consider ventilation monitors or oxygen deficient sensors and alarms. Check the monitors and alarms before and during cryogen use.
(3) Always wear safety goggles and/or face shield.
(4) Always wear appropriate cryogen gloves; do not leave skin exposed. Do not wear metal jewelry or watches.
(5) Examine containers and pressure relief valves for signs of defect. Never use a container that has defects. Ask cryogenic vendor for assistance with questions on cryogenic equipment and pressure relief valves.
(6) Ensure that all equipment and containers are free of oil, grease, dirt, or other materials which may lead to flammability hazard upon contact with liquid oxygen.
(7) Select working materials carefully. Cold cryogenic liquids may alter the physical characteristics of many materials, make them brittle and fail.
(8) Verify there is pressure relief for any place that there can be a pressure build-up.
(9) All cryogenic systems and Dewars must have pressure relief valves to release excessive pressure, and bursting discs and loose fitting lids on Dewar flasks. The pressure relief valves should be inspected regularly.
(10) Use only fitted transfer tubes designed for use with the Dewar container. Damaged transfer tubes should be replaced. Do not handle transfer tubes with your bare hands as the fitting is not insulated.
(11) When transferring to a secondary container, do not fill the secondary container to more than 80% of capacity (60% if the temperature is likely to be above 30 C).
(12) Do not lower warm experiments into Dewars of cryogen.
(13) Immediately re-cap any container to prevent atmospheric moisture from entering and forming an ice plug in the opening.
(14) Provide proper venting for the Dewars used in experiments.
(15) Use care in transporting cryogens; do not use fragile containers. Use a hand truck or the lowest shelf of a cart for transport of cryogens. When available, use service elevators for transferring unsealed containers of cryogens.
(16) Store cryogens in well-ventilated areas to prevent oxygen deficiency.
(17) Use only approved storage vessels that have pressure relief valves.
(18) Never adjust, block, or plug a pressure relief valve. The vendor is required to check the pressure relief valve before filling the Dewar.
(19) Avoid contact of moisture with storage containers to prevent ice plugs in relief devices.
(20) Do not use cryogens or dry ice in walk-in cold rooms, because they may not have sufficient air exchange and could become hazardously oxygen deficient.

(21) Wear loose fitting gloves made for cryogenic work (blue cryogenic gloves) or smooth leather welding type gloves without gauntlets. Loose fitting gloves can be thrown off if some cryogen leaks or is spilled into them.
(22) Rubber gloves should not be used because they will harden instantly - if your hand is bent, you may not be able to remove your hand.
(23) A thin gas barrier forms between the skin and the cryogenic liquid when it is spilled on the skin. This will protect you unless the liquid hits you under force. This gas barrier is very cold and can also burn you.
(24) Use non-metallic tongs to add or remove materials from cryogenic liquids.
(25) Face shields and goggles provide the best protection for the eyes and face. Safety glasses will not protect your face, and cold liquids can hit your face and run under the glasses into your eyes. Safety goggles will keep liquid out of eyes but leave face exposed.
(26) When filling Dewars or transferring cryogenic liquids from one container to another, face shields must be worn.
(27) Avoid working with cryogens overhead, as a spill can more likely result in serious injury. Extra care should be taken when working with cryogens overhead, such as when filling lab equipment. If necessary use a ladder and work from above with no one below.
(28) An apron made of leather or other non-absorbent material should be used when working with liquid cryogens. Most clothing material will absorb spilled liquid cryogens, bringing the liquid close to the skin.
(29) If skin comes into contact with a cryogen, run the area under cool or warm water for fifteen minutes. Never use hot or cold water. The re-warming, or thawing, of affected area(s) should be done gradually. It may take up to 60 minutes to thaw the affected area(s) and bring back the natural color of the skin.

ANNEX A

Department of Chemistry and Life Science Pre-Accident Plan

Upon witnessing or being involved in an incident or accident in the laboratory, follow the steps below for the appropriate and prompt response:



Follow on actions:
**Department Head will determine whether a 15-6 investigation is required and initiate the action if necessary.
**Safety Officer will complete incident report (DA 285-AB) and submit to Garrison Safety Office.