Safety Handbook

Department of Natural Sciences

Northwest Missouri State University

December 2016

Introduction

In early 2009, University of California at Los Angeles graduate student Sheri Sangji was involved in a terrible lab accident. While handling a syringe of pyrophoric t-butyl lithium solution, she accidently removed the plunger from the syringe causing the compound to burst into flame and ignite her synthetic sweater. She was wearing nitrile gloves but no flame retardant lab coat. She suffered serious burns over 40% of her body and subsequently died of her injuries 18 days later. Her supervisor was Dr. Patrick Harran, a highly regarded chemist doing cutting edge cancer research. Subsequent investigation revealed that Ms. Sangji had missed her mandatory chemical safety training and that Dr. Harran's laboratory had been cited only two weeks before the accident for numerous safety violations. The university settled the case with the state by creating a Center for Lab Safety, establishing comprehensive corrective safety measures, and endowing with half a million dollars a scholarship in Ms. Sangji's name. As of 2014 Dr. Harran faces criminal prosecution for four felony counts of negligence that could result in 4-1/2 year prison sentence. (Christensen, Kim 2013, "UCLA Professor to Stand Trial in Death of Assistant in Lab Fire", *Los Angeles Times* online http://articles.latimes.com/2013/apr/26/local/la-me-ucla-prof-20130427.)

The purpose of this document is to provide faculty, staff, and students in the Department of Natural Sciences with the guidance, procedures, and techniques necessary to operate in a safe manner. Many of the department's activities such as handling hazardous chemical and biological materials, and travel and research to off campus locations are inherently dangerous. Thus safety and composite risk management (CRM) are the responsibility of everyone in the department.

The Department of Natural Sciences consists of the five disciplines of biology, chemistry, geology, physics, and nanoscale science. Given the diverse nature of department activities, a one-size-fits-all approach to safety will not work. Thus the department embraces customized safety plans for each discipline area tied together through the implementation of composite risk management (CRM).

Composite risk management is the process of identifying and reducing risk through the implementation of appropriate risk mitigation procedures. Department faculty and staff create a CRM worksheet for each class, lab, or activity that poses a risk to health and safety. The CRM worksheet with instructions is provided in Appendix 1. The CRM process involves five steps for each subtask of a major activity: identify the hazards, assess the risk, develop controls to mitigate the risk, implement the controls, and supervise and evaluate. This is a never-ending circular process.

This Safety Handbook consists of general safety information, guidance, procedures, and techniques followed by discipline specific chapters. Appendices provide guidance and tools applicable to all disciplines and departmental personnel.

Leadership is a key component of any safety program. The Chair of Natural Sciences provides overall leadership by taking personal responsibility as the senior departmental safety officer. All departmental personnel are safety officers and must set the example by personally adhering to safety standards and procedures, teaching students about safety, and insisting on adherence to safety standards and procedures in every departmental activity—everyday. Northwest owes nothing less than safety excellence to our students, their families, and ourselves.

Important contact Information

Personnel	**Phone number**	**E-mail**
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Emergency Contact	**Phone Number**
University Police	660-562-1254
Fire and Ambulance	911

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Part A

General Safety

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Responsibilities

Department Chair

The department chair is responsible for the establishment and implementation of a safety program. In addition the department chair is responsible for:

- Maintaining the safety program and promoting safe practices and procedures;
- Providing documentation for the safety program;
- Ensuring compliance among instructors, students, researchers and lab personnel.
- Ensure that faculty/activity supervisors/staff vacating a laboratory space decontaminate and clean all equipment, work areas, and storage areas prior to another employee's use of the laboratory.

Prior to the commencement of classroom, laboratory or field activities for educational or research purposes a Composite Risk Management Worksheet (CRM) found in Appendix 1 must be submitted to the department chair. The chair should be notified when changes are made to the scope of the existing work. The CRM is a framework for assessing real and potential risks of procedures to be performed and determining what controls should be implemented to ensure safety for all involved.

For instance the CRM will assist in:

- Determining the real and potential biohazards of a proposed activity
- Determining the appropriate equipment, practices and procedures to ensure containment of chemical and biohazards
- Selecting the microbiological practices and laboratory techniques for handling potentially infectious agents and recombinant or synthetic nucleic acid materials
- Preparing procedures for dealing with accidental spills and personnel and environmental contamination
- Identifying risks associated with the work performed in the lab and determining the applicability of various precautionary medical practices, serological monitoring, and immunization

Faculty/Activity supervisor

In regard to safety and regulatory compliance, the key person in the classroom, laboratory and the field is the faculty or activity supervisor. The activity supervisor may be an instructor, principal investigator (PI) or other full-time university employee. This is the individual who has been assigned the responsibility and discretionary authority to set work practices. The attitude of this person will be reflected by others working in the laboratory.

The activity supervisor is responsible for:

- Administering the safety program;
  - Provide discipline and enforce rules
  - Be alert for unsafe conditions
  - Promptly take effective corrective action when necessary
- Participating in appropriate training programs;
  - proper use and maintenance of emergency equipment

    - new hazardous chemical labeling requirements
- Training and supervising students;
    - Review procedures with students for potential health, safety and environmental problems
    - Train students in appropriate Standard Operating Procedures and document training

Specifically, the activity supervisor has the primary responsibility for:

- Performing risk assessments for activities and procedures to be performed in the lab and completing a Composite Risk Management Worksheet (CRM)
- Securing approval by the appropriate University compliance committees (e.g. IRB, IACUC) for the proposed activity or research prior to initiation of work
- Completing annual reviews and renewals of compliance committees, as required, in a timely manner
- Providing appropriate procedural and laboratory specific training to personnel particularly students
- Providing all the appropriate personal protective equipment to laboratory personnel for work performed
- Enforcing safety practices and procedures that have been determined to be appropriate for the activity/lab
- Ensuring proper operation of and performing preventative maintenance on laboratory and activity equipment
- Reporting accidents and exposure incidents to the Chemical Safety Manager

Students/Laboratory Personnel

Students/research laboratory personnel are ultimately responsible for working safely in the laboratory. Persons should ensure that all work is conducted in accordance with recognized chemical and biological safety procedures and should follow the Department of Natural Sciences Safety Handbook except where superseded by a more stringent guideline determined by the activity supervisor.

All students and laboratory personnel must complete all required training and help to maintain laboratory safety through compliance with laboratory procedures and communication with the activity supervisor.

The responsibility of students and laboratory personnel includes knowing:

- specific activity practices (SOPs)
- potential hazards of chemicals and infectious agents in use
- emergency and spill procedures
- location and use of safety equipment and facilities
- signs and symptoms of lab acquired infections or exposures to the materials in use

Safety and Emergency Equipment

Eyewash Stations and Safety Showers

- Every faculty member, activity supervisor, laboratory personnel and student must know the location of eyewash stations and safety showers and how to operate the safety equipment.

- Eyewash stations and safety showers are located in several places within the department. Signs indicating the location of these safety devices will be posted in each area.
- Eyewash stations will be flushed for 3 minutes once a week by the chemical safety manager. Safety showers will be tested monthly. Eyewashes must be capable of a flow rate of 0.4 gallons per minute for 15 minutes, and the safety showers must have a flow rate of 20 gallons per minute (ANSI recommendation).
- Problems with eyewash stations and safety showers should be reported immediately.
- The area around all eyewash stations and safety showers must be kept clear to allow easy access.
- When the eyes are exposed to chemicals, they must be flushed for 15 minutes. The eyelids should be held open and the eyes constantly moved during the 15 minute flushing period. Contact medical personnel promptly after first aid treatment. An incident report (Appendix 2) must be completed after the individual is attended.
- When chemicals are spilled on the skin or clothing, the individual should immediately proceed to the safety shower and remove contaminated clothing. An emergency situation is not the time for modesty. Contaminated shirts and sweaters should be cut off to prevent spreading chemicals to the face. The minimum flushing time is 15 minutes. Medical personnel should be contacted. An incident report (Appendix 2) should be completed after the individual is attended.

Fire Extinguishers and Blankets

- Fire extinguishers and blankets are located in laboratories or in several places within the department.
- Their locations must be clearly marked. Fire extinguishers must be inspected monthly and recharged annually by the Health and Safety Manager.
- Fire extinguishers must be compatible with the type of fire. Incompatible extinguishers can make the fire much worse. The lab supervisor should evaluate the chemicals and materials most commonly used in the lab, and contact the Health and Safety Manager for assistance in the selection of appropriate fire extinguishers.
- Only persons with hands-on training should operate a fire extinguisher.
- Fires should be fought only if escape is possible. Do not fight a fire that starts between you and the exit, leave immediately.
- If you discharge a fire extinguisher even briefly, it should be immediately reported to the Health and Safety Manager so that it can be recharged or replaced.

First Aid Kits

- First aid kits are located in all the laboratories and in several places within the department
- There is signage indicating locations of first aid kits.
- Notify the chemical safety manager of any supplies in the first aid kit that need to be replenished or replaced
- The first aid kits will be restocked annually or more often as needed by the Chemical Safety Manager in conjunction with the University Wellness Services.
- If first aid is given, follow-up with trained emergency medical personnel is recommended.

Chemical Spill Kits

- Chemical spill kits are located in all laboratories that store chemicals.
- Chemical spill kits are labeled for identification.
- Each spill kit contains materials to contain small manageable spills of hazardous acid, base, oils and volatile chemicals.
- **It is recommended that you familiarize yourself with the contents of the spill kit BEFORE a hazardous chemical spill occurs.**

Practices and Procedures

General Safety

- A room safety policy is posted in all laboratory areas
- Wear proper attire for the activity (lab, field work, etc.)
- Follow instructions and standard operating procedures as given by lab supervisor
- Refrain from horseplay during an activity
- Avoid working alone if possible
- Immediately notify the lab supervisor of any unsafe working conditions or practices

Warning Signs and Labels

- Emergency telephone numbers are posted prominently in each laboratory.
- Signs should be posted to draw attention to the location of emergency equipment such as the fire extinguisher, fire blanket, eyewash station, safety shower and first aid kit.
- All labs should have a list of emergency contacts posted inside the lab or on the lab door.
- All containers must be labeled with their contents and a hazard warning (if applicable).
- Lab refrigerators and freezers should be clearly labeled with signs stating that no food or drink is allowed.

Housekeeping

- Maintain a clean and uncluttered work space.
- Workers are jointly responsible for common areas.
- Doorways and walkways shall not be blocked or used for storage.
- Do not block access to exits, hallways and emergency equipment.
- Equipment and instruments should be cleaned and decontaminated as necessary.

Part B

Biological Safety

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Biohazards and Potentially Infectious Material

Definition

Biohazards are infectious agents or biologically derived materials that present a risk or potential risk to the health of humans or animals, either directly through infections or indirectly through damage to the environment. Infectious agents have the ability to replicate and give rise to the potential of large populations in nature when small numbers are released from a controlled situation.

Biohazardous material" means any material that contains or has been contaminated by a biohazardous agent. Biohazardous agents include, but are not limited to:

- Human, animal and plant pathogens - bacteria; fungi; viruses; rickettsiae; chlamydia; prion, parasites
- Cultured human and animal cells and the potentially biohazardous agents these cells may contain
- All human blood, blood products, tissues and certain body fluids
- Certain recombinant products
- Allergens
- Infected clinical specimens
- Tissue from experimental animals; plant viruses, bacteria and fungi
- Toxins

Routes of Biohazard Exposure

Exposure and subsequent infection of an individual with a biohazardous agent can occur by several routes, i.e., aerosol inhalation, splash, animal bites, sharps, and similar situations where direct contact can occur.

Aerosols

Some of the laboratory operations which release a substantial number of droplets are almost trivial in nature, such as breaking bubbles on the surface of a culture as it is stirred, streaking a rough agar plate with a loop, a drop falling off the end of a pipette, inserting a hot loop into a culture, pulling a stopper or a cotton plug from a bottle or flask, taking a culture sample from a vaccine bottle, opening and closing a petri dish in some applications, or opening a lyophilized culture, among many others. Most of these only take a second or so and are often repeated many times daily. Other more complicated procedures might be considered more likely to release organisms into the air, such as grinding tissue with a mortar and pestle, conducting an autopsy on a small animal, harvesting infected tissue from animals or eggs, intranasal inoculation of small animals, opening a blender too quickly, etc. The possibility of aerosol production should always be considered while working with infectious organisms.

Contact

The control of potential exposure by the contact route requires that procedures be conducted in a manner that avoids contamination of body or work surfaces. This is accomplished through the use of gloves and other personal protective clothing, protection of work surfaces with appropriate absorbent disposable covering, use of care in the performance of procedures, and cleaning and disinfecting work surfaces. Procedures where exposure via direct contact may occur include: decanting of liquids,

pipetting, removal of screw caps, vortex mixing of unsealed containers, streaking agar surfaces, and inoculation of animals.

It should also be recognized that dispersal of contaminants to other surfaces can occur by their transfer on the gloves of the laboratory worker, by the placement of contaminated equipment or laboratory ware, and by the improper packaging of contaminated waste.

Oral

Mouth pipetting is prohibited. Mechanical pipetting devices are required. Indirect oral exposures can be avoided through the use of the personal hygienic practice of regular hand washing, no eating or drinking in the work area, and by not placing any objects, including fingers, into the mouth. The wearing of a N-95 dust and vapor mask or face shield will protect against the splashing of biohazardous material into the mouth.

Splash

The wearing of a face shield, safety glasses, or goggles will protect workers against splashing biohazardous material into the eyes.

Sharps

The single procedure that presents the greatest risk of exposure through inoculation is the use of a needle and syringe. These are used principally for the transfer of materials from diaphragm-stoppered containers and for the inoculation of animals. Their use in the transfer of materials from diaphragm-stoppered containers can, in addition, result in the dispersal of biohazardous material onto surfaces and into the air. Depending upon the route of inoculation of animals, the use of a needle and syringe may also result in the contamination of the body surfaces. Because of the imminent hazard of self-inoculation, the use of the needle and syringe should be limited to those procedures where there is no alternative, and then the procedure should be conducted with the greatest of care. Inoculation can also result from animal bites and scratches.

Animal Exposure

Animals have the potential to cause injury, transmit zoonotic disease, and/or cause allergic reaction to those who have contact. These animal hazards can occur by either direct contact from handling an animal or just by being in close proximity, i.e., working or passing through an animal housing room. Understanding routes of disease transmission, disease or allergy signs and symptoms, personal protective equipment (PPE), waste handling, and emergency contacts is very important.

Biological Agent Risk Classification

Biological agents are categorized in Classes or Risk Groups based on their relative risk. The classification system takes the following into consideration: pathogenicity of the organism, mode of transmission and host range, availability of effective preventive measures (e.g., vaccines), availability of effective treatment (e.g., antibiotics), and other factors.

Class 1 (NIH Risk Group One)
Agents of no or minimal hazard under ordinary conditions or handling.

Class 2 (NIH Risk Group Two)
Agents of ordinary potential hazard. This class includes agents which may produce disease of varying degrees of severity from accidental inoculation or injection or other means of cutaneous penetration but which are contained by ordinary laboratory techniques.

Class 3 (NIH Risk Group Three)
Agents involving special hazard or agents derived from outside the United States that require a federal permit for importation unless they are specified for higher classification. This class includes pathogens that require special conditions for containment.

Class 4 (NIH Risk Group Four)
Agents that require the most stringent conditions for their containment because they are extremely hazardous to laboratory personnel or may cause serious epidemic disease. This class includes Class 3 agents from outside the United States when they are employed in entomological experiments or when other entomological experiments are conducted in the same laboratory area.

NOTE: See Appendix 3 for the classification of various biological agents.

Biosafety Levels

In contrast to Risk Groups, Biosafety Levels (BSL) prescribe procedures and levels of containment for the particular microorganism or material. There are four BSLs which consist of combinations of laboratory practices and techniques, safety equipment, and lab facilities. Each combination is specifically appropriate for the operations performed, the documented or suspected routes of transmission or the infectious agents, and for the laboratory function or research. The biosafety level recommendation for an organism is the level at which that organism can be handled safely.

Appendix 4 contains a summary of practices, equipment and facility requirements for agents assigned to biosafety levels 1–4 (BSL 1–4). Only work at biosafety levels 1-2 is permitted at Northwest Missouri State University. No work at biosafety level 3 or 4 is allowed at the University.

Practices and Procedures

Adherence to standard practices and techniques for a particular activity is critical to ensure safety of all involved. Persons working with biohazardous materials must be aware of potential hazards and must be trained and proficient in the techniques required to handle the material safely.

When standard safety practices are not sufficient to control the hazards associated with a particular agent or procedure, additional measures will be needed. Appropriate facility design and engineering features, safety equipment and management practices must supplement personal safety practices and techniques.

Signage and Labeling

The responsible individual(s) must ensure that labels on incoming containers of biohazardous agents are not removed or defaced. They must also ensure laboratory containers of biohazardous agents are labeled where required. Laboratory containers, including bottles, flasks, sample vials, etc., must be marked, labeled or coded in all cases. This will aid in preventing any confusion concerning agent identification. An example of an appropriate label may be found in Appendix 5.

A completed Laboratory Information Sheet (Appendix 11) should be posted on the outside door of all laboratories. The information sheet contains the universal biohazard warning label (Fig 1), which should also be posted on any equipment used for storage or manipulation of biohazardous material which is potentially infectious to humans. Materials considered infectious to humans include but are not limited to:

Figure 1
International symbol for biological hazards

- Human pathogens, Risk Group 2* and above (viral, bacterial, fungal, parasitic, or prion)
- Animal blood and/or tissues infected with agents also infectious to humans
- Human blood, blood products, or fluids
- Human derived cell lines or tissues
- Viral vectors
- Live vaccines

* http://oba.od.nih.gov/rdna/nih_guidelines_new.htm#_Toc331174051

Examples of proper placement of signage using the universal biohazard symbol include:

- Doors to laboratories which contain or manipulate materials
- Animal housing or procedure rooms where agents infectious to humans are present
- All equipment and materials used to manipulate, or store materials (ex: centrifuges, freezers)
- Containers used to transport biohazardous materials between locations
- Waste containers for untreated biohazardous waste

Infectious Agents

Standard practices provide safe methods for managing infectious agents in the laboratory environment where they are being handled or maintained. The purpose of these practices are to reduce or eliminate exposure of people and the outside environment to potentially hazardous agents. The following are some standard practices and procedures.

Standard Microbiological Practices

- Access to the laboratory is limited or restricted when work with biohazardous agents is in progress. Laboratory doors are kept closed when experiments are in progress.
- Work surfaces are decontaminated daily and after any spill of biohazardous material.
- All contaminated liquid or solid wastes are decontaminated before being disposed of or otherwise handled.
- Mechanical pipetting devices are used; mouth pipetting is prohibited.

- Eating, drinking, smoking, storing of food for human consumption, handling contact lenses and applying cosmetics are not permitted in the work area.
- Persons wash their hands after they handle biohazardous materials and animals and when they leave the laboratory.
- All procedures must be carefully performed to minimize the creation of aerosols.
- The wearing of laboratory coats, gowns, or uniforms is recommended when feasible. Laboratory clothing or gloves must not be worn in non-laboratory areas.
- Contaminated materials are to be decontaminated away from the laboratory and placed in a durable leak-proof container that is covered before being removed from the laboratory.
- Safety protocols for the handling of sharps, such as needles, scalpels, pipettes, and broken glassware are adhered to.
- An insect and rodent control program is maintained.
- Incidents that may result in exposure to infectious materials must be immediately evaluated and treated accordingly.
- Animals and plants not associated with the work being performed must not be permitted in the laboratory.

The following are specific to activities in which BSL-2 organisms are used.

- In general, persons who are at increased risk of acquiring infection or for whom infection may be unusually hazardous are not allowed to work with BSL-2 organisms. Persons at increased risk may include children, pregnant women, and individuals who are immunodeficient or immunosuppressed. Each individual circumstance should be assessed by the activity supervisor to determine who may enter or work in the area.
- The activity supervisor will assure that only persons who have been advised of the potential hazard and who meet any specific entry requirements (e.g., immunizations) enter the laboratory or animal rooms.
- When biohazardous materials or infected animals are present in the laboratory or animal rooms, a hazard warning sign incorporating the universal biohazard symbol is posted on all laboratory and animal room access doors and on such other items (i.e., equipment, containers, materials) as appropriate to indicate the presence of biohazardous agents. The hazard warning sign should identify the agent, list the name of the responsible person(s), and indicate any special requirements for entering the area (immunization, respirators, etc.).
- Animals not involved in the experiment being performed are not permitted in the laboratory.
- All wastes from laboratories and animal rooms must be appropriately decontaminated before being disposed.
- The use of hypodermic needles and syringes is restricted to gavage, parenteral injection, and aspiration of fluids from laboratory animals and diaphragm vaccine bottles. Hypodermic needles and syringes are not used as a substitute for automatic pipetting devices in the manipulation of biohazardous fluids. Serial dilutions of biohazardous agents should not be done in diaphragm bottles with needles and syringes because of the hazards of autoinoculation and of aerosol exposure. Cannulas should be used instead of sharp needles whenever possible.

- If activities of lesser biohazard potential are conducted in the laboratory concurrently with activities requiring Biosafety Level 2, all activities will be conducted at Biosafety Level 2.
- Gloves will be worn for all procedures requiring the handling of biohazardous materials or infected animals. If feasible, hold small laboratory mammals with restraint devices when they are receiving injections or otherwise being handled provides an additional level of protection for personnel.
- Serological procedures with inactivated antigens shown to be free of residual infectivity can be performed on the open bench.
- All spills, accidents, and overt or potential exposures to biohazardous materials must be immediately reported to the activity supervisor. A written record must be prepared and maintained. Appropriate medical evaluation, surveillance, and treatment must be provided.
- When appropriate, considering the agent(s) handled, baseline serum samples are collected from and stored for all laboratory and other at-risk personnel. Additional serum specimens may be collected periodically depending on the agents handled or the function of the facility.
- A safety or operations manual identifying known and potential hazards and specifying practices and procedures to minimize or eliminate such risks should be prepared or adopted. Personnel should be advised of special hazards and are required to follow standard practices and procedures.

Containment equipment

- Biological safety cabinets (Class II) or other appropriate personal protective or physical containment devices are used for working with BSL-2 organisms whenever:
  - Procedures with a high potential for creating biohazardous aerosols are conducted. These may include centrifuging, grinding, blending, vigorous shaking or mixing, sonic disruption, opening containers of biohazardous materials whose internal pressures may be different from ambient pressures, inoculating animals intranasally, and harvesting infected tissues from animals or eggs.
  - High concentrations or large volumes of biohazardous agents are used. Such materials may be centrifuged in the open laboratory if sealed heads or centrifuge safety cups are used and if they are opened only in a biological safety cabinet.

- It is recommended that fungi cultures be manipulated in a biological safety cabinet when practical. Particular care is required when opening plates, tubes, or bottles containing fungi, for this operation may release a large number of spores.

Laboratory Facilities

- The laboratory should be designed so that it is easily cleaned.
- Bench tops should be impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.
- Laboratory furniture should be sturdy and spaces between benches, cabinets, and equipment should be accessible for cleaning.
- Each laboratory should contain a hand washing sink. It is preferred that the sinks be foot or elbow operated when working with BSL-2 organisms.

- If the laboratory has windows that open, they should be fitted with fly screens.
- An autoclave for decontamination of infectious laboratory wastes should be available in the same building as the laboratory.

Animals

All animal protocols involving the use of rDNA; infectious or transmissible agents; human blood, body fluids or tissues; toxins; carcinogenic, mutagenic, teratogenic chemicals; or physically hazardous chemicals (reactive, explosives, etc.) must be submitted to the University Institutional Animal Care & Use Committee (IACUC). Refer to the Northwest Missouri State University IACUC Handbook, the National Research Council Guide for the Care and Use of Laboratory Animals or view http://www.aphis.usda.gov/ for further animal use information.

Animals on Campus

The spread of infectious agents between animal populations or between animals and humans can be prevented by adhering to basic guidelines.

- All animal room doors must remain closed at all times, except when entering and exiting the room.
- Eating, drinking, smoking, applying cosmetics, and handling contact lenses in animal rooms or procedure rooms is prohibited.
- Hand contact with the nose, eyes or mouth is strongly discouraged when working with animals.
- Hands must be washed with soap and water immediately after handling any animals or animal equipment, and before leaving the animal facility or laboratory.
- Extra caution must be taken with needles or other sharp equipment used with animals. Needles should remain capped until ready to use and then promptly and properly discarded. Remember to keep a designated sharps container nearby for disposal of sharps, and don't recap unless absolutely necessary. See Appendix 6 for acceptable methods for needle recapping.
- Handling only those animal species for which proper handling training has been provided can prevent injury.
- Any bites or other wounds must be washed immediately with soap and water and appropriate medical attention sought. All accidents and injuries occurring at work or in the course of employment must be reported to the individual's supervisor, even if no medical attention is required:
- Unauthorized persons are prohibited from entering animal rooms.

When working with animals that have been treated with known infectious or transmissible agents special precautions must be adhered to.

- Disposable gloves should be worn when handling animals, bedding or soiled cages.
- Disposable or washable outer garments (such as lab coats, gowns, coveralls) should be worn to protect personal clothing from contamination when working with animals.
- Careful handling procedures should be employed to minimize the dissemination of dust from animal and cage refuse.

- Footbaths should be used (if provided) when entering and leaving animal rooms.
- Cages, bowls and watering devices should be thoroughly disinfected regularly.
- Bedding materials from cages used for animals infected with agents transmissible to humans should be decontaminated (preferably by autoclaving) before being discarded.

Animals in the Field

Fieldwork involving wild animals requires adapting the basic animal infection control guidelines to the particular situation in the field. Wild animals potentially transmit many diseases, including rabies, Hantavirus Pulmonary Syndrome, Leptospirosis, West Nile Virus infection, Salmonellosis, Tularemia and plague. Field work may also involve exposure to disease-transmitting insects and arthropods. Take appropriate precautions to prevent exposure to diseases, such as West Nile Virus infection or Lyme Disease, carried by insect and arthropod vectors. Individuals should consult Safety Guidelines for Field Experiences in **Appendix 7** for more detail safety information about working in the field.

Sharps

Policies for the safe handling of sharps, such as needles, scalpels, pipettes, and broken glassware must be developed and implemented. Whenever practical, activity supervisors should adopt improved engineering and work practice controls that reduce risk of sharps injuries.

Precautions, including those listed below, must always be taken with sharp items. These include:

- Careful management of needles and other sharps are of primary importance. Needles must not be bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal.
- Used disposable needles and syringes must be carefully placed in conveniently located puncture-resistant containers used for sharps disposal.
- Non disposable sharps must be placed in a hard walled container for transport to a processing area for decontamination, preferably by autoclaving.
- Broken glassware must not be handled directly. Instead, it must be removed using a brush and dustpan, tongs, or forceps and placed in a container labeled “Broken Glass Only”. Any broken glassware that is contaminated with infectious material must be autoclaved prior to disposal.
- Plastic ware should be substituted for glassware whenever possible.

Syringes and Needles

The hypodermic needle is a dangerous instrument. To reduce the chance of accidental injection, aerosol generation, or spills, the use of syringes should be avoided when alternate methods are available. Needles used to transfer and inject biological and non-biological containers should be avoided as this is an unnecessary use of sharps in the lab. Replace sharp needles with blunt needles of the same gauge whenever possible.

The following practices are recommended for hypodermic needles and syringes:

- Use the syringe and needle in a biological safety cabinet only and avoid quick and unnecessary movements of the hand holding the syringe.

- Examine glass syringes for chips and cracks and needles for barbs and plugs. This should be done prior to sterilization. Use of needle-locking syringes is advised and be sure that the needle is locked securely into the barrel. Replace glass syringes with plastic disposable syringes whenever possible.
- Expel excess air, liquid, and bubbles from a syringe vertically into a cotton square moistened with an appropriate disinfectant.
- Do not use the syringe to forcefully expel a stream of infectious fluid into an open vial for the purpose of mixing.
- If syringes are filled from test tubes, take care not to contaminate the hub of the needle, as this may result in the transfer of infectious material to the fingers.
- When removing a syringe and needle from a rubber-stoppered bottle, wrap the needle and stopper in a cotton square moistened with an appropriate disinfectant. If there is concern of the disinfectant contaminating sensitive experimental materials, a sterile cotton square may be used and immediately discarded into a biohazard bag.
- When inoculating animals, position the hand that is holding the animal in such a way that puncture wounds are avoided.
- Be sure the animal is properly restrained prior to the inoculation and be on the alert for any unexpected movements of the animal.
- Before and after injection of an animal swab the injection site with an appropriate antiseptic.
- Discard syringes into an appropriate sharps container.
- Do not bend, shear, or otherwise manipulate the needle.

Ethidium Bromide

Ethidium bromide (EtBr) is commonly used in laboratories to visualize DNA or RNA during or after electrophoresis. It is not specifically defined as an Environmental Protection Agency (EPA) hazardous waste nor is it listed as a carcinogen by multiple regulatory agencies. Since it tests positive in several mutagenicity assays, caution should be used when handling concentrated ethidium bromide stock solutions and e6thidium bromide in crystal/powder form and resultant waste. At high concentrations it is irritating to the eyes, skin, mucous membranes and upper respiratory tract. The toxic effects of EtBr may be experienced if swallowed, inhaled, or absorbed through the skin. Refer to the Ethidium Bromide Waste Management Guidelines found in **Appendix 8** for detailed procedures.

Personal Protective Equipment (PPE)

Personal protective equipment (protective clothing and safety apparatus/equipment) should be used to protect from contact with infectious, toxic and corrosive agents, excessive heat, cold, fire, and other physical hazards. Suitable Personal Protective Equipment (PPE) also protects the experiment from contamination. The extent and kind of clothing and equipment to be selected for any particular activity depends upon the activity and levels of associated risk. While PPE is an important component of any biological safety program, PPE is used with the understanding that PPE serves as a second line of defense. Good techniques, procedures, and appropriate equipment are the primary barriers against potential exposure to hazardous agents. For assistance in performing risk assessments and determining PPE contact the Health and Safety Manager. Below are some general guidelines for the use of PPE.

General Guidelines for the Use of PPE:

- Overt exposure to agents at all level of risk should be followed by immediate decontamination of the PPE and change into clean PPE to protect the individual, the experiments and the environment.
- Provisions should be made for PPE to be provided to visitors and maintenance or security personnel, if applicable.
- PPE worn within the laboratory should not be worn outside the laboratory.
- Personnel should be encouraged to use disposable facial tissues instead of personal handkerchiefs.
- PPE should be placed in an appropriately designated area or container for storage, washing, decontamination or disposal.
- All PPE should be decontaminated before being laundered or discarded. Treat contaminated areas of PPE with an appropriate disinfectant. Lab coats with extensive contamination may be autoclaved.
- Change PPE as soon as feasible whenever it is compromised, soiled or torn.
- Wear appropriate sizes and keep an adequate supply of PPE available.
- Wash hands whenever PPE is removed.
- Do not touch door handles, elevator buttons, telephones, computers or other clean surfaces or items with gloved hands.
- Wear closed-toe shoes and long pants when there is a possibility of exposure to infectious, toxic and corrosive agents, excessive heat, cold, fire, or other physical hazards.
- Long hair should be tied back when there is a possibility of exposure to infectious, toxic and corrosive agents, fire, or other physical hazards.

Laboratory Clothing

A commonly used PPE item within the laboratory is special clothing. Both reusable and disposable clothing is available. Whichever is used, it shall be durable, designed to provide protection and prevent exposure of the skin to harmful agents, as well as be compatible with the methods of decontamination employed. Laboratory clothing serves to protect the wearer, the experiment, and the environment against contamination. Laboratory clothing includes lab coats, lab gowns, dedicated clothing or scrubs, shoe covers, and dedicated shoes and socks. The necessary laboratory clothing needed should be determined by a lab-specific risk assessment of procedures with the biohazardous material in use. For assistance in the selection of specialized laboratory clothing, contact the Health and Safety Manager.

Solid front wrap-around clothing offers better protection than pull-over type clothing or clothing with front closures. Long sleeved garments with snug fitting cuffs are preferred over open or short sleeves. Snug fitting cuffs prevent splashes, splatters and aerosols from making contact with exposed skin on the lower arms. Longer single-use gloves can be pulled over snug fitting cuffs to seal out any infectious materials.

Aprons are necessary for protection against liquids spilling or splashing on clothing. It is recommended that appropriate aprons be worn to protect against the potential harmful effects of liquid waste. Aprons may also be used to provide protection from steam and hot water in locations such as animal handling facilities, autoclave rooms, and laboratory glass-washing rooms.

Gloves

Gloves should be comfortable and of sufficient length to prevent exposure of the wrist and forearm. Depending upon intended use, the composition and design of the glove may vary to provide the desired level of flexibility, strength, impermeability, and resistance to penetration by sharp objects, as well as protection against heat and cold. No one glove can be expected to be satisfactory for all intended uses. Some gloves are pre-tested for viral penetration, chemical resistance, and puncture resistance. Ask glove manufacturers for documentation regarding any pre-testing of gloves.

Disposable (single use) gloves provide a barrier between infectious agents and the skin. Glove use is a basic precept of preventing infectious agent transmission. Breaks in the skin barrier of the hand (damaged cuticles, scrapes, micro-cuts, dermatitis, etc.) are common and the use of hand-lotions is recommended to prevent this. Latex gloves can be degraded by common hand lotions which contain petroleum based products therefore, it is important to choose a water-based hand lotion for laboratory applications.

Gloves should be removed and hands washed before exiting the laboratory. Use the one glove method or an appropriate secondary container when transporting materials through common use areas.

<u>General Guidelines for the Use of Gloves:</u>

- Change gloves periodically, when gloves become soiled, and always wash hands after removing gloves or other PPE
- Gloves will not prevent needle sticks or other puncture injuries
- Check gloves for visible tears before use
- Do not reuse disposable latex or nitrile gloves
- Discard contaminated gloves in a biohazard bag immediately after use
- Double glove when cleaning spills

Face and Eye Protection

Protection of the face and eyes is of prime importance in laboratories due to the potential for foreign material, both liquid and solid, to splash on the head, face and eyes, or contact lenses. A variety of face shields, head covers/hoods, protective goggles, and lenses are available from safety supply houses. The selection is dependent upon materials of construction, fit, comfort, and compatibility with the work and the overall facial area requiring protection. Face shields and goggles can provide splash protection. Safety glasses provide impact protection from projectiles.

Contact lenses do not provide eye protection. It is recommended that contact lenses not be worn when working around chemicals, fumes, and other hazardous material and dust particles since these items may become trapped in the space between the contact lens and the cornea. When contact lenses are worn, eye protection, such as tight fitting goggles, should be worn. Contact lenses should never be handled in the laboratory.

Respiratory Protection

Protection of the respiratory system is a major concern of any biological safety program because infectious organisms can readily enter the human body through the respiratory tract. The probability of this occurring depends on the type and infectious dose of the particular organism. Control measures, such as the use of biological safety cabinets, should always be considered as a first line of defense against respiratory infection when working with infectious organisms. Respirators should only be considered as a second line of defense after feasible control measures have been put into place and additional controls are still needed.

Surgical masks do not provide respiratory protection. Surgical masks were designed to protect patients and products from the wearer and to protect the wearer from splashes to the nose and mouth. The wearer of a surgical mask is not protected from infectious aerosols therefore the use of surgical masks as respiratory protection is not allowed.

Respirators vary in design, application, and protective capability. Respirators can be placed into two categories, air purifying and supplied air. By far, the most commonly used respirators in laboratories are air purifying respirators. These protect by purifying the existing breathing air through a filter (for particulates) or cartridge (for gases and vapors). Dust masks that have been approved by NIOSH are also considered to be air purifying respirators. These are ranked by their filtering efficiencies and by whether they can be used in an environment containing oil aerosols. Approved dust masks will have one of the following designations – N95, N99, N100, R95, R99, R100, P95, P99, or P100. For assistance in the selection of appropriate respiratory protection, contact the Health and Safety Manager.

Laboratory Equipment

Biological Safety Cabinets

Biological safety cabinets (BSCs), when used properly, provide a clean work environment for research activities. Biological safety cabinets offer personnel, product, and environmental protection. The BSC provides primary containment for infectious materials. A BSC should be certified annually after initial installation and certification and when moved to a new location.

The efficacy of BSCs depends upon the behavior of the operator and the orientation of the unit in the facility. Such things as rapidly moving arms in and out of the cabinet, people walking rapidly around the BSC or open lab doors may disrupt the airflow pattern and reduce the effectiveness of the cabinet. Minimize the storage of materials in and around the cabinet and always leave the BSC running while in use.

Many BSCs are equipped with “germicidal ultraviolet” (UV) lamps. Time of exposure, distance, presence of dust or debris, and UV lamp intensity all affect the germicidal effect of the UV lamp. UV lights should never be utilized as a primary means of disinfection of a biological safety cabinet. The UV lamp needs to be cleaned periodically to remove dust. UV lamps may damage eyes, skin, and laboratory equipment. UV lamps should be turned off while the room is occupied.

The use of Bunsen burners inside of a biological safety cabinet is not recommended because it:

- Disrupts airflow, compromising the protection of the individual and the sample(s).
- Causes excessive heat build-up within the cabinet.

- May damage the HEPA filter or melt the adhesive holding the filter together, compromising the cabinet's integrity
- Presents a potential fire or explosion within the cabinet
- Inactivates manufacturer's warranties on the cabinet

There are several alternatives to the use of Bunsen burners:

- Use disposable sterile loops and lab supplies
- Autoclave utensils and equipment
- Replace Bunsen burners with electrical incinerators for sterilization
- If a flame is absolutely necessary, use a touch-plate microburner to provide flame on demand.

Refer to the Tissue Culture Room Standard Operating Procedures in Appendix 9 for operating procedures for the biological safety cabinets.

Centrifuge Equipment

All centrifugation of potentially biohazardous material shall be done using centrifuge safety buckets or sealed centrifuge tubes in sealed rotors. Each person operating a centrifuge should be trained on the proper operating procedures.

The following procedures for centrifugation are recommended:

- Examine tubes and bottles for cracks or stress marks before using them.
- Always balance tubes before centrifugation.
- Wipe outside of tubes with disinfectant before placing in safety cups or rotors.
- Never overfill centrifuge tubes as leakage may occur when tubes are filled to capacity. The maximum for centrifuge tubes is 3/4 full.
- Always cap tubes before spinning. Use screw cap tubes.
- Place all tubes in safety buckets or sealed rotors when centrifuging infectious materials. Inspect the "O" ring seal of the safety bucket and the inside of safety buckets or rotors.
- Never exceed safe rotor speed.
- Stop the centrifuge immediately if an unusual condition (noise or vibration) begins.

Microtome/Cryostat

Due to the very sharp blade and the nature of the materials used with the microtome/cryostat, training is essential in the use of the equipment and in the hazards of the materials used with the equipment. Users should be informed of the need to prevent cuts and scrapes as well as protect the eyes, nose, mouth and skin from exposure to the materials being used. New personnel should be trained in the proper use and maintenance of the equipment, and demonstrate proficiency prior to use.

Miscellaneous Equipment (Waterbaths, Cold Storage, Shakers)

Water baths should be treated with chemicals to prevent growth of microorganisms and should be regularly cleaned and decontaminated. Deep freezers, liquid nitrogen containers, refrigerators, and dry ice chests should be checked and cleaned out periodically to remove any broken containers containing

infectious material and decontaminated. All infectious or toxic material stored in refrigerators or deep freezers should be properly labeled. Security measures should be appropriate with the hazards.

The degree of hazard represented by contaminated liquid nitrogen reservoirs will be largely dependent upon the infectious potential of the stored microorganisms, their stability in liquid nitrogen, and their ability to survive in the airborne state. Investigations suggest that storing tissue culture cell lines in containers other than sealed glass ampoules might result in potential inter-contamination among cell lines stored in a common liquid nitrogen repository.

Shaking machines should be examined carefully for potential breakage of flasks or other containers being shaken. Screw-capped durable plastic or heavy walled glass flasks/vials should be used. These should be securely fastened to the shaker platform. An additional precaution would be to line the shaker with absorbent material.

Transport of Biological Materials on Campus

Biological specimens transported between laboratories and animal facilities on campus should be properly contained in a sealed, leak-proof, shatter-proof secondary container. This container should be sealed in the laboratory and the outside should be disinfected. This will allow for safe transport of the specimen without gloves. An example of proper transportation would be a sealed tissue culture flask placed into a sealed plastic bag and then placed into a small cooler with a tight-fitting lid.

Decontamination and Disposal of Biohazardous Waste

The following guidelines describe the safe and appropriate handling and disposal of infectious waste. These wastes include human blood and body fluids, sharps, infectious microbiological materials, pathological specimens, and blood, body fluids, and tissues from infected animals.

Definitions

Autoclave - a device utilized for exposure of instruments, liquids, and potentially infectious waste to steam at a high pressure in order to decontaminate the materials or render them sterile.

Biohazardous Waste - human or animal tissue or fluids that are contaminated or may be contaminated with pathogenic organisms or recombinant DNA which may be hazardous to humans, animals, plants or the environment.

Blood and blood products - human blood, blood products such as serum, plasma and other blood components, and body fluids.

Decontamination - use of physical or chemical means to remove, inactivate, or destroy agents on a surface or item to the point where they are no longer infectious particles and the surface or item is rendered safe for handling, use, or disposal. Decontamination is generally considered to be a log 6 reduction, not sterilization.

Disinfectant - an agent that destroys harmful bacteria and/or viruses on inanimate surfaces. Common types include household bleach, quaternary ammonium compounds, phenolic compounds, and iodophors. Products making disinfectant claims must be registered with the Environmental Protection Agency (EPA), and state it on the label with a registered EPA number.

Infectious Waste - hazardous waste which is capable of causing infections in humans, including but not limited to, contaminated animal waste human blood and blood products, pathological waste, and discarded sharps.

Medical Waste - any solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals, including but not limited to: blood-soaked bandages, discarded surgical gloves - after surgery, used sharps, cultures, stocks, and swabs used to inoculate cultures, removed body organs.

Microbiologicals - wastes including all cultures and stocks of infectious agents. These should be collected in appropriate containers, autoclaved, and discarded with regular trash (solids) or into the sanitary sewer via sink (liquids).

Pathologicals - wastes including tissues, organs, and body parts discarded from surgical, obstetrical, autopsy, and laboratory procedures.

Sharps - includes needles, syringes, scalpels, and glass vials. These should be placed in sharps containers.

Waste Procedures

Separation and labeling of infectious waste (which may include red bagging, universal biohazard symbol, etc.) shall be done at the point of generation. During collection, storage and transportation, all waste should be managed such that the integrity of the packaging is preserved and that rapid microbial growth and putrefaction is inhibited. Sharps containers should be rigid, impervious and puncture-resistant; plastic bags should be tear-resistant, leak-resistant, and sturdy enough to withstand handling.

Whenever possible, infectious waste should be treated to render it non-infectious and non-recognizable as to its former character.

Infectious waste

Infectious waste should be properly treated to render it non-infectious. Autoclaving and chemical treatment are the most common methods. Treated waste is considered solid waste and may be safely landfilled, i.e. placed in the regular trash. This waste does not require a red bag. This material shall be placed in autoclave bags or other clearly identifiable containers and properly labeled with autoclave tape or other means that show that the waste is no longer hazardous. Blood and blood products may be disposed into the sanitary sewer.

Autoclaving of Biohazardous Waste

Orange or clear autoclave bags containing biohazardous waste should be decontaminated in an autoclave. Autoclave bags should not be overfilled and should be placed in a secondary container prior to autoclaving. Once autoclaved they can be disposed of in the regular trash.

Animal waste

Animal waste can include carcasses, body parts, tissue, body fluids, excreta, and bedding. All waste shall be designated by the activity supervisor to be either non-hazardous or hazardous. Waste shall be considered to be non-hazardous if it is derived from an animal that has not been treated or manipulated by chemical means or does not meet the criteria of being hazardous. Typically, non-hazardous carcasses include those animals used in dissection research, teaching labs, etc. Animal waste should be considered to be hazardous if any of the following apply:

- Preserved in formaldehyde, formalin or other carcinogenic solution.
- Derived from an animal that has been injected with a Resource Conservation and Recovery Act listed chemical, toxin, teratogen, mutagen or chemotherapy drug.
- Derived from animals infected with zoonotic diseases (transmissible from animals to human) or purposely infected with agents infectious to humans.
- Derived from an animal deemed hazardous by special circumstance

Due to the special disposal needs of hazardous animal waste disposal, care should be taken to minimize generation of hazardous waste. The Health and Safety Manger should be notified of the activity and expected volume of waste. Any waste that is unable to be confirmed as non-hazardous waste will be assumed to be hazardous. Every effort should be made to identify all waste due to disposal costs incurred on unknown waste. Infected animal waste that is also contaminated with hazardous chemicals or radioactive materials is a type of mixed waste. This type of waste poses special safety and regulatory problems and should not be generated if at all possible. The Health and Safety Manager should be consulted before generating this type of waste.

Nonhazardous animal waste may be disposed of in the regular trash. Animal carcasses and tissue should be double bagged to prevent leakage of body fluids. The outer bag should be opaque for the courtesy of others. All hazardous classified animal carcasses should be disposed of through a contracted waste disposal vendor. Under no circumstances shall hazardous carcass waste be disposed of in the regular trash. Hazardous carcasses may be double bagged and frozen or kept in sealed buckets until a hazardous waste disposal can be arranged through the Health and Safety Manager.

Decontamination of Laboratory Surfaces

Laboratory surfaces should be decontaminated after work with biohazardous materials and at the end of the day. Disinfectants should be examined for efficacy against the infectious agent in use. Disinfectants should be prepared according to the manufacturer directions for dilution and shelf-life. Storage of disinfectants should be in properly labeled containers.

Part C

Chemical Hygiene Plan

2016

Annual Review of Chemical Hygiene Plan

Date	Reviewers

Chapter 1: Introduction

Purpose

Laboratory safety is an important issue in university teaching and research labs. This chemical hygiene plan is designed to provide faculty, teaching assistants, and students with information on the safe handling and use of chemicals and laboratory equipment. In addition, this hygiene plan contains policies and procedures for maintaining the chemical inventory, reducing and proper disposal of waste, and general requirements for safety in the laboratory and storage areas.

Scope

In accordance with the Occupational Safety and Health Administration (OSHA) lab standard (29 CFR 1910.1450), the chemical hygiene plan will contain information on safe laboratory practices, control measures for limiting chemical exposure, and employee training and information. The plan also includes procedures for obtaining information on medical consultations and examinations and a list of chemicals that require extra protection. Some procedures, while not needed for OSHA compliance, are required to comply with federal and state regulations from the Environmental Protection Agency (EPA), Department of Homeland Security (DHS) and the Missouri Department of Natural Resources (DNR). *The chemical hygiene plan is to be reviewed annually and updated with additional sections as the need arises.*

Chapter 2: Standard Operating Procedures for Safe Laboratory Practices

Chemistry Laboratories

General Procedures

1. The lab can be a dangerous place, but proper planning and attention to safety procedures will ensure a safe learning environment. Before entering the lab, prepare for the experiment by considering the tasks to be accomplished, the chemicals and equipment to be used, and safety procedures to be followed. Completing a Composite Risk Management (CRM) worksheet will assist with this task.
2. Proper attire is required when working in the lab. Do not wear shorts, open-toed or open-heeled shoes in the laboratory. Wear a lab coat when using hazardous chemicals or when splashing is possible.
3. Safety goggles must be worn at all times in the lab. The safety of contact lenses in the lab is currently under study. The department recommendation is to avoid wearing contacts in the lab. If this cannot be avoided, non-vented safety goggles must be worn over contacts to prevent vapors from reaching the eye.
4. Before starting an experiment, locate the exits from the room. Note that some doors exit to storage areas rather than the hallway. Look for safety equipment including a fire extinguisher, fire blanket, safety shower, eye wash station, waste disposal container, broken glass container, first aid kit and spill kit. If applicable, look for the mercury spill kit.
5. Inspect equipment for the day. Make sure that the lab benches are clean, and that glassware is free of chips and cracks. If using gas cylinders, ensure that the cylinders are secured to a solid surface.

Use only the equipment appropriate to the experiment. Secure equipment against bumping and jostling to prevent breakage and spills.

6. If the conditions above are not met, immediately notify your instructor, teaching assistant or chemical safety manager. Also, report any unsafe working practices to the above people.
7. Check the labels of all chemicals before use. Note the chemical name, concentration and hazard labels on the containers. Review the SDS for the chemical. If a container is unlabeled, do not dispense its contents and notify your instructor, teaching assistant or chemical safety manager.
8. Horseplay is not allowed in the lab.
9. Limit your risk of chemical exposure. Do not eat, drink, chew gum, chew tobacco or smoke in the lab. Do not bring food or beverages into the lab or storage areas. Do not apply cosmetics or adjust your contacts in lab. **When gloves are worn in lab, they should be removed before exiting the lab. Gloves used to handle chemicals should not be used to open doors, etc.**
10. Keep the door closed while working in the laboratory to prevent vapors and fumes from entering the hallway.
11. Keep the work and common areas clean. Promptly wipe up any spills. Place broken glassware in the broken glass container. Wipe down the lab bench and put away glassware at the end of the lab.
12. Bunsen burners and gas outlets should be checked at the end of each lab. Never leave a lit Bunsen burner unattended.
13. If a fire, serious spill, or accident involving broken glass or equipment occurs, notify the proper authorities and stay out of the area or leave the room entirely, unless your help is needed by the instructor. Never try to hide an accident or prevent it from coming to your instructor's attention.
14. Use proper waste disposal techniques. Place needles and syringes in a puncture-proof container. Place waste in the appropriately labeled containers.
15. Both departmental and any applicable laboratory specific rules and regulations are to be posted in one or more of the following locations, at each faculty member's discretion:
    a. In a high visibility/high traffic area within the teaching/research lab.
    b. On the outside of the lab on a door or a bulletin board.
    c. In documentation provided to students served by said lab.

These options, especially the lattermost, will be accompanied by a signed, student safety-contract acknowledging receipt, understanding of, and compliance with the aforementioned rules (*see Chemistry Teaching Laboratories*, item 2 and Appendix 12).

Health and Hygiene

1. Proper clothing lessens the chance of chemical spills on the skin. Long pants or skirts are required for adequate protection. Loose sleeves should be avoided as they could fall into chemicals or flame during the experiment.
2. Shoes worn in the laboratory should have closed toes and heels. Leather shoes are more chemical resistant than cloth shoes.
3. Long hair should be tied back to avoid falling into chemicals or flame.

4. Remove rings and watches. Chemicals trapped between the jewelry and skin can cause a more severe irritation than would occur on exposed skin. When applicable, wear gloves that are compatible with the chemicals used in the laboratory.
5. Eye protection is needed at all times in the lab. Safety goggles that meet American National Standards Institute Z87.1-1989 are required for proper chemical splash and impact resistance. Goggles meeting these standards are labeled Type G, H, or K. Safety glasses and prescription glasses alone are not acceptable as they do not form a complete seal around the eyes.

   Use of contact lenses should be avoided during the laboratory. Chemical fumes can seep under the lens and be held against the cornea causing severe and possibly permanent damage. Secondly, it is possible for soft contact lens material to react with and be dissolved by organic solvent vapors. Furthermore, during the stress of an emergency, contact lenses may be virtually impossible to remove. Students who must wear contacts should wear non-vented safety goggles at all times during the laboratory. Notify the lab instructor if you must wear contacts during class.
6. Under no circumstances should you pipette by mouth. Pipette bulbs and aids are provided for safe pipetting.
7. Wash hands frequently during lab experiments. Immediately wash hands and affected skin after chemical exposure. Wash hands and forearms to remove any chemical residue before leaving the lab.
8. Never attempt to identify a chemical by taste or smell. If absolutely necessary, smell a chemical by wafting vapors towards your nose.
9. Avoid exposure to aerosols, fumes, gases and particulates by working in a fume hood. When fume hoods are not available, keep the face as far from the chemicals as possible. Likewise, when heating a test tube or other container, point the open end of the vessel away from yourself and others.

Food, Beverages and Chemical Contamination

1. Eating, drinking and using tobacco are expressly prohibited in all laboratories and chemical storage areas. Accidental ingestion of chemicals can have severe consequences.
2. Food and drinks cannot be stored in areas were chemicals are stored or used.
3. Do not use glassware or lab equipment to prepare or contain food or drink.
4. Lab refrigerators and freezers should be clearly labeled with signs stating that no food or drink is allowed.
5. Do not chew gum or tobacco in the lab or storage areas. These products may absorb chemical aerosols and lead to ingestion of hazardous compounds.

Housekeeping

1. Keep your area clean. Close cabinets and drawers. Dispose of chemical wastes, used paper towels and broken glassware properly and immediately.
2. Chemical spills and accidents require immediate attention. Spill kits are available in every lab and the storeroom. Spilled chemicals and the items used to clean spills must be disposed of properly. After managing a large spill of a non-hazardous chemical or any spill of a hazardous chemical, an incident report (Appendix 2) must be completed.
3. Exit doors should be clearly labeled and unobstructed. While working in the lab, doors should be unlocked to allow access by emergency workers if needed.

4. Aisles and hallways should be kept clear to allow easy access to safety equipment in an emergency situation.
5. Never store chemicals on the floor, even for a brief time. Containers on the floor present a tripping hazard as well as the potential for spills.
6. All doors must be shut at the end of the lab. Doors to the hallway must be locked and checked from the outside at the end of each lab.

Laboratory Equipment Maintenance and Use

1. Laboratory equipment should be inspected on a regular basis. Before using any equipment, check for signs of stress or damage. Report any problems to your instructor, teaching assistant or chemical safety manager.
2. Select the proper size apparatus for the experiment, allowing about 20% empty space to allow for expansion. All equipment should be clean and dry before using.
3. Glassware, ring stands and other equipment should be kept away from the edge of the bench to prevent spills and breakage. Whenever possible, glassware should be secured with clamps or other proper holding devices.
4. Centrifuges should be properly balanced and monitored until they reach maximum speed to prevent moving.
5. When setting up ring stands and distillation kits, center the weight of the load to prevent tipping.
6. Use clamps to securely hold condensers and water hoses.
7. Never heat chemicals in a closed container. Expansion can shatter the container.
8. Use boiling stones or other nucleation devices when heating liquids to prevent violent boiling.
9. When heating a test tube, point the opening of the tube away from yourself and others in the lab.
10. When an exothermic reaction is possible, suspend a thermometer in the liquid and monitor the temperature.
11. Check heating mantles and other electrical equipment for frayed wires and plugs and other sources of sparks before use. Use only enclosed, non-sparking stirring and heating plates when working with flammable compounds.
12. Before heating any chemicals, ensure that the auto-ignition point of all chemicals being used is sufficiently higher than the maximum temperature generated by the method of heating.
13. Use appropriate condensers and traps to prevent material from being released into the air.
14. To minimize the release of the chemicals into the air and possible exposure, work inside a fume hood when using toxic chemicals or those with flammable vapors.

Glassware

1. Borosilicate glass, such as Pyrex and Kimax, should be used widely in the lab. Soft glass should be used only for graduated cylinders, stirring rods and glass tubing.
2. Glassware should be clean and dry before use. Inspect all glassware for chips, stars and cracks before using. Glassware that cannot be used should be returned to the storeroom for disposal.

3. Dispose of broken glass in the cardboard container labeled “Broken Glass Only”.
4. Whenever possible, avoid exposing glassware to extreme temperatures and to sudden changes in temperature. When moved quickly from one temperature to another, glass may crack.
5. Never heat a closed container.
6. As stated above, use boiling stones or other nucleation devices when heating liquid to avoid violent boiling.
7. Secure separatory funnels with retainer rings to prevent loosening of the stopcock.
8. When inserting thermometers or other glass into stoppers, lubricate the glassware to prevent breaking. Many accidents occur during this procedure.
9. Only thick-walled glass should be used under high pressure and with vacuums. Thin-walled glass may shatter under such conditions.

Protective Apparel and Equipment

1. Eyewash stations are located in all laboratories and the storeroom. Eyewash stations are to be tested weekly as per 29 CFR 1910.151 and inspected annually to ensure compliance to ANSI standards. Frequent flushing of the system ensures that eyewash stations are working properly and lowers the risk of bacterial infection.
2. Safety showers are located in all labs and the storeroom. These are to be tested monthly and inspected annually for voluntary compliance with ANSI Z358.1-1998.
3. First aid kits are located in every laboratory and the storeroom. The contents of the kits should be restocked annually or as needed.
4. Thermal gloves should be used when handling heated or very cold materials, including dispensing liquid nitrogen and working with dry ice.
5. Fire blankets and extinguishers are present in the labs and storeroom. Extinguishers are inspected monthly and recharged annually.
6. Spill kits are available in all labs and the storeroom. Select the appropriate components based on the type of spill. All components used in the cleanup of spilled reagents must be treated as hazardous waste and disposed of following standard procedures.
7. All laboratories must be equipped with a fire alarm that will sound in the hallway as well as in the room.
8. All laboratories must have access to a telephone or cell phone and a list of emergency phone numbers.
9. The appropriate type of gloves (latex, vinyl or nitrile) will be provided when particularly hazardous or irritating chemicals are used. When using chemicals that require other types of gloves refer to the Ansell Glove Guide to determine the appropriate glove. (http://www.ansellpro.com/download/Ansell_7thEditionChemicalResistanceGuide.pdf)
10. During most routine laboratory work, safety goggles provide adequate eye protection. UV-absorbing goggles or regular goggles with a UV absorbing face shield should be worn when using UV lamps, trans-illuminators or lasers.

11. Breathing vapors, gases, and aerosols should be avoided at all times. Fume hoods should be used when feasible for experiments that produce such products. The most common cryogen encountered in the lab is liquid nitrogen. Although not technically a cryogen, dry ice (solid carbon dioxide) poses many of the same hazards.

Cryogenic Hazards

1. Goggles, thermal gloves, closed-toe shoes and a lab coat or apron are necessary when working with cryogens.
2. Use cryogens only in a well-ventilated area. Rapid expansion of the liquids into gas can cause oxygen depletion.
3. Only use approved containers for cryogens. Pressure build up can cause the container to explode.
4. Never lower your head into a dry ice chest. Keep your face as far from it as possible.

Systems under Pressure

1. When working with systems under pressure use only apparatuses specifically designed for this purpose.
2. Do not move a desiccator or other container that has been evacuated.
3. Systems under pressure should have a relief valve.
4. Gas cylinders must be secured to the wall, bench/table and floor with three pints of contact to prevent accidental tipping which can lead to rupturing of the tanks.

Warning Signs and Labels

1. Signs should be posted to draw attention to the location of emergency equipment such as the fire extinguisher, fire blanket, eyewash station and first aid kit.
2. All labs should have a list of emergency contacts posted inside the lab or on the lab door. Labs that use hazardous chemicals should have a hazard communication placard on the door (Appendix 11).
3. Chemical labels should contain the chemical name and a hazard designation such as carcinogen, irritant, sensitizer, toxic, highly toxic or flammable.
4. All wash bottles must be properly labeled (full name, avoid abbreviations) with their contents and a hazard warning.
5. Waste containers must be labeled with the amount and type of chemicals they contain using a departmental label.
6. Glassware used for mixing and temporary storage of chemicals should be labeled with the name and, if applicable, concentration of the contents prior to being used.

Unattended Operations

1. Try to avoid reactions that must run overnight or while you are away from the lab.
2. If experiments must be left unattended, carefully inspect all the equipment for signs of weakness or instability. The experiment should be clearly and visibly labeled with a description, expected timeframe (start and end date), and the name and contact information for the responsible party.
3. Post signs with emergency contact information on the door to the lab.

Working Alone

1. Whenever possible, avoid working alone.
2. If you must work alone, make certain that someone knows where you are.
3. If a phone is not located in your immediate work area, keep a cell phone nearby in case of an accident.

Laboratory Security

1. When laboratories are not in use, the doors are to be locked. Unless the door has fob access, doors must be locked with a key from the hallway.
2. The chemical storeroom is to be used only by qualified individuals who have had safety training. For their safety, students other than teaching assistants are not permitted in the storeroom.

Chapter 3: Standard Operating Procedures in Teaching Laboratories

Chemistry Laboratories

Waste Management

To ensure proper waste disposal in General Chemistry Lab (24-113), General Chemistry I Lab (24-115), and General Chemistry II Lab (24-117) a copy of the lab manual or a chemical list should be submitted to the chemical safety manager prior to the first day of experimentation in lab. If the course does not use a manual or is not planned completely before the start of the semester, a weekly chemical list may be substituted. The same waste management plan can be arranged for upper-level labs as well but will be at the discretion of each faculty member.

Waste containers will be prepared on Friday afternoon for the following week and checked periodically by the chemical safety manager. If a container is ¾ full during the week, please notify the chemical safety manager immediately. Extra waste labels are in a folder in the wall pocket mounted in each lab. An example of how to complete the label is in the appendix of this document.

Teaching Assistants and Training

Students being considered to serve as teaching assistants must have successfully completed the course they will be assisting in. (Chem 24-115 or Chem 24-117 can be substituted for Chem 24-114.) In addition, teaching assistants and practicum students must receive some form of safety training on procedures and policies in the lab. Teaching assistants assisting in upper-division courses must also have

successfully completed Organic Chemistry, preference will be given to those who have taken Laboratory Safety.

However, OSHA allows training information to be passed to employees in a non-classroom setting. Accordingly, supervisors may elect to provide teaching assistants/practicum students laboratory-specific safety training, especially unique laboratory procedures and the handling of hazardous operations and chemicals, but all teaching assistants/practicum students will be responsible for the study of and compliance with the relevant sections of this Chemical Hygiene Plan, as dictated by their supervising instructor.

Safety Contracts

As stated above (**General Procedures**, item 15), lab instructors must provide safety information to their students on or before the first day of lab. All laboratory students must sign a contract stating that they are aware of and will abide by the safety rules in the lab. Students who do not sign such a contract will not be able to participate in lab experiments (see Appendix 12).

Lab Security and Supervision

The lab doors should be locked when classes are not in session for security and unlocked during lab in case emergency workers need to enter the room. Students may only enter the lab once the faculty member or teaching assistant is present. Students should be adequately supervised at all times.

Chemicals from the Storeroom

Chemicals originating from the storeroom, not upper-division lab prep rooms, must be properly checked out. Containers should be returned when no longer in frequent use. Returned chemicals should be signed back into the storeroom. If not re-shelved by a faculty member the chemicals may be placed in the container labeled “for shelving” to be shelved by the chemical safety manager.

An annual chemical audit of the inventory, which is usually held during June and July, will require storeroom chemicals to be briefly returned to the stockroom. Once inventoried they may be signed out again. Should an instructor need to maintain possession of a stockroom chemical during the inventory procedure, those chemicals will remain on a cart and not be re-shelved, once accounted for, to facilitate their return to the faculty member’s lab.

RO Water

An extra carboy of RO water is available in the storeroom. Please have the teaching assistant leave your empty carboy when removing the full one.

Chapter 4: Operating Procedures for Safety Control Measures

Minimize Exposure

1. Plan experiments and student labs that use the smallest amount of chemicals. Choose less toxic or hazardous compounds when you have a choice.

2. When massing noxious or hazardous chemicals, work in a balance enclosure to minimize your exposure to the chemicals through dust and powder particles.

3. When using noxious or hazardous chemicals, work in a fume hood to minimize your exposure to the chemicals through vapors and fumes. Dry powders may be incompatible with work in a fume hood, where air velocities may actually increase the risk of making chemicals airborne. Discretion should be exercised.

4. Be prepared with proper clothing, eye protection and gloves.

Never Underestimate Risk

1. Use the SDS to evaluate the potential hazard of a chemical before using it. Follow the precautions listed on the sheet. Due diligence should be done to obtain an SDS for all chemicals, but if one is unavailable the chemical should be treated as hazardous.

2. Check for incompatibilities amongst the chemicals used for an experiment.

3. Be prepared to use the safety equipment before you need it.

Personal Protective Equipment

1. When working with chemicals, wear long pants and closed toed shoes. Long hair should be tied back. Safety goggles are mandatory.

2. When working with hazardous chemicals use gloves that are compatible with your materials, a lab coat, and work in a fume hood if possible.

3. Use a face shield and/or splash guard when splashes or violent reactions are likely.

4. It is always better to be over-prepared and over-protected than to be under-prepared and under-protected during an emergency.

Inspection Programs

1. Eye wash stations will be flushed once a week.

2. Safety showers will be flushed once a month.

3. Biosafety cabinets, safety hoods and balance enclosures will be re-certified annually.

4. Laboratories will be rigorously inspected by the chemical safety manager once a year usually during the summer months. These annual inspections will cover the following:
    - General safety
    - Signs
    - Chemical storage
    - Biological contamination control
    - Waste handling and disposal
    - Equipment

5. A complete chemical inventory audit will be conducted once a year.

Chapter 5: Safety and Emergency Equipment

Eyewash Stations and Safety Showers

1. Eyewash stations and safety showers are located in every laboratory and the chemical storeroom. Signs indicating the location of these safety devices will be posted in each area.

2. Eyewash stations will be flushed for 3 minutes once a week by the chemical safety manager. Safety showers will be tested monthly. Eyewashes must be capable of a flow rate of 0.4 gallons per minute for 15 minutes, and the safety showers must have a flow rate of 20 gallons per minute for 15 minutes.

3. Problems with eyewash stations and safety showers should be reported immediately.

4. The area around all eyewash stations and safety showers must be kept clear to allow easy access.

5. When the eyes are exposed to chemicals, they must be flushed for 15 minutes. The eyelids should be held open and the eyes constantly moved during the 15 minute flushing period. Contact medical personnel. An incident report (Appendix 2) must be completed after the individual is attended.

6. When chemicals are spilled on the skin or clothing, the individual should immediately proceed to the safety shower and remove contaminated clothing. An emergency situation is not the time for modesty. Contaminated shirts and sweaters should be cut off to prevent spreading chemicals to the face. The minimum flushing time is 15 minutes. Medical personnel should be contacted. An incident report must be completed after the individual is attended.

Fire Extinguishers and Blankets

1. Fire extinguishers and blankets are located in each lab and the chemical storeroom. Their locations must be clearly marked. Fire extinguishers must be inspected monthly and recharged annually by the Health and Safety Manager.

2. If a fire is small, such as contained in a beaker, try to smother it first. When the fire is out, fill out an incident report. All fires – no matter how minor – must be recorded to help us refine the lab safety procedures.

3. All other fires require evacuating the room, calling 660-562-1254, and pulling the fire alarm. Room numbers are posted both inside the lab door and outside. Contact numbers are posted outside each lab. Someone from the lab should meet the fire fighters at the door of the building to advise them of the type of fire.

4. If you have not been trained in how to use a fire extinguisher, do not attempt to put out a lab fire. If you know how to fight a fire, only do so if you have the right type of extinguisher and can fight the fire from a location that allows you to safely exit the room

5. Fire extinguishers in a chemistry lab must be compatible with the type of fire. Incompatible extinguishers can make the fire much worse. Use carbon dioxide or dry chemical extinguishers (labeled BC or ABC) for Class A, B, and C fires. Use a Class D fire extinguisher or sand bucket for fires involving combustible metals.

   Class A – substances such as wood and cardboard

   Class B – combustible or flammable compounds such as kerosene, gasoline and organic solvents

   Class C – electrical equipment

   Class D – combustible metals such as magnesium and potassium

6. Fire extinguishers in the department are either carbon dioxide or dry powder (potassium dihydrogen phosphate). Sand buckets are also provided to serve as a Class D extinguisher. Evaluate the chemicals and materials most commonly used in your lab, and decide if you would prefer a different type of extinguisher. Scott Walk of Environmental Services can exchange the extinguishers.

7. Do not throw water on a chemical fire. This action may worsen the fire.

8. To use the fire extinguisher, pull the pin. Aim at the base of the fire and squeeze the handle. Aim the nozzle of the fire extinguisher at the base of the flames and sweep across the breadth of the fire. Once you believe the fire is extinguished, do not leave or turn your back on the fire. Re-ignition is common. Let the professionals determine when a fire is safely out.

9. If any part of your clothing catches fire, remember to Stop, Drop, and Roll. Stop moving, drop to the floor, and roll to suffocate the flames. Seek immediate medical attention.

10. Fire blankets work well for smothering small fires. If a person is on fire and is standing, do not wrap the fire blanket around him. This will not smother the flames but will force them up towards the head.

11. Seek medical attention for any burn on the face, hands or feet or for burns over large areas.

12. Remember that your safety is more important than the damage that can be caused by a fire. Your responsibility is to protect yourself and others in your lab.

13. If you discharge a fire extinguisher even briefly, it should be immediately reported to Environmental Services, extension 1183.

First Aid Kits

1. First aid kits are located in each lab and the storeroom and are indicated with signs.

2. If you are running low on any supplies in the first aid kit, notify the chemical safety manager.

3. The first aid kits will be restocked annually or more often if needed.

Chemical Spill Kits

Each spill kit contains materials to contain small manageable spills of hazardous acid, base, oils and volatile chemicals. **It is recommended that you familiarize yourself with the contents of the spill kit BEFORE a hazardous chemical spill occurs.**

1. Spill kits are contained in labeled white buckets located in each lab and in the storeroom.

2. Each spill kit contains materials to clean up a small hazardous chemical spill and a cleanup protocol.

3. If you use the spill kit to clean up a manageable spill:
   a. Fill out the spill incident form.
   b. Notify the chemical safety manager immediately.
   c. A new spill kits will be provided to replace the used one.

4. DO NOT attempt to clean up a large spill of a hazardous chemical. Evacuate the area and call Campus police.

Fume Hoods Including the Perchloric Acid Hood

1. When not in use, fume hood sashes should be lowered.

2. Chemicals should not be stored in a hood that is used for an experiment.

3. When volatile or corrosive chemicals must be kept in a hood, the hood should remain on.

4. When working in a hood, only open the sash fully when setting up the reaction. Work with the hood sash at the lowest possible position. A lowered sash can provide some protection from splash, spill or explosion. However, the sash is not intended for use as a safety shield.

5. As much as possible, work at least six inches into the hood to minimize escape of materials.

6. Large objects should not be kept in the hood. If they must be in the hood, they must be elevated two inches to allow for free airflow.

7. Hood performance is greatly diminished by drafts. Hoods should be located away from open windows and doors. Do not walk directly behind someone working at a hood. This type of draft can force air from the hood into the lab.

8. The department of Natural Sciences has a policy against the use of perchloric acid and none is found in the inventory. The perchloric acid hood in room 3360 has been contaminated with HCl and is no longer safe for perchloric acid use.

Balance Enclosures

(adapted from Labconco User's Manual)

Balance enclosures provide personnel protection when properly installed and operated by effectively containing toxic or noxious particulates. Enclosures use a single HEPA filter, which is rated at least 99.99% efficient for 0.3-micron particles. Review the high performance features and safety precautions before you begin working in the enclosure.

A. Using the Balance Enclosure for Routine Daily Work Procedures

Since HEPA filters are disposed as hazardous waste, a record of the chemicals used in the enclosure is required. Use the log to document the chemical used in the enclosure.

Thoroughly understand procedures and equipment required before beginning work. Balances typically work best with the draft shield closed tightly and the enclosure set between 60 – 90 fpm. Arrange for minimal disruptions while enclosure is in use.

1. **Sign** the balance enclosure user log.
2. **Start-up:** Turn on exhaust system and accessory light. Only raise the sash for loading and cleaning. Check the baffle air slots for obstructions. Allow the enclosure to operate unobstructed for 1 minute. Wear a long sleeved lab coat and appropriate gloves. Use protective eyewear. Consult the chemical SDS for appropriate PPE.
3. **Loading materials and equipment:** Load only the materials required for the procedure. Do not overload the enclosure. Do not obstruct the air foil, or rear baffle slots. Large objects should be elevated above the work surface to permit airflow to sweep under the equipment. After loading, wait one minute to purge airborne contaminants from the work area.
4. **Work techniques:** Keep all materials inside the lower air foil, and perform all contaminated operations as far to the rear of the work area as possible. Segregate all clean and contaminated materials in the work area. Avoid using techniques or procedures that disrupt the airflow patterns of het enclosure.
5. **Final purging:** Upon completion of work, the enclosure should be allowed to operate for two to three minutes undisturbed, to purge airborne contaminants from the work area before shutting down the blower.
6. **Unloading materials and equipment:** Objects in contact with contaminated material should be surface decontaminated before removal from the enclosure.
7. **Shutdown**: Turn off the exhaust system and light.

B. Weekly Maintenance

1. Wipe down interior surfaces of the enclosure with a disinfectant or cleaner, depending upon the usage of the unit and allow to dry.
2. Using a damp cloth, clean the exterior surfaces of the enclosure, particularly the front and top to remove any accumulated dust.
3. Operate the exhaust system, noting the airflow velocity though the enclosure using a source of visible smoke. Airflow monitors are recommended for constant monitoring.

C. Monthly Maintenance

1. Determine the actual face velocity through the sash opening of the enclosure where the average reading should be at the specified velocity.
2. The enclosure rear baffle should be checked for any blockage to ensure that the enclosure is maintaining proper airflow.
3. All weekly activities.
4. Check face velocity.

D. Annual Maintenance

1. Replace the fluorescent lamps.
2. Have the enclosure validated by a qualified certification technician.
3. All monthly activities.

Decontamination of Balance Enclosures

When used in conjunction with biohazards, decontamination with formaldehyde should be done before the following actions are taken:

- Maintenance work in contaminated areas
- HEPA filter changes
- Moving the cabinet to a new location
- Changing research programs
- After a gross spill of biohazardous material

Chapter 6: Employee Training and Information

Training

1. An annual safety training meeting for faculty will be established during fall planning days. Other training will be provided on an as-needed basis when new equipment or chemicals are added to the inventory or when deemed necessary.

2. Teaching assistants are required to have safety training annually. In addition, first time teaching assistants must pass a safety test before being allowed to assist in lab.

3. Lab instructors must provide safety information to their students on or before the first day of lab. All laboratory students must sign a contract stating that they are aware of and will abide by the safety rules in the lab. Students who do not sign such a contract will not be able to participate in lab experiments.

4. Lab instructors must, likewise, provide safety information to undergraduate and graduate research students on or before the first day of work in the lab. All undergraduate and graduate research students must sign a contract stating that they are aware of and will abide by the safety rules in the lab. Students who do not sign such a contract will not be eligible to work in the lab.

Location of Chemical Hygiene Plans

1. All faculty, staff and graduate teaching assistants will be given a copy of the chemical hygiene plan.

2. Additional copies of the plan will be stored in the storeroom and wall pockets in all laboratory areas.

Safety Data Sheets

1. Safety Data Sheets are available for all chemicals in the inventory via the following link: http://www.nwmissouri.edu/naturalsciences/sds/index.htm

2. If a faculty member purchases a chemical for research, they are responsible for obtaining the SDS from the supplier and providing a copy to the chemical safety manager for archiving and adding to the online database.

3. Hard copies of SDS are filed alphabetically in the file cabinet in GS3400.

4. In addition to the master copy, each faculty member is required to maintain a copy of the SDS for all chemicals used in his/her laboratory.

Storeroom Safety Area

A safety area has been established to the left of the hood in the storeroom. Additional spill kits, mercury spill kits, absorbent material, and first aid supplies are kept in this area.

Chemical Inventory in CISPro

1. All chemicals for the chemistry discipline and some from biology are maintained in the CISPro online database. In addition to the online CISPro chemical inventory, a paper copy of chemicals will be kept in a file on the computer table in the storeroom.

2. The chemical safety manager will be notified of any new chemical purchases that will then be added to the database.

Chemical Inventory Not in CISPro

1. Chemical inventories that are not in CISPro are maintained by the responsible faculty member.

2. Individual faculty are responsible for adding to or deleting from their chemical inventory.

3. Copies of the inventory should be made available to the chemical safety manager. It is the responsibility of the individual faculty member to maintain the inventory throughout the school year.

Storage of Reference Manuals

Reference manuals on CISPro, de-ionized water purifier and fume hood maintenance will be kept on the bookshelves to the right of the storeroom fume hood.

Filed Incident Reports and Inspection Records

1. Inspection records for eyewashes and safety showers are on file in the chemical safety manager's office in GS 3390.

2. Once follow-up is complete, incident reports will be filed by the chemical safety manager.

Chapter 7: Standard Operating Procedures for Chemical Storage, Inventory and Waste Disposal

Selection of Chemicals

Prior to selecting and ordering a chemical for use in a laboratory experiment, the supervising faculty member should review the potential hazards of the substance under the conditions in the laboratory at the time of use and determine whether safer alternatives are available to assure adequate ventilation, compatibility with other chemicals in use and the relative risk to exposure ratio.

Ordering and Receipt of Chemicals in CISPro

1. Where applicable, chemicals orders will be compiled by the chemical safety manager and approved by the department chair prior to their purchase. Individual chemicals for immediate use will be purchased as needed and inventoried by the chemical safety manager upon receipt.

2. When received, all chemicals will be barcoded, given a storage designation, and entered into the CISPro inventory.

3. Unless noted otherwise (refrigerated, tax-free ethanol, etc.), new chemicals will be stored in the storeroom. Faculty who need new chemicals for immediate use or for storage in their lab space can pick up their chemicals from the storeroom or appropriate refrigerator or freezer after initial inventory.

4. The chemical safety manager will email the faculty when the chemicals have been inventoried and stored.

5. The chemical safety manager will add new SDS to the library for any new chemicals. Updates will be made both annually and as new chemicals are entered into the inventory.

Ordering and Receipt of Chemicals <u>not</u> in CISPro

1. Chemicals orders will be compiled by the responsible faculty member and approved by the department chair prior to their purchase. Individual chemicals for immediate use will be purchased as needed and inventoried by the respective faculty member.

2. The chemical safety manager will make available to each respective faculty member a set of location/serial number tags for each laboratory.

3. When received, all chemicals will be tagged using the specific location tag and added to the inventory for that lab.

4. New chemicals will be stored in the laboratory in the designated chemical storage area.

5. The responsible faculty member will add new SDS to their library for any new chemicals, and provide the chemical safety manager with a copy.

6. Updates will be made both annually and as new chemicals are entered into the inventory.

Chemical Storage in the Storeroom

1. Every chemical must have a storage designation printed on its barcode which matches the inventory location in CISPro.

2. Chemicals should be kept in the storeroom or in upper-division lab prep rooms unless they require refrigeration or freezing.

3. Due to space shortage in the storeroom, some acids, bases and flammable chemicals may be kept in other locations (e.g. storage shed; see below) in the appropriate type of cabinet. The contents of the cabinets should be clearly labeled on the outside of the cabinet.

4. Inert chemicals, those with low volatility and low hazard ratings and solutions at low concentrations may be kept in the lab where they are used. The barcode and inventory should include this location rather than the storeroom.

5. Unknown solutions for the teaching labs may be stored in the prep rooms for the lab to prevent confusion between different courses and different experiments within a course. In addition to the contents and concentration, if applicable, unknowns should be labeled with the course and experiment name.

6. Chemicals may never be stored on the floor where the containers could be overturned easily.

Chemical Storage in the Laboratories

1. Every chemical must have a storage designation or tag which matches the inventory location.

2. Chemicals should be kept in their designated area as determined by the faculty member.

3. Chemicals may never be stored on the floor where the containers could be overturned easily.

Safety Data Sheet Requirement
(adapted from OSHA Brief[1])

The 2012 revised Hazard Communication Standard (HCS), 29 CFR 1910.1200 requires the chemical manufacturer, distributor, or importer to provide Safety Data Sheets (SDS) for each hazardous chemical to inform users of the hazards of the chemical. SDSs are required to have a 16-section format where 12 sections are mandatory and four sections are non-mandatory. Appendix 13

The Department of Labor (OSHA) requires employers to have a Safety Data Sheet (SDS) for every substance stored or used in a laboratory. A Safety Data Sheet is a document that contains relevant information about a material, as referenced by OSHA Hazard Communication Standard 29 CFR, Part 1910.1200, referred to as the "Right to Understand" Law. A substance may not be stored in the stockroom or laboratory without an SDS being available (unless it is a substance for which no SDS exists - a research sample). The SDS provides information on known toxic properties of the substance, its corrosiveness, flammability, and how to deal with spills, accidental exposure, and fires involving the substance. The SDS is the key to safe laboratory practice.

OSHA does not dictate how or where you get the SDS, just that you either have it immediately available in the laboratory, or know how to obtain it rapidly when it is needed.

All chemicals in the Natural Sciences inventory have SDS available for download via a link on the Natural Science website (http://www.nwmissouri.edu/naturalsciences/sds/index.htm). OSHA requires copies to be available and easily accessible for quick retrieval. The Safety Committee suggests a loose-leaf notebook with the SDS in alphabetical order.

Storage Facilities and Practices
(adapted from UME CHP[2])

[1] https://www.osha.gov/Publications/OSHA3636.pdf
[2] Section II.C (http://chemistry.umeche.maine.edu/Safety/HygienePlan.pdf)

"Often, the provision of adequate storage space is given little consideration in the design of laboratory buildings. Lack of sufficient storage space can create hazards due to overcrowding, storage of incompatible chemicals together, and poor housekeeping. Adequate, properly designed and ventilated storage facilities should be provided to ensure personnel safety and property protection." (ICESH-Chemguide, page 6) [3]

Safe practice and OSHA regulations require the storage of like classes of compounds together and away from other compounds with which they might react if their containers leaked or were broken. Color coding of containers for various storage classes is common practice among chemical manufacturers.

Chemicals must be stored according to their chemical characteristics. Within each category, materials can be arranged alphabetically. One may not merely arrange substances on a shelf alphabetically without regard to their chemical characteristics. Therefore, knowledge of the various classes of chemicals and their chemical properties is an absolute requirement for managing the chemical stockroom. Solvents must have their own special fire-resistant cabinets; oxidants are stored away from reductants; acids are stored away from bases; and peroxidizables are monitored and discarded at regular intervals.

Storage areas for chemicals "must have restricted access. Signs indicating "Authorized Personnel Only" should be posted at entrances to these areas and the areas should be locked. Only personnel with special instruction on the hazard and safe handling of dispensed chemicals should be permitted access to the areas."[4]

Management and maintenance of the chemical stockroom must follow the following professional practices:

1. The chemical stockroom storage area must be well illuminated and have adequate local exhaust ventilation. The stockroom should be maintained at an air pressure less than that of surrounding areas (see Engineering Control section). A well-ventilated stockroom should be equipped with an exhaust fan that will accomplish at least six room air changes per hour. The storage area must also be kept below 40 ^{o}C.

2. Storage areas must be equipped with fire extinguishers, eyewash fountains, and materials for cleaning up spills.

3. Chemicals must not be stored on the floor. Also all storage must be maintained below eye level.

4. Passageways cannot be used as storage areas. Access to exits, emergency equipment and utility controls must not be blocked.

5. Chemical storage areas must not be used a preparation area and must be kept clean, organized and safe by the storeroom manger.

6. The fume hood in the storeroom must be in continuous operation day and night.

[3] http://www.nars.org/Documents/ICESH-Chemguide.pdf
[4] http://www.ehs.uci.edu/programs/ih/Universalchp/chp.html

7. Bottles larger than 2 L must be stored on the lowest shelf of the storage area.

8. Liquid containers of more than 250 ml require secondary storage; that is, they must be placed in a chemical-resistant (polypropylene or polyethylene) tub or tray for secondary containment.

9. Ideally, chemical containers will be stored on lipped shelves which are securely attached to a wall. The best shelving is steel with acid-resistant paint, next is wood with acid-resistant paint. Shelving must be labeled clearly to indicate what kinds of chemicals may be stored there.

10. Chemically resistant trays should be used for storage of corrosive liquids and solvents to contain any leakage or spill.

11. Chemicals that exhibit air and moisture sensitivity must be stored in appropriate air or water-tight containers, respectively. These chemicals must be handled by a well-trained/knowledgeable chemist.

12. Hazardous Material Storage Cabinets

    When approved storage cabinets are used, the following prudent safety practices must be followed:
    a. Cabinets designed for the safe storage of chemicals can only do so if used and maintained properly, inspected on a regular basis, and never overloaded beyond their capacities.
    b. Only compatible materials must be stored inside the cabinet.
    c. Chemicals of similar vapor density must be stored together when using mechanical ventilation (e.g., heavier than air vapors are vented through the bottom vent and lighter than air vapors through the top vent).
    d. Paper or cardboard must not be stored inside cabinets with chemicals.
    e. Storage cabinet doors must be able to close, and double stacking of hazardous chemicals prohibited.
    f. Storage cabinets should be vented by providing two vents on opposite sides of the cabinet that are equipped with flame-arrestor screens.
    g. All corrosive chemicals must be kept in cabinets especially designed to contain them.

13. Avoid contact between incompatible chemicals. Chemicals must be segregated by hazard classification and compatibility in a well-identified area, as follows:
    A. <u>Flammables:</u>
    There are two major aspects of safe practice in the storage of flammables:
        1. Limit the quantity to be stored by buying the smallest quantity of flammables that will serve the purpose

        2. Use proper storage equipment: both liquid and solid, should be kept in a fireproof locking cabinet. If flammables must be stored cold, an "explosion-safe" or "explosion-proof" refrigerator should be used.

           The proper equipment for storing solvents includes metal safety cans for quantities larger than one quart, or double-walled metal cabinets approved by the National Fire Prevention Association, in which the bottles should be kept when not in use.

B. Storing acids and bases

1. Acids and bases must be separated from each other and in a cool dry place separate from all other chemicals. Unbreakable acid-resistant trays or tubs must be placed under bottles of acids to contain any leakage or spill. Acids and bases are of concern for two reasons: they are generally corrosive, and their reactions with each other are usually highly exothermic. Hence acids and bases should be stored apart from each other.

2. Acids will be stored in adequately ventilated areas (with the primary container placed inside an unbreakable outer container). Storage problems are minimized if acids are purchased in the smallest practicable containers rather than in the common 4-liter bottles.

3. Concentrated nitric and sulfuric acids are oxidants; they must be stored together, and away from all other substances (see section on Oxidizing Agents below).

4. Sulfuric acid is a strong dehydrating agent. It cannot be stored compatibly with hydrochloric acid. If it is inadvertently mixed with another strong acid such as hydrochloric acid, the sulfuric acid would immediately dehydrate the hydrochloric acid. The result of this reaction would be a large amount of thermal energy generation and the immediate off-gassing of hydrogen chloride due to the removal of water as a solvent.

5. Other corrosive acids: HCl, HBr, acetic acid, formic acid are to be stored together and separately from sulfuric and nitric acids.

C. Oxidizers and reducing agents must be stored separately from one another and away from all other chemicals:

1. *Oxidizing Agents* should be stored away from substances that they may oxidize vigorously.
   Oxidizers must be separated from flammables, organic materials and oxidizable inorganic substances. “Oxidants include: perchloric acid and perchlorate salts; chlorate salts, hypochlorites such as bleaching powders and "liquid bleach"; liquid bromine; perbromate and bromate salts; chromic acid and its salts; hydrogen peroxide; and potassium permanganate. Concentrated nitric and sulfuric acids also are oxidants; they must be stored together, and away from all other substances.”[5]

2. *“Reducing agents* are substances that are especially easily oxidized. Particular care should be taken to keep them separate from oxidizing agents, both in storage and when placed out in the laboratory for student use. The accidental combining of oxidizing and reducing agents by confused students represents a significant fire and explosion hazard. Such materials include: elemental sulfur in any allotropic form; powdered carbon (carbon black, activated carbon, powdered charcoal, graphite powder); sodium and potassium metals; most aldehydes; and all hydrocarbons and most solvents. Paper, sawdust, and wood shavings also are reducing agents.”[6]

[5] Section VI.B (http://chemistry.umeche.maine.edu/Safety/HygienePlan.pdf)
[6] Section VI.B (http://chemistry.umeche.maine.edu/Safety/HygienePlan.pdf)

D. Peroxide-Forming Chemicals

1. Peroxide-forming materials such as ether solvents should be labeled with the date the container was first opened and disposed of after six months of the opening date because ethers form peroxides on prolonged contact with oxygen in the air. This is especially critical for peroxidizables. Once these chemicals become contaminated with sufficient peroxides they pose a serious hazard.

2. "Since most peroxidizable materials are solvents and are flammable, they must be kept in a flammables cabinet; a separate one for peroxidizables as opposed to merely flammables is a good idea, but separation by shelf is acceptable."[7]

3. "Classes of compounds that form peroxides by autoxidation include:
   a. Ethers with methyl, primary and/or secondary alkyl groups, including acyclic and cyclic ethers.
   b. Hydrocarbons with allylic, benzylic, or propargylic hydrogens.
   c. Saturated hydrocarbons with exposed tertiary hydrogens.
   d. Compounds belonging to the classes listed above cannot form peroxides without exposure to oxygen (or other oxidizers). After use and prior to storing these materials, flush the container with an inert gas such as nitrogen or argon before sealing.

4. Commercially available samples of peroxidizable compounds normally contain stabilizers or inhibitors to extend the shelf storage lifetime. Upon long term storage, however, the effect of the stabilizer becomes depleted.

5. For additional information about peroxides and peroxide forming chemicals, refer to NFPA 43B, "Code of Organic Peroxide Formulations". The following recommendations (see e and f below) for discard timeframes were obtained from Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington D.C., 1995."[8]

6. The following chemicals can be a severe peroxide hazard on storage with exposure to air. It is recommended that they be discarded within 3 months after the first opening of the container:
   a. Potassium metal
   b. Potassium amide
   c. Sodium amide

7. The following chemicals can be a peroxide hazard on storage with exposure to air. It is recommended that they be discarded within 6 months after opening the container:

   - Cumene Iisopropylbenzene)
   - Cyclohexene
   - Cyclooctene
   - Cyclopentene

[7] Section VI.B (http://chemistry.umeche.maine.edu/Safety/HygienePlan.pdf)
[8] http://www.ehs.uci.edu/programs/ih/Universalchp/chp.html

- Decalin (Decahydronaphthalene)
- Diethyl ether (ethyl ether)
- Diethylene glycol dimethyl eether (diglyme)
- Dioxane
- Ethylene glycol dimethyl ether (glyme)
- Ethylene glycol monoethers (cellosolves)
- Furan
- Methylcyclopentane
- Methylcyclohexane
- Methyl isobutyl ketone
- Tetrahydrofuran
- Tetralin (Tetrahydronaphthalene)

8. Samples must be tested for peroxides before each use, especially if distillation is being planned. Solvents in glass bottles that have been opened before but are less than six months old can be visually inspected for peroxide signs by holding a flashlight to either backlight or sidelight the bottle. Look for the following signs:
    a. Clear liquid presenting wisp-like structures floating in suspension indicates early signs of peroxide contamination. Peroxide crystals may be found on the bottom of the container, side walls of the glass, and threaded cap.

    b. Hard crystal formation in the form of chips, ice-like structures, crystals, solid mass or cloudy media, are critical signs of gross peroxide contamination. Do not handle. Contact Environmental Health & Safety (EH&S) for proper disposal.

    c. If an old container is found, every attempt should be made to inspect the container without moving or picking up the container. If this is not possible immediately contact EH&S for proper disposal.

    d. Ethers have limited shelf life and should be purchased in the smallest practical containers. Each container should have the manufacturer's expiration date and date when first opened. For diethyl ethers, even unopened containers should be disposed of prior to the manufacturer's expiration date.[9]

9. Health Hazards are substances that pose a health hazard through either acute (immediate) or chronic (long-term) toxicity. Examples of substances that are acutely toxic are sodium cyanide and ammonium molybdate; chronic toxicity is displayed by many organics such as aniline derivatives, chlorinated hydrocarbons, and thiocyanates. These substances should be stored together, away from materials of other classes."[10] Containers of such substances should be stored in trays or tubs made of polyethylene or other unbreakable material to contain any leakage or spill.

10. All other compounds not included in the above categories should be stored alphabetically according to their functional groups. Nonhazardous materials such as

[9] http://www.ehs.uci.edu/programs/ih/Universalchp/chp.html
[10] Section II.C.5 (http://chemistry.umeche.maine.edu/Safety/HygienePlan.pdf)

calcium chloride, buffer solutions, copper metal, and so on should be labeled with green or gray dots (or bands).

The stockroom manager, in collaboration with the faculty, is responsible for maintaining a clean and safe storage area.

11. Stored chemicals must be checked by the stockroom manager for container integrity and deterioration. If the chemical container is in a specific faculty member's lab, the manager must notify the appropriate faculty member of any problems in order that appropriate/necessary safety measures are taken.

12. Air sampling will be conducted if there is reason to believe that exposure levels for regulated substances may exceed the action level, or in the absence of an action level, the OSHA Permissible Exposure Level (PEL). Results of air sampling analysis will be shared with the Department. The office of Environmental Health and safety may be requested to conduct an industrial hygiene evaluation of the workplace (stockroom and/or any laboratory) at any time.

Maintaining Inventory and Disposing of Containers

1. Keeping a current inventory of all chemicals helps ensure that the teaching and research labs will run smoothly.

2. All containers of chemicals should have a barcode and storage designation based on the Flinn System. Additionally, chemicals within a Flinn category are separated based on properties and are then alphabetized. Each shelf should be labeled appropriately.

3. Chemicals that may be used to produce drugs or explosives should be kept in the storeroom and aliquoted in the smallest possible amounts for use in the labs.

   As discussed in **Chemistry Teaching Laboratories**, item 4, storeroom chemicals must be properly checked out of the storeroom. Use the log in the storeroom to document chemical sign out and usage. At that time please note the name of the chemical, the barcode number and the estimated mass/volume removed from the container. (Appendix 10). The chemical safety manager will update the amounts in the inventory. Re-shelving by students is forbidden.

4. When a container is to be permanently removed from the storeroom, record the barcode number and the new location on the appropriate sign-out sheet. Leave the information and the chemical safety manager will update the inventory and print a new barcode.

5. Occasionally containers designated for other storage locations will need to be moved to the storeroom. In this case, place the container in the fume hood or in the bins below the computer.

6. Solutions made for labs do not need to be barcoded and inventoried. They should be properly labeled with the chemical name, hazard information, date and the name of the person who made the solution.

7. All empty containers must be processed through the storeroom inventory. Place empty containers in the hood or the bins below the computer in the storeroom. The barcodes for these containers will be removed from the inventory. Empty containers will be placed on a designated shelf for communal use as waste receptacles.

8. If you would like to keep an empty container to use for waste, email the barcode number to the chemical safety manager and then remove the barcode from the container.

Storage Shed

1. The storage shed located west of Garrett-Strong building is used to store large amounts of chemicals that cannot safely be stored in small flammable or acid cabinets.

2. If you need a chemical from the storage shed, do not go to the shed alone. Check the key out from the Natural Sciences administrative assistant in GS2610.

3. Sign the chemical out just as you would if you were removing it from the storeroom. A new barcode will be printed and delivered to the new location. If you do not need to take the container to your lab, leave the container in the storeroom fume hood or in the bins beneath the computer.

Transfer of Chemicals

1. Gas cylinders must be moved on a cart with a three-point system that is available in the storeroom.

2. When chemicals must be moved between floors, only the person responsible for the chemicals should be in the elevator.

3. Use a bottle carrier from the stock room when transporting large glass bottles. These carriers provide cushioning and secondary containment in case of breakage. Return the carriers to the storeroom promptly after use.

4. A cart and shallow plastic bins are available for transporting chemicals and glassware between the labs and the storeroom.

Spills

1. Neutralize basic spills with the citric acid provided in the spill kit in each lab or storeroom.

2. Neutralize acidic spills with the baking soda provided in the spill kit.

3. All items used to mop up a spill must be treated as hazardous waste and disposed of properly. Seal all used items in the spill kit and return to the storeroom for disposal. Pick up a new spill kit from the storeroom.

4. A box of vermiculite is located to the left or the hood in storeroom. It may be used to absorb large spills.

5. Oil spills may be absorbed with the oil only particulate kept in both the spill kits and the storeroom.

6. A mercury spill kit may be found on to the left of the storeroom hood. Follow the directions enclosed in the kit and return to the storeroom fume hood in a tightly sealed container. **Persons who work with mercury should familiarize themselves with the mercury spill kit.**

7. The chemical safety manager is available to clean up spills.

8. If a spill is large or you cannot manage it, evacuate the area and call 660-562-1254. Campus safety will alert the members of the hazardous materials team to assess and remedy the situation.

Waste Disposal

1. Waste from the labs must be stored in appropriate containers. These bottles will be stored in bins designated as "Satellite Waste Accumulation Area, SWAA" in the hood.

2. If there is no hood in a room where hazardous waste is generated, the bin designated as the SWAA should be stored in a well-ventilated area in the lab.

3. Hoods labeled Satellite Waste Accumulation Sites should be kept on at all times. Please lower the sash to within three or four inches of the base to ensure that the hood is not releasing fumes into the labs. Do not completely shut the hood as turbulence will be great when the hood is reopened.

4. Waste containers must have a university label as to the amounts and types of chemicals in the container. (Appendix 1)

5. Waste containers should not be filled more than 3/4 full to allow for expansion.

6. Students should be given direction on waste disposal and be monitored during clean up.

7. The chemical safety manager will inspect each waste area weekly or more often as needed. As needed, the University Health and Safety officer will be notified to pick up the waste and relocate it to a central waste accumulation area.

8. The department is responsible for all chemical waste, even after it is picked up by our disposal company. Please use the smallest amount and the least hazardous chemicals in the lab.

Chapter 8: Emergency Response and Provisions for Additional Protection

Lab Assistant's Procedure for Medical Response

Should a situation arise in lab which requires medical and/or emergency attention, the following procedure should be followed by the lab assistant. (Example situations include falls, fainting by a student, diabetic emergency, substantive chemical spills and/or major burns).

1. The lab assistant should immediately notify the Office Manager (i.e., Lisa Crater) or office assistant on duty to notify Campus Safety.

2. On the way back from the Office, stop and alert the Chemical Safety Manager (GS3390).

3. If possible, find another faculty member to assist the instructor.

4. The above steps should be completed as quickly as possible. Upon returning to the lab, the laboratory assistant should instruct the other students to move out into the hallway, so as to be sensitive to the privacy of the student of concern.

5. Check with the instructor on duty for any special instructions.

6. Retrieve the student's safety contract from the appropriate folder in the safety contract drawer. Check whether the student has any relevant medical conditions.

   The most common injury in lab is minor burns from use of the hot plate or Bunsen burner. The most common source of drama in the lab is fainting. Rarely—very rarely—is the latter a true medical emergency. Common causes of fainting include insufficient sleep, lack of breakfast, anemia, partying and/or drinking the night before, or other underlying medical conditions intrinsic to the student and not the laboratory environment.

   Because the back story is not always known, it is important to exercise precautions, while not unnecessarily dramatizing the situation. The laboratory assistant is critical to this process.

Incident reports

Incident Report Forms

1. Incident report forms are located in folders in the wall pocket inside the labs. The reports should be completed and turned into the chemical safety manager for follow up and filing. Accidents will happen regardless of safety procedures in place. By keeping records of all incidents, we may improve our safety procedures in the future. (Appendix 2)

2. Incident reports should be completed anytime a student, staff or faculty member is injured – no matter how minor the injury is.

3. Any spills of hazardous chemicals as well as all large spills and all fires require a report.

4. The reports should be completed and turned into the chemical safety manager for filing after follow up.

   By keeping records of all incidents, we may improve our safety procedures in the future. This reporting system will be used to help identify and correct any unexpected hazards in the laboratory.

Prior Approval for Unorthodox Procedures

1. Prior approval from the department is needed when acutely toxic, radioactive, or highly dangerous chemicals are needed for new protocols or when protocols are scaled up to larger volumes.

2. The chemical safety manager, department chair and faculty will work together to ensure ventilation, personal protective equipment, safety procedures and waste disposal methods are adequate to maintain a safe working environment.

3. If experiments must be conducted with hydrofluoric acid and cyanide, antidotes must be available in the work area before the chemicals are ordered.

Medical Consultation and Examination

(adapted from UMN Lab Safety Plan, RICE CHP)

1. "All employees who work with hazardous chemicals will have an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:
   a. Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the lab, the employee will be provided an opportunity to receive an appropriate medical examination."[11] The process should follow normal workers' compensation channels established on campus. Before you seek any medical help, call the Northwest Human Resources (or Dept. office) and fill out the form (Employee Injury Report-Workers Compensation).
   b. "Where exposure monitoring reveals an exposure level routinely above the action level for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical examination will be given to the affected employee as prescribed by the standard for the chemical.
   c. Whenever a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure occurs, the affected employee will be provided an opportunity for a medical consultation."[12] This consultation will determine the need for a medical examination.

2. All medical consultations and exams will be performed by or under the direct supervision of a licensed physician and will be provided without cost to the employee. For serious injuries or those requiring immediate attention, the injured employee should be taken to the emergency room of SSM St. Francis Hospital. For life-threatening injuries or illness, call 911 and request an ambulance. Less serious injuries should be handled by making an appointment with the victim's physician or through SSM St. Francis Hospital.

3. Northwest Missouri State University "will provide the examining physician with the following information:
   a. The identity of the hazardous chemical or chemicals to which the employee may have been exposed;

[11] http://www.d.umn.edu/chem/pdfs/labSafetyPlan.pdf
[12] http://www.professor.rice.edu/professor/Chemical_Hygiene_Plan.asp?SnID=94219570

b. A description of the condition under which the exposure occurred including quantitative exposure data, if available;
c. A description of the signs and symptoms of exposure that the employee is experiencing, if any."[13]
d. Additionally, a copy of the SDS from GS 3400 should be provided to the physician.

4. "The examining physician will provide to the Department of Natural Sciences a written report including the following:

   a. Any recommendation for further medical follow-up;
   b. The results of the medical examination and any associated tests;
   c. Any medical condition that may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the work place; and
   d. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment. The written opinion of the physician will not reveal specific findings of diagnosis unrelated to occupational exposure."[14]

Chapter 9: Standard Operating Procedures for Working with Particularly Hazardous Substances

(Adapted From Belmont Abbey CHP[15])

According to the OSHA Lab Standard (29 CFR 1920.1450) chemicals identified as carcinogens, reproductive toxins, or those with acute toxicity are considered to be particularly hazardous. Additional protective measure should be taken with all reproductive toxins and acutely toxic chemicals as well as select carcinogens. In addition to meeting the standard operating procedures explained in this chemical hygiene plan, individuals working with these classes of chemicals must meet the additional protective measures as explained in the following section. In addition, please consult the SDS for information on the specific hazards of a particular chemical. In addition, the OSHA Lab Standard requires that 1) the PEL for regulated substances not be exceeded, 2) for substances that have action levels, requirements for medical and exposure monitoring become effective, 3) for select carcinogens, reproductive toxins, and substances with a high degree of acute toxicity, additional protective measure beyond general laboratory practice must be considered.[16]

The principle investigator is responsible for identifying chemicals that fall into the hazardous category and taking measure to ensure the safety of people working in the lab. For all such chemicals, **a** designated area must be established. Depending on the needs of the lab, this could be anywhere from a taped off area of a bench, to a fume hood, or the entire lab. The area should be clearly labeled as to the class of chemical being used. The principle investigator is also responsible for ensuring that the PEL is not being exceeded. At Northwest, where monitoring equipment is not available, it is suggested that these chemicals be used in a sealed glove box (preferred), balance enclosure or in a designated fume hood with the sash lowered. All work with particularly hazardous chemicals should focus on the

[13] http://employees.csbsju.edu/CJANSKY/chp--sec17.htm
[14] http://www.d.umn.edu/chem/pdfs/labSafetyPlan.pdf
[15] http://belmontabbeycollege.edu/student-life/CampusSafety/Section8ChemicalHygienePlan.pdf
[16] http://belmontabbeycollege.edu/student-life/CampusSafety/Section8ChemicalHygienePlan.pdf

consistent use of containment devices, the establishment of designated areas, the removal of contaminated waste and a decontamination protocol.

Carcinogens

In general, a carcinogen is a substance capable of causing cancer. However, while many chemicals are suspected of being carcinogenic, much research is needed for conclusively identifying a chemical as carcinogenic. It falls within prudent practices to treat suspected carcinogens in the same manner as you would treat known carcinogens. A select carcinogen, one for which you must meet additional standards, are those exhibiting the greatest hazard. These are defined as substances that are 1) regulated by OSHA as a carcinogen, 2) is listed in the "known to be carcinogenic" category in the annual report by the National Toxicology Program, 3) is listed under Group I (carcinogenic to humans) by the International Agency for Research on Cancer Monographs (IARC), or 4) is listed in either Group 2A or 2B by IARC and causes significant tumor development in animals at relatively low doses.[17]

For more information on identifying carcinogens, please see the following web page:
http://www.osha.gov/SLTC/carcinogens/recognition.html

Additional Provisions for Working with Select Carcinogens

1. Consult the SDS or a database for information regarding toxicology, special precautions, additional personal protective equipment needed, waste handling procedures, decontamination procedures, and emergency responses.

2. For unusually toxic chemicals not in the current inventory, the person should take responsibility to ensure that adequate measures are in place before the chemical arrives from the manufacturer and may require committee approval.

3. Researchers must keep a current list of particularly hazardous substances.

4. Any research conducted on these carcinogens must be documented in a laboratory notebook including the chemical name, amount and names of all those working with the chemical.

5. All work involving quantities greater than 10 mg must be done in designated area clearly labeled "Designated Area for Use of Carcinogens – Authorized Personnel Only".

6. All chemical labels must be labeled as carcinogenic or suspected carcinogen.

7. Avoid skin and eye contact by wearing appropriate goggles, gloves, and other apparel.

8. Those hazardous chemicals that produce dust, aerosols, or vapors, must be used in a fume hood or glove box. Volatiles must be stored in secondary containment.

[17] http://www.d.umn.edu/chem/pdfs/labSafetyPlan.pdf

9. Equipment used for these chemicals should be isolated from the rest of the laboratory equipment. Vacuum pumps must be protected by HEPA filters with high-efficiency scrubbers and vented into a fume hood.

10. All waste from these chemicals must be labeled “Carcinogen”.

11. All equipment, protective apparel and surfaces must be decontaminated at the end of each work session.

Reproductive Toxins

Reproductive toxins are generally chronic toxins, the effect of which only becomes evident after repeated or long duration exposures. Reproductive toxins can affect both men and women. Developmental toxins, however, have adverse effects on the embryo or fetus during pregnancy.

For more information on reproductive toxins, please see the web page: http://www.osha.gov/SLTC/reproductivehazards/index.html.

1. Consult the SDS or a database for information regarding toxicology, special precautions, additional personal protective equipment needed, waste handling procedures, decontamination procedures, and emergency responses.

2. Previous permission must be obtained before adding reproductive toxins to the lab’s inventory. This step ensures that adequate measures are in place before the chemical arrives from the manufacturer.

3. Researchers must keep a current list of particularly hazardous substances.

4. Any research conducted on these reproductive toxins must be documented in a laboratory notebook including the chemical name, amount and names of all those working with the chemical. Women of childbearing age should be especially cautious when working with either reproductive or developmental toxins.

5. All work involving quantities greater than 10 mg must be done in designated area clearly labeled “Designated Area for Use of Reproductive Toxins – Authorized Personnel Only”.

6. All chemical labels must be labeled as “Warning -- Reproductive Toxin”.

7. Avoid skin and eye contact by wearing appropriate goggles, gloves, and other apparel.

8. Those hazardous chemicals that produce dust, aerosols, or vapors, must be used in a fume hood or glove box. Volatiles must be stored with secondary containment.

9. Equipment used for these chemicals should be isolated from the rest of the laboratory equipment. Vacuum pumps must be protected by HEPA filters with high-efficiency scrubbers and vented into a fume hood.

10. All waste from these chemicals must be labeled “Reproductive Toxin”.

Chemicals with Acute Toxicity

Chemicals with a high degree of acute toxicity have a median lethal dose (LD_{50}) of 50 mg or less per kg of body weight when given orally to rats. LD_{50} is the quantity of material which is lethal in 50 % of the rats tested. At the present time, there is no definitive list of acutely toxic chemicals. Please consult your SDS for the LD_{50} to determine if your chemical falls into this class.

For more information regarding chemicals with acute toxicity, please see:
http://www.osha.gov/SLTC/hazardoustoxicsubstances/index.html OR

1. Consult the SDS or a database for information regarding toxicology, special precautions, additional personal protective equipment needed, waste handling procedures, decontamination procedures, and emergency responses.

2. Previous permission must be obtained before adding compounds with a high degree of acute toxicity to the lab's inventory. This step ensures that adequate measures are in place before the chemical arrives from the manufacturer.

3. Researchers must keep a current list of particularly hazardous substances.

4. Any research conducted on these compounds with a high degree of acute toxicity must be documented in a laboratory notebook including the chemical name, amount and names of all those working with the chemical. Women of childbearing age should be especially cautious when working with either reproductive or developmental toxins.

5. All work involving quantities greater than 10 mg must be done in designated area clearly labeled "Designated Area for Use of Compounds with a High Degree of Acute Toxicity – Authorized Personnel Only".

6. All chemical labels must be labeled as "Warning -- Compounds with a High Degree of Acute Toxicity".

7. Avoid skin and eye contact by wearing appropriate goggles, gloves, and other apparel.

8. Those hazardous chemicals that produce dust, aerosols, or vapors, must be used in a fume hood or glove box. Volatiles must be stored with secondary containment.

9. Equipment used for these chemicals should be isolated from the rest of the laboratory equipment. Vacuum pumps must be protected by HEPA filters of high-efficiency scrubbers and vented into a fume hood.

10. All waste from these chemicals must be labeled "Compounds with a high degree of acute toxicity".

Chapter 10: Conclusion and Compliance

The chemical hygiene plan for the Department of Natural Sciences at Northwest Missouri State University has been created to provide faculty, staff and student employees with guidelines, rules and regulations needed to ensure a safe working and learning environment as well as comply with all applicable state and federal regulations. All members of the department are expected to follow this plan just as they would follow the spirit of the state and federal regulations. Violations of procedures and policies of this Chemical Hygiene Plan will be reported to the department chair as infractions occur.

To ensure compliance and a safe environment, labs are checked weekly and inspected yearly by the faculty member responsible for their given labs as well as the chemical safety manager. Additionally, external audits may be conducted as needed. Such audits will be conducted in the manner in which a regulatory agency would inspect the facilities. Possible penalties for failure to comply are explained in the Northwest Missouri State University Policy and Procedures Manual, which can be found in its most updated form at http://www.nwmissouri.edu/policies/index.htm.

Additional Safety Resources

Please consult the following websites for additional information regarding safe laboratory practices.

Excellent selection of links to chemical safety sites from Oklahoma State University.
http://www.pp.okstate.edu/ehs/links/labchem.htm

Chemical compatibility for glove manufacturers other than SafeSkin
http://www.labsafety.com/refinfo/ezfacts/ezf212.htm

Good source for general safety information, storage information, and simplified SDS which are useful in teaching students how to read SDS
http://www.flinnsci.com/Sections/Safety/safety.asp

American Chemical Society safety page which has much useful information
http://membership.acs.org/c/ccs/

Department of Homeland Security Chemical Facility Anti-Terrorism Standards
http://www.dhs.gov/xprevprot/laws/gc_1166796969417.shtm

Environmental Protection Agency Hazardous Waste Management
http://www.epa.gov/osw/hazwaste.htm

OSHA Lab Standard -- 29 CFR 1910.1450 (More manageable than the OSHA site)
http://www.cise.columbia.edu/nsec/safety/manual/07-labstandard.pdf
Missouri Department of Natural Resources
www.dnr.mo.gov

Northwest Missouri State University Policies and Procedures Manual
http://www.nwmissouri.edu/policies/az.htm

Part D

Geology Safety Plan

2016

Introduction

Safety is a high priority among the geology faculty, especially in the lab courses and in rooms involved with student/faculty research. Student/faculty safety must remain at the forefront of our planning each year, to avoid becoming complacent. The primary issues concern the lab courses and individual research, both for students and faculty. While safety is a high priority, actual risks are relatively low.

Laboratory Courses

Lab courses use some chemicals, primarily for the identification of rocks and minerals.

- Dilute hydrochloric acid is used in the majority of the geology lab courses, especially the General Education courses which involve large numbers of students each year. These rooms include GS 1290, 1310, 1400 and 1420. The concentration of the HCl is so low, however (10%), that no personal protective equipment (PPE) is required.

- Students are made aware of this fact, to alleviate any anxieties they may have over handling chemicals in the classroom. PPE is available to any student who requests safety gear. In addition, an eye wash/shower station is located in GS 1420.

Individual Research Projects

Individual research projects primarily involve GS 1400, 1420 and 1460. Such projects may include the use of more hazardous chemicals, such as acetic acid, sulfuric acid, and nitric acid.

- Any student that uses these types of chemicals is supervised by a faculty member and is required to use PPE (gloves, goggles and apron).

- GS 1460 houses fume hoods and three rock saws. Any student using this space is given training on the proper use of the equipment, PPE, and the eye wash/shower station that is located in the room.

- Students working on individual research are supervised while working in the room. After sufficient experience has been gained in the use of the equipment, students may be allowed to work independently in GS 1460.

Part E

Safe Handling of Nanomaterials 2016

Introduction

Nanoscale science refers to the investigation of species in the nanoscale size regime (usually 1-100 nanometers in breadth). This size scale places is larger than most traditional chemicals, but still at the sub-cellular level. These species have the potential to exhibit size-specific quantum effects, as well. Examples of nanomaterials include DNA, proteins, macromolecules, fullerenes, quantum dots, and carbon nanotubes.

Nanomaterials and related nanotechnology are emerging fields of research. In contrast to more mature areas of science (e.g., microbiology, small-molecule organic synthesis, etc.), many of the discoveries in nanoscale science precede robust environmental, toxological, and health risk assessments. *Since the precise risks are unknown, caution should be exercised, treating nanomaterials under the assumption that they are hazardous.*

Nanomaterials Safety Considerations

The following considerations and precautions should therefore be kept in mind when handling nanomaterials. (This list is not exhaustive; continued caution should be exercised.)

General Nanomaterials. Nanomaterials are often heterogeneous substances and can vary in size, shape, surface modification (e.g., hydrophilic, lipophilic, etc.), concentration, and composition. This is analogous to some biohazards, and in contrast to many commercially available chemicals which come highly purified and homogenous. Because of this variability, caution should be exercised in rationalizing the safety of one nanomaterial based upon the results of another nanomaterial.

Size-specificity. The behavior of nanomaterials is not simply a function of composition but also of size and shape. For example, many of the quantum effects observed in nanomaterials are not seen in bulk or in chemical complexes made up of only a few atoms. For example, the physical, (bio)chemical, and quantum properties of gold vary dramatically across the bulk-, nano-, and molecular-scales. Therefore, the safety of materials in the nanoscale size regime should not be rationalized from the safety of the analogous bulk material.

Heavy metal toxicity. Many nanomaterials are based upon heavy metals (e.g., lead selenide, cadmium telluride, gallium arsenide, silver, etc.) that in other contexts have demonstrated mild to acute toxicity. The entrance of these metals into the body, the environment, water systems, etc. can pose serious and possibly unknown risks. Given such potential risks, precautions should be taken to minimize or prevent personal exposure and to isolate the waste stream. These include—but are not necessarily limited to—those outlined at the end of this section.

Biohazards. Given their size compatibility and relative ease of surface modifications, nanostructures have the potential to cross cellular membranes. Therein, nanostructures have the potential—for both good and bad—to interact with macromolecules (protein, DNA), cellular functions (transcription, translation, and replication), and enzymatic activity. Therefore safety precautions analogous to other biohazards should be taken (see Part A Biology).

Persistence and accumulation. Given their size, nanomaterials have the potential to accumulate in the liver, spleen, and lymphatic system of mammals.[1] Moreover, many nanomaterials (e.g., carbon nanotubes and fullerenes) are extremely stable. The net result of these two features allows the concentration of nanomaterials to build up in ecological and organismal systems—even if individual exposure events are small. As such, the precautions outlined below should be taken to minimize personal exposure to nanomaterials and their release into the environment.

Physio-mechanical pathways. Chemical and biochemical pathways are not the only potential hazards from nanomaterials. Given the size, shape, and mechanical stability of nanomaterials, they can pose health risks by causing cellular and tissue *inflammation*. Two historical analogies will help clarify: mesothelioma and silicosis. The latter is caused by repeated exposure to sand or glass dust. Even though silica (SiO_2, sand/glass) is unreactive, chemical inert, and thermally stable, particulate exposure causes lung inflammation, which leads to silicosis. Similarly, asbestos is stable and inert, and yet by non-(bio)chemical pathways causes mesothelioma. By analogy, one should *not* conclude from the stability and inertness of nanomaterials that they are necessarily non-hazardous.

Handling Nanomaterials

Given the considerations outline above, the following precautions should be taken. This list is consider minimum, standard precautions, and is not necessarily exhaustive. Other precautions may be necessary in context-specific situations.

- *Personal protection equipment.* ***Gloves and goggles should always be worn when handling nanomaterials.*** These are important first measures of protection against absorption through the skin and other sensitive tissue. Respirators may also be necessary when the risk of inhalation is moderate to high. More advanced PPE may at times be necessary.
- *Minimization.* For teaching and research contexts, nanomaterials should always be synthesized and manipulated in as small of quantities as reasonably possible. This is a principle of "green" science that serves to minimize risk, exposure, and waste.
- *Dry powders.* A containment apparatus should be utilized when working with dry or light solids which can be easily made airborne and inhaled. Particular caution should be exercised whenever milling, grinding, or cutting of nanomaterials is performed. Dry powders may also be incompatible with work in a fumehood, where air velocities may actually increase the risk of making nanomaterials airborne.
- *Wet solutions.* In general, wet solutions are considered safer than dry powders, as the potential of becoming airborne has been decreased. Nevertheless, great care should still be taken when working with solutions or suspensions of nanomaterials, particularly when working with solvents that may aid in the transport of nanomaterials through PPE, tissue, and/or cellular membrane (e.g., dimethylsulfoxide/DMSO).
- *Volatile compounds.* Compounds with a moderate to high vapor pressure should be manipulated inside a fumehood whenever possible to minimize respiratory exposure.
- *Enclosure resources.* Fumehoods, a glovebox, a clean room, sterile isolation chambers, and other enclosures are available for use when nanomaterials are synthesized and manipulated. The *perceived* "inconvenience" of these resources should prevent them from being utilized.

- *Waste Disposal.* All products and by-products from the synthesis and manipulation of nanomaterials should be properly disposed of according to the University's waste management protocol.

For further information, see:

(1) Cademartiri, Ludovico; and Ozin, Geoffrey A. *Concepts of Nanochemistry.* Weinheim: Wiley-VCH Verlag GmbH & Co, 2009

(2) "*Emerging methods and tools for environmental risk assessment, decision-making, and policy for nanomaterials: summary of NATO Advanced Research Workshop*" Linkov, Igor; Steevens, Jeffery; Adlakha-Hutcheon, Gitanjali; Bennett, Erin; Chappell, Mark; Colvin, Vicki; Davis, J. Michael; Davis, Thomas; Elder, Alison; Foss Hansen, Steffen; Hakkinen, Pertti Bert; Hussain, Saber M.; Karkan, Delara; Korenstein, Rafi; Lynch, Iseult; Metcalfe, Chris; Ramadan, Abou Bakr; and Satterstrom, F. Kyle. *Journal of Nanoparticle Research.* **2009,** *11* (3), 513–527. doi: 10.1007/s11051-008-9514-9

(3) National Nanotechnology Initiative. "*Strategy for nanotechnology-related environmental, health and safety research*" (2008). http://www.nano.gov/sites/default/files/pub_resource/nni_ehs_research_strategy.pdf?q=NNI_EHS_Research_Strategy.pdf

(4) United States Department of Labor, Occupational Safety and Health Administration (OSHA): https://www.osha.gov/dsg/nanotechnology/nanotechnology.html

Part F

Physics Safety Plan

2016

Introduction

Increasing safety in the physics laboratories has been an ongoing process taking years to accomplish. All radioactive isotopes that required licensing were disposed of years ago. The action plan after this was simple – no chemicals, no open flames and no glassware.

Hazards

Physical Hazards. Labs requiring a source of heat use hotplates. Students can still burn themselves but they will not set themselves on fire. With no glassware to break in the labs, the students will not seriously cut themselves. Eliminating the use of glassware is difficult – at best we can minimize its use. We still need to use various light bulbs in the lab.

Chemical Hazards. Mercury thermometers were replaced with computer thermometers that use electrical properties to measure temperature. This eliminated both a dangerous chemical mercury, and glassware that students frequently broke.

The elimination of chemicals has large repercussions on what is needed for student safety. No safety goggles or lab coats are used in the physics labs.

Electrical Hazards. Electrical dangers are minimized by purchasing appropriate equipment that does not allow the student to make contact with a dangerous source of electric current. As a result of these safety measures, the only safety equipment that is in the physics labs is a fire extinguisher and a first aid kit. The phone number of campus safety is posted in the labs in the event of an emergency.

Laboratories

Observation Lab. Special mention needs to be made of certain specific laboratory safety issues. An observing session is required of students in astronomy. These observing sessions are conducted at Bearcat Observatory at Mozingo. Students drive their own cars or ride with the instructor to Mozingo. Appropriate driving instructions should be given to the students as well as reminders to dress warm as many of these observing sessions are done in cold weather.

Computer labs. Computer labs should be appropriately designed to place the student in a proper position for typing that will not cause repetitive use injuries such as carpal tunnel.

Undergraduate Research

Finally, undergraduate research projects need to begin with a review of safety issues relating to the project. If the project will make use of chemicals then the **Chemical Hygiene Plan** should be consulted to be sure that appropriate precautions and procedures are taken. If the project makes use of any biological species then the **Biological Safety Manual** should be consulted.

Part G

Composite Risk Management 2016

General

Composite Risk Management (CRM) is the Department of Natural Sciences' primary decision making process for identifying hazards and controlling risks across the full range of department activities including classes, labs, research projects, and field trips. CRM is a process used to mitigate and reduce risks associated with hazards that could injure or kill people, damage or destroy equipment or facilities, or otherwise negatively impact department operations. The guiding principles of CRM are:

1. Integrate CRM into all phases of departmental operations (planning/design, preparation, execution, and cleanup).
2. Make risk decisions at the appropriate level. Generally department activities should have low residual risk (initial risk + controls = residual risk) and thus the responsible faculty/staff member makes the decision to accept the residual risks. Higher levels of residual risk require approval from the chair, dean, or provost.
3. Accept no unnecessary risk. Accept no level of risk unless the benefits outweigh the potential costs.
4. CRM is a circular process applied continuously.
5. Do not be risk averse. Identify and control hazards so the department can accomplish its missions of education, scholarship, and service.

Composite Risk Management has five steps:

1. Identify hazards.
2. Assess hazards to determine risk based on probability and consequence of the risks.
3. Develop controls to reduce (mitigate) risks and make decisions.
4. Implement the controls.
5. Supervise implementation and evaluate the process (then return to step one).

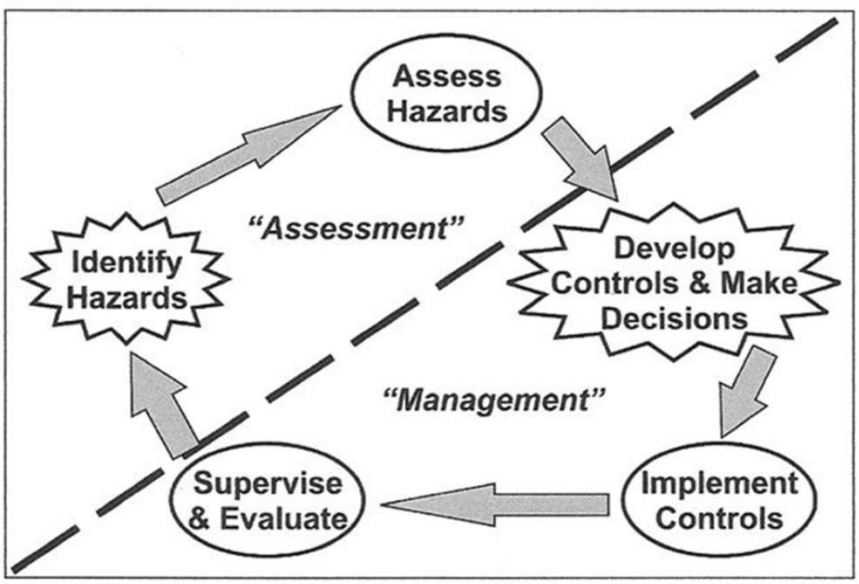


Figure 1-2. CRM process

Responsibilities

Department Chair

The Chair of Natural Sciences is responsible for safety and CRM implementation in the department. The Chair ensures that all department faculty and staff are trained in the CRM process, and ensures that faculty and staff complete a CRM Worksheet for each required activity and update these worksheets each year. The Department Chair has the authority to approve activities that have a **high** residual risk. The Chair forwards activities with **very high risk** to the College Dean for approval. (It is highly unlikely the department will undertake any activity with a high or very high residual risk.) The Natural Sciences Office Manager collects the CRM worksheets from Discipline Coordinators and digitally archives them.

Discipline Coordinators

Given the diverse activities and varying technical skills associated with departmental operations, Discipline Coordinators collect and review CRM worksheets from faculty/staff in their disciplines. Discipline Coordinators are the authority to approve activities with a **moderate** residual risk.

Faculty/Staff

Faculty and staff members (including graduate teaching assistants with responsibility for a lab or class) complete a CRM worksheet for each class, lab, research project, or field trip/activity. Once the initial CRM is complete the faculty/staff member will update the CRM worksheet once a year by adding new activities and deleting discontinued activities. Traditional "lecture" classes are exempt from the CRM Worksheet requirement. Faculty/Staff members are experts in their fields and have the authority to approve activities with a **low** residual risk. Faculty/Staff preparing the CRM must sign and scan the form to provide it in digital format to the Office Manager.

Completion of CRM Worksheets helps demonstrate that department faculty and staff take safety seriously. Well thought out and properly completed CRM Worksheets show department members have done due diligence to ensure a safe and secure working environment by mitigating the risk of inherently hazardous departmental activities.

CRM Worksheet

The CRM Worksheet (Appendix 1) is available in the online departmental "Dropbox" or from the Natural Sciences Office Manager. The CRM form is in Microsoft Excel format and allows for as many entries as necessary.

Fill out the CRM worksheet as follows:

1. Activity: This is the class, lab, research project, field trip/activity, etc.
2. Begin Date and End Date: Start and completion dates of activity.
3. Date prepared: Date the form was prepared in year, month, and date format.
4. Prepared by: Name, rank/title, and position of the faculty/staff member preparing the form (e.g. Dr. Jane Doe, Associate Professor of Biology, Instructor).
5. Subtask: These are subcomponents of the major task that entail risk. For example, the activity may be a chemistry lab and the subtask may be individual experiments that use different

chemicals. If using different chemicals or materials that have differing safety requirements, then include each chemical or material as a subtask, or address the risk and risk mitigation as individual entries.

6. Hazards: Identify the hazards associated with the subtask.
7. Initial Risk Level: Assess the initial risk based on the Risk Assessment Matrix that compares probability of the hazard to severity of hazard to derive the level of risk (low, moderate, high, very high). Enter this risk assessment in box 7.
8. Controls: These are the steps taken to mitigate the risk. For example, review of the Safety Data Sheet for a chemical used in a lab may indicate that certain personal protective equipment (PPE) such as eye protection, and protective clothing (lab coat and gloves) will reduce the risk from exposure to the chemical. Use of specific PPE would be the control. Be specific when detailing controls.
9. Residual Risk Level: Assess the residual risk based on the Risk Assessment Matrix taking into account the required controls. Application of controls to mitigate risk should usually result in a lower residual risk level.
10. How to Implement: Address leadership, supervision, and protocols to ensure that controls are implemented to reduce risk.
11. How to Supervise: This identifies the individual by name or position who is responsible for implementing the control. For example, this could be Dr. Doe or teaching assistants.
12. Was the Control Effective: This is the assessment process to determine if a control should be sustained or if the control requires improvement.
13. Overall Risk Level After Controls are Implemented: This is the overall residual risk assessment derived from assessing column 9.
14. Risk Decision Authority: This is the name, rank/title, position, and signature of the person authorized to make the risk decision. Faculty/staff have authority to accept low risk (the desired normal circumstance). Discipline Coordinators have authority to accept moderate risk (less desirable but possible). The NS Department Chair has authority to accept high risk and the Dean of the College of Arts and Sciences has the authority to accept extremely high risk (extremely unlikely the department would undertake anything so dangerous as to have high or extremely high residual risks).

Note

Risk management is used in many activities including business, government, and the military. The NS CRM process is derived from the US Army Composite Risk Management Program (now known in the Army simply as “Risk Management”) as it is one of the simplest and easy to implement processes available. Much of the information in this section is derived from US Army Field Manual 5-19 published by the US Department of the Army in 2006. The department CRM Worksheet is adapted from Department of the Army Form 7566 published in April 2005.

Appendices

Appendix 1: Composite Risk Management Worksheet (CRM) and Risk Assessment Worksheet

COMPOSITE RISK MANAGEMENT WORKSHEET

Department of Natural Sciences, Northwest Missouri State University

DRAFT Version 1.0 November 2013 ***DRAFT***

1. ACTIVITY	2a. BEGIN DATE	2b. END DATE	3. DATE PREPARED *(YYYY/MM/DD)*

4. PREPARED BY		
a. NAME	b. RANK/TITLE	c. POSITION

5. SUBTASK	6. HAZARDS	7. INITIAL RISK LEVEL	8. CONTROLS	9. RESIDUAL RISK LEVEL	10. HOW TO IMPLEMENT	11. HOW TO SUPERVISE (WHO)	12. WAS CONTROL EFFECTIVE?

13. OVERALL RISK LEVEL AFTER CONTROLS ARE IMPLEMENTED *(check one)*

☐ LOW ☐ MODERATE ☐ HIGH ☐ EXTREMELY HIGH

14. RISK DECISIOIN AUTHORITY			
a. NAME	b. RANK/TITLE	c. POSITION	d. SIGNATURE

Adapted from DA FORM 7566, APR 2005

Risk Acceptance Authority Levels

Extremely High -College Dean	**High** - Department Chair	**Moderate** - Coordinators	**Low** - Faculty/Staff Members

Risk Assessment Matrix

			HAZARD PROBABILITY				
			FREQUENT	LIKELY	OCCASIONAL	SELDOM	UNLIKELY
			A	B	C	D	E
SEVERITY	CATASTROPIC	I	EH	EH	H	H	M
	CRITICAL	II	EH	H	H	M	L
	MODERATE	III	H	M	M	L	L
	NEGLIGIBLE	IV	M	L	L	L	

EFFECT

1. **CATASTROPHIC** - Death or permanent total disability, system loss, major property damage.
2. **CRITICAL** - Permanent partial disability, temporary total disability, major system damage, major property damage.
3. **MODERATE** - Minor injury, lost workdays, compensable injury/illness, minor system damage, minor property damage.
4. **NEGLIGIBLE** - First aid or minor supportive medical treatment, minor system impairment.

PROBABILITY

A. **FREQUENT** - Occurs often - resources are continuously exposed.

B. **LIKELY** - Occurs frequently - resources are exposed frequently and/or several times.

C. **OCCASIONAL** - Occurs sometimes - resources are exposed sporadically.

D. **SELDOM** - Remote occurrence - resources are possibly exposed.

E. **UNLIKELY** - Rare occurrence of exposure

RISK LEVELS

Extremely High – Loss of ability to accomplish the mission

High – Significantly degrades mission capability

Medium – Degrades mission capability

Low – Little or no impact to mission capability

Examples

I/A = Extremely High

II/B = High

III/C = Medium

IV/D = Low

Appendix 2: Incident Report

Incident Report
Northwest Missouri State University

Date: _____ Time: _____ Course: _____ Section: _____

Location: _____ Instructor: _____

Department: _____

Name of Student: _____

Student email: _____ Phone number: _____

Description of injury or incident:

What was done to help the student?

What safety procedures were in place?

Was campus safety contacted?

Circle equipment used so that it may be refilled:

Spill kit fire extinguisher fire blanket sand bucket first aid kit

Comments:

_____ _____
Student signature Faculty or staff signature

Please returned completed report to
Chemical Safety Manager
Garrett-Strong 3390

Follow up date: _____ Date filed: _____

Appendix 3: Biological Agent Classifications

The following list of biological agent classification was taken from the Guidelines for Research Involving Recombinant DNA Molecules, April 2002. The complete NIH guideline can be viewed at http://www4.od.nih.gov/oba/rac/guidelines/guidelines.html.

Class 1 Agents

Class 1 agents are not associated with disease in healthy adult humans. Examples of class 1 agents include asporogenic Bacillus subtilis or Bacillus licheniformis, Escherichia coliK12, adenoassociated virus (AAV) types 1 through 4, and recombinant AAV constructs, in which the transgene does not encode either a potentially tumorigenic gene product or a toxin molecule and are produced in the absence of a helper virus.

Those agents not listed in Classes 2, 3, and 4 are not automatically or implicitly classified in Class 1; a risk assessment must be conducted based on the known and potential properties of the agents and their relationship to agents that are listed.

Class 2 Agents

RG2 agents are associated with human disease which is rarely serious and for which preventive or therapeutic interventions are often available.

Class 2 -Bacterial Agents Including Chlamydia

- *Acinetobacter baumannii* (formerly *Acinetobacter calcoaceticus*)
- Actinobacillus
- *Actinomyces pyogenes* (formerly *Corynebacterium pyogenes*)
- *Aeromonas hydrophila*
- *Amycolata autotrophica*
- *Archanobacterium haemolyticum* (formerly *Corynebacterium haemolyticum*)
- *Arizona hinshawii* -all serotypes
- *Bacillus anthracis*
- *Bartonella henselae, B. quintana, B. vinsonii*
- Bordetella including *B. pertussis*
- *Borrelia recurrentis, B. burgdorferi*
- Burkholderia exceptions listed in Appendix B-III-A (RG3)of the NIH guidelines)
- *Campylobacter coli, C. fetus, C. jejuni*
- *Chlamydia psittaci, C. trachomatis, C. pneumoniae*
- *Clostridium botulinum, Cl. chauvoei, Cl. haemolyticum, Cl. histolyticum, Cl. novyi, Cl. septicum, Cl. tetani*
- *Corynebacterium diphtheriae, C. pseudotuberculosis, C. renale*
- *Dermatophilus congolensis*
- *Edwardsiella tarda*
- *Erysipelothrix rhusiopathiae*
- *Escherichia coli* -all enteropathogenic, enterotoxigenic, enteroinvasive and strains bearing K1 antigen, including *E. coli* O157:H7
- *Haemophilus ducreyi, H. influenzae*
- *Helicobacter pylori*
- Klebsiella -all species except *K. oxytoca* (RG1)
- Legionella including *L. pneumophila*
- *Leptospira interrogans* -all serotypes
- Listeria

- Moraxella
- Mycobacterium (exceptions listed in Appendix B-III-A (RG3)of the NIH guidelines) including *M. avium complex, M. asiaticum, M. bovis* BCG vaccine strain, *M. chelonei, M. fortuitum, M. kansasii, M. leprae, M. malmoense, M. marinum, M. paratuberculosis, M. scrofulaceum, M.simiae, M. szulgai, M. ulcerans, M. xenopi*
- Mycoplasma, except *M. mycoides* and *M. agalactiae* which are restricted animal pathogens
- *Neisseria gonorrhoeae, N. meningitidis*
- *Nocardia asteroides, N. brasiliensis, N. otitidiscaviarum, N. transvalensis*
- *Rhodococcus equi*
- Salmonella including *S. arizonae, S. cholerasuis, S. enteritidis, S. gallinarum-pullorum, S.meleagridis, S. paratyphi, A, B, C, S. typhi, S. typhimurium*
- Shigella including *S. boydii, S. dysenteriae*, type 1*, S. flexneri, S. sonnei*
- *Sphaerophorus necrophorus*
- *Staphylococcus aureus*
- *Streptobacillus moniliformis*
- Streptococcus including *S. pneumoniae, S. pyogenes*
- *Treponema pallidum, T. carateum*
- *Vibrio cholerae, V. parahemolyticus, V. vulnificus*
- *Yersinia enterocolitica*

Class 2 -Fungal Agents

- *Blastomyces dermatitidis*
- *Cladosporium bantianum, C. (Xylohypha) trichoides*
- *Cryptococcus neoformans*
- *Dactylaria galopava (Ochroconis gallopavum)*
- Epidermophyton
- *Exophiala (Wangiella) dermatitidis*
- *Fonsecaea pedrosoi*
- Microsporum
- *Paracoccidioides braziliensis*
- *Penicillium marneffei*
- *Sporothrix schenckii*
- Trichophyton

Class 2 -Parasitic Agents

- Ancylostoma human hookworms including *A. duodenale, A. ceylanicum*
- Ascaris including *Ascaris lumbricoides suum*
- Babesia including *B. divergens, B. microti*
- Brugia filaria worms including *B. malayi, B. timori*
- Coccidia
- Cryptosporidium including *C. parvum*
- Cysticercus cellulosae (hydatid cyst, larva of *T. solium*)
- Echinococcus including *E. granulosis, E. multilocularis, E. vogeli*
- *Entamoeba histolytica*
- Enterobius
- Fasciola including *F. gigantica, F. hepatica*
- Giardia including *G. lamblia*
- Heterophyes
- Hymenolepis including *H. diminuta, H. nana*

- Isospora
- Leishmania including *L. braziliensis, L. donovani, L. ethiopia, L. major, L. mexicana, L. peruvania, L. tropica*
- Loa loa filaria worms
- Microsporidium
- *Naegleria fowleri*
- Necator human hookworms including *N. americanus*
- Onchocerca filaria worms including, *O. volvulus*
- Plasmodium including simian species, *P. cynomologi, P. falciparum, P. malariae, P. ovale, P. vivax*
- Sarcocystis including *S. sui hominis*
- Schistosoma including *S. haematobium, S. intercalatum, S. japonicum, S. mansoni, S. mekongi*
- Strongyloides including *S. stercoralis*
- *Taenia solium*
- Toxocara including *T. canis*
- Toxoplasma including *T. gondii*
- *Trichinella spiralis*
- Trypanosoma including *T. brucei brucei, T. brucei gambiense, T. brucei rhodesiense, T. cruzi*
- Wuchereria bancrofti filaria worms

Class 2 -Viruses

- Adenoviruses, human -all types
- Alphaviruses (Togaviruses) -Group A Arboviruses
  - Eastern equine encephalomyelitis virus
  - Venezuelan equine encephalomyelitis vaccine strain TC-83
  - Western equine encephalomyelitis virus
- Arenaviruses
  - Lymphocytic choriomeningitis virus (non-neurotropic strains)
  - Tacaribe virus complex
- Bunyaviruses
  - Bunyamwera virus
  - Rift Valley fever virus vaccine strain MP-12
- Calciviruses
- Coronaviruses
- Flaviviruses (Togaviruses) -Group B Arboviruses
  - Dengue virus serotypes 1, 2, 3, and 4
  - Yellow fever virus vaccine strain 17D
- Hepatitis A, B, C, D, and E viruses
- Herpesviruses -except Herpesvirus simiae (Monkey B virus)
  - Cytomegalovirus
  - Epstein Barr virus
  - Herpes simplex types 1 and 2
  - Herpes zoster
  - Human herpesvirus types 6 and 7
- Orthomyxoviruses
  - Influenza viruses types A, B, and C
- Papovaviruses
  - All human papilloma viruses
- Paramyxoviruses

    - Newcastle disease virus
    - Measles virus
    - Mumps virus
    - Parainfluenza viruses types 1, 2, 3, and 4
    - Respiratory syncytial virus
- Parvoviruses
    - Human parvovirus (B19)
- Picornaviruses
    - Coxsackie viruses types A and B
    - Echoviruses -all types
    - Polioviruses -all types, wild and attenuated
    - Rhinoviruses -all types
- Poxviruses -all types except Monkeypox and restricted poxviruses including Alastrim, Smallpox, and Whitepox
- Reoviruses -all types including Coltivirus, human Rotavirus, and Orbivirus (Colorado tick fever virus)
- Rhabdoviruses
    - Rabies virus -all strains
    - Vesicular stomatitis virus -laboratory adapted strains including VSV-Indiana, San Juan, and Glasgow
- Togaviruses (see Alphaviruses and Flaviviruses)
    - Rubivirus (rubella)

Appendix 4: Biosafety Levels

Below is a summary of practices, equipment and facility requirements for agents assigned to biosafety levels 1–4 (BSL 1–4). Only work at biosafety levels 1-2 is permitted at Northwest Missouri State University. No work at biosafety level 3 or 4 is allowed at the University.

Biosafety Level	Agents typically in use	Practices	Safety Equipment (Primary Barriers)	Facilities Secondary Barriers)
1	Not known to cause disease in healthy adults	Standard microbiological practices	None required, PPE: laboratory coats; gloves; face protection as needed	Open bench top, sink required
2	Pose moderate hazard to personnel and the environment. Hazards are autoinoculation, ingestion, mucous membrane exposure.	BSL-1 practice plus: limited access; biohazard warning signs; "sharps" precautions; biosafety manual defining any needed waste decontamination or medical surveillance polices	Class I or II BSCs or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials; PPE: laboratory coats; gloves; face protection as needed	BSL-1 plus an autoclave is available.
3	Indigenous or exotic agents with potential for aerosol transmission; disease may have serious or lethal consequences.	BLS-2 practice plus: Controlled access; Decontamination of all waste; Decontamination of lab clothing before laundering; Baseline serum or vaccination as needed.	Class I or II BSCs or other physical containment devices used for all manipulations of agents; PPE: protective lab clothing; gloves; respiratory protection as needed.	BSL-2 plus physical separation from access corridors, self-closing, double-door access exhausted air not recirculated, negative airflow into laboratory.
4	Dangerous or exotic agents which pose high risk of life-threatening disease, aerosol-transmitted lab infections; or related agents with unknown risk of transmission.	BSL-3 practice plus; Cloting change before entering; Shower on exit. All material decontaminated on exit from facility.	All procedures conducted in Class III BSCs or Class I or II BSCs in combination with full-body, air-supplied, positive pressure personnel suit.	BSL-3 plus separate building or isolated zone, dedicated supply/exhaust, vacuum, and decon systems, other requirements outlined in BMBL.

Appendix 5: Hazardous Waste Label

CAUTION: HAZARDOUS WASTE
HAZARDOUS WASTE DISPOSAL LABEL
DEPARTMENT OF NATURAL SCIENCES

Lab Group _____ **Profile #** _____
Responsible Individual _____ **Phone** _____
Accumulation Start Date _____

	Contents	**Approximate %**
	_____	_____
	_____	_____
Use IUPAC	_____	_____
Nomenclature	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____

Hazard Class (if known)

1. Poison
2. Flammable Liquid
3. Flammable Solid
4. Oxidizer
5. Corrosive
6. Peroxide Former
7. Sensitive to Shock, Friction, Air or Water

Date container is full _____
Date container is moved to storage area _____

Appendix 6: Needle Recapping

Although recapping needles is not recommended in the lab, there are times in which it must be done. In the event that needles must be filled in advance of their use, there are safe methods that can be used to "recap" them using one hand. Here are several suggestions for doing this in a safe manner:

1. “One-handed scoop” method:

Place the cap on the benchtop and hold the syringe in one hand. Keep the other hand by your side. Slide the needle into the cap, then lift it up and snap it on securely using only one hand.

2. Using a sterile 50 mL centrifuge tube or Styrofoam rack:

Place the uncapped needle inside a conical tube temporarily instead of recapping. Alternatively, put the cap inside an open centrifuge tube or rack so that the needle can be inserted into it and the cap and secured by firmly pushing the needle downward into it. There are also commercial needle recapping devices available for this purpose.

Remember to keep a designated sharps container nearby for disposal of sharps, and don’t recap unless absolutely necessary!

Appendix 7: Safety Guidelines for Field Experiences

Field experience is an important part of teaching and research at Northwest Missouri State University. Since these activities occur off campus, this guide is intended to help plan and prepare for health and safety problems that might be encounter in the field.

General Field Safety Guidelines

The following safety guidelines are presented for any type of fieldwork in any location. Of course, each field trip is unique and the best way to address specific hazards is to prepare individual risk assessments.

Prior to Departure

One of the most important parts of fieldwork is planning and preparation *before* leaving. The individual that is coordinating the field work is responsible for completing a Composite Risk Management Worksheet (Appendix 1) and submitting it to the Department chair prior to the start of the activity.

A Student Travel Process Packet can be obtained from the department office manager and must be completed for any off-campus activity. Part 1 of the Student Travel Overview Form should be filled out by the University personnel responsible for the trip. This form is designed to clarify the travel conditions and expectations of both the University and Student. Part 2 is completed by each student and includes verification that each student understands the expectations and provides emergency contact information. This information will help to insure that there is clear communication between the University and the Student. Each student participant must also read and sign a Release of Liability. This packet should be turned in to the Department Office PRIOR to departure and should remain on file until the trip is over. Immediately prior to department the advisor/sponsor should complete the Student Roster form and submit it to the Department Office for ease of emergency contacts. A copy may be taken on the trip to serve as a roster for the trip advisor/sponsor. For multiple day trips the Student Travel Overview Form and the Release of Liability may be completed once but a new Student Roster must be completed prior to each outing.

If a fieldwork involves travelling outside of the country, individuals should check on the required and recommended vaccinations for the location. Some countries require proof of vaccinations prior to entry. A travel appointment should be scheduled as far in advance as possible since some vaccines are given as a series over a six-month period. Consider taking a CPR/First Aid class.

Safety provisions should be assembled and check everything before leaving. Safety provisions may include:

- First aid kit and first aid manual. These should be taken on any trip and are described in detail below.
- Allergy treatments
- Sunscreen and hat
- Water purification tablets or filter devices
- Vehicle emergency kit
- Flashlight
- Flares (Do not take on plane)
- Two-way radio (if working alone in an isolated or dangerous area)

- Personal protective equipment for fieldwork activities (safety glasses/goggles, gloves, hard hat, sturdy work boots, etc.). EHS can recommend protective equipment depending on your activities.
- Tool to removed fishhooks from skin if using hooks for fishing
- Seasickness tablets (be aware of drowsiness side effects)

Research involving animals, including wild animals, requires registration with and approval from the Institutional Animal Care and Use Committee (IACUC). Consultation with the Institutional Review Board or other committees depending on the nature of the research may be needed. In addition, a scientific collection permit from the state is required for any activities that involve the capture or handling of wild animal populations.

Individuals should consult with their health insurance provider about how coverage applies to medical treatment in the fieldwork locale, should that become necessary.

During Field Experience

Individuals should check in with their group regularly, and should advise the advisor/sponsor of any changes in schedule. Whenever possible, fieldwork activities should be done in teams of at least two people. The "buddy" system is the safest way to work. Individuals should always make sure the advisor/supervisor knows where they will be and when they plan to return. After each day's work individuals should notify the advisor/sponsor when they return.

Medical Care and First Aid

First aid kits are highly recommended for all off-campus experiences. It is recommended that at least one individual who is trained in first aid and CPR be present.

Physical & Environmental Hazards

There are many general physical and environmental hazards that exist in nearly every location worldwide.

Insects

During field work, mosquito and tick bites can expose individuals to serious disease. Individuals are strongly advised to wear appropriate protective clothing and use insect repellent. Upon return, individuals should examine themselves for ticks. If a tick is attached, it should be carefully removed.

Wildlife

Wild animals pose special hazards. They can potentially carry diseases, including Hantavirus, Leptospirosis, Rabies, Rat-Bite Fever, Salmonella and Plague. Latent infections are more common in field-collected animals. Some animals normally possess bacteria that are pathogenic in humans.

The activity supervisor is responsible for assessing the risk and taking appropriate protective measures. For example, many amphibians and reptiles carry Salmonella spp as part of their normal flora. Precautions to be taken include providing for hand-washing or hand-decontamination procedures in the field. Hand-decontamination procedures should consider the susceptibility of the organisms potentially present. For example, Purell© is not effective against Salmonella. However, Sani-dex© Antimicrobial Hand Wipes containing 40% alcohol are effective against gram negative organisms and are routinely supplied in field safety kits.

Individuals who must handle wild animals or work in the field should take appropriate precautions to protect themselves. Each situation is unique but some possible precautionary measures are outlined below:

- **Obtain training** to properly and safely handle to animal specimens and follow the specified protocols.
- **Prevent skin contact** with infectious materials by wearing rubber, plastic or latex gloves. (i.e., when handling captured animals, contaminated traps, or disturbing burrows and nests). Additional protection may be necessary to provide protection against bites.
    - Reusable gloves should be decontaminated before removing the gloves. A 10% solution of household bleach (1 ½ cups of bleach per gallon of water) is an appropriate disinfectant, as are most household detergents.
    - Thoroughly wash hands with soap and water after removing gloves.
    - If hand washing facilities are not available, Rinse gloves with water or use a disinfectant wipe. Wash your hands thoroughly as soon as hand washing facilities are available
    - Never wash or reuse disposable gloves
- **Wear eye protection,** safety goggles or glasses provide appropriate protection.
- **Wear respiratory protection** appropriate to the danger risk level to minimize exposure to airborne particles. For assistance in the selection of appropriate respiratory protection, contact the Health and Safety Manager.
- **Wear protective gear** and use appropriate restraining devices.
- **Safely transport traps containing live animals.**

Field dissection is strongly discouraged. Instead, transport animals to a laboratory with appropriate containment equipment in order to process them under safer working conditions. See the Natural Sciences Biosafety Manual for information on how to properly handle animal tissue within the lab.

Appendix 8: Ethidium Bromide Management Guidelines

Ethidium bromide (3,8 diamino-5-ethyl-6-phenyl phenathridinium bromide, dromilac, CAS #1239-45-8) also referred to as EtBr, is commonly used as a marker for identifying and visualizing nucleic acid bonds in electrophoreses and in other methods of gel-based nucleic acid separation. It is available as a dark red, crystalline, non-volatile solid and is moderately soluble in water. Ethidium bromide fluoresces a red-orange color under ultraviolet light and when bound to nucleic acid its brightness increases.

Safety Considerations

Although ethidium bromide is not regulated as a hazardous waste by the EPA, it is still a potent mutagen and is moderately toxic after an acute exposure and should be handled with care. The powder form is considered an irritant to the upper respiratory tract, eyes and skin.

Try to minimize the potential for spills. When practical, purchase ready-made stock solutions from chemical manufacturers in lieu of mixing the solutions in house. Preparation of stock solutions and any operations capable of generating ethidium bromide dust or aerosols should be conducted in a fume hood to prevent inhalation. Nitrile gloves, a lab coat and eye protection should be worn as with working with any hazardous material.

When an ultraviolet light source is used in work with Ethidium bromide, added caution is required. As a general rule, avoid exposing unprotected skin and eyes to intense UV sources.

Waste Management

Before beginning any work that will generate large amounts of concentrated ethidium bromide waste, the Health and Safety Manager should be consulted about possible alternative methods of waste treatment (i.e. filtration).

<u>Aqueous solutions</u>

Concentrated ethidium bromide stock solutions should be collected in satellite waste accumulation areas and disposed of as hazardous waste through the Health and Safety Manager.

Aqueous solutions with trace amounts of ethidium bromide (<10µg/ml, 0.01% by wt.) may be disposed down a sink drain. Run plenty of water to flush the solution. Aqueous solutions containing greater than 10µg/ml ethidium bromide should be collected in a sealable waste bottle that is properly labeled (Appendix 5) and disposed of through the Health and Safety Manager.

<u>Solids</u>

Ethidium bromide in crystal/powder form should be collected in satellite waste accumulation areas and disposed of as hazardous waste through the Health and Safety Manager.

Agarose gels with trace amounts of ethidium bromide (<10µg/ml, 0.1%w/v) may be disposed of in the regular trash. These gels should first be wrapped in plastic before being placed in the trash. Agarose gels containing ethidium bromide in concentrations >10µg/ml should be placed in a waste container to prevent liquid from escaping. The container must remain closed unless adding gels and it must be properly labeled (Appendix 5) and disposed of through the Health and Safety Manager.

<u>Contaminated glassware, equipment, ect.</u>

Glassware and equipment containing ethidium bromide should be emptied of the liquid solution containing the ethidium bromide and disposed of according to the procedures listed above. Contaminated glassware and equipment can then be triple rinsed and the rinsate can be released to the

sewer system as long as the rinsate ethidium bromide concentration is <10µg/ml. Concentrations of rinsate greater than 10µg/ml must be disposed of according to the procedures listed above.

Any gloves, test tubes, paper towels, etc., that are grossly contaminated with concentrated ethidium bromide should be collected in satellite waste accumulation areas and disposed of as hazardous waste through the Health and Safety Manager.

Spills

For spills of concentrations up to 10 mg/ml:

- Absorb with paper towel and then treat area with 70-95% ethanol/isopropanol and wipe up. Items that are contaminated with trace amounts of ethidium bromide may be disposed of in the regular trash. All other items should be collected and disposed of as hazardous waste.
- Repeat as necessary until area does not fluoresce when exposed to UV light.
- Rinse area with soap and water. The paper towels for this step maybe discarded into the regular trash.
- DO NOT clean ethidium bromide spills with bleach solutions.

For large spills or spills of concentrations greater than 10 mg/ml:

- Contact the Health and Safety Manager or University Police (after hours) for clean-up.

Emergency Procedures

If ethidium bromide contacts the eyes, immediately flush them with copious amounts of cold water for at least 15 minutes. For skin contact, remove contaminated clothing and immediately wash the affected area with soap and copious amounts of cold or cool water. If a person inhales ethidium bromide dust, move them to fresh air. After any eye or internal exposure (inhalation or ingestion) to ethidium bromide, the affected person should immediately seek medical evaluation.

Ethidium Bromide Alternatives

SYBR Safe™ DNA gel and SYBR Green products can be treated as non-hazardous materials requiring no special waste disposal procedures.

Appendix 9: Tissue Culture Room Standard Operating Procedure

General Rules

1. Wear gloves – but note that these are to protect you and are not inherently clean!
2. Keep the work surface clean
   - clean with 70% ethanol
   - keep the work area clear enough to allow work without reaching over an item and preventing inadvertent brushing of a sterile tip against another object.)
3. Use sterile reagents and media and work to keep them that way
   - do not reuse tips
   - clean the outside of reagent bottles with 70% ethanol
   - autoclave or sterile filter as appropriate)
4. Keep bottles, flasks and tubes covered as much as possible.
5. Remove liquid from containers at an angle.
6. Clean with 70% ethanol often (surfaces and gloves).
7. Remember that it is the inside of containers (autoclaved bottles, centrifuge tubes, etc) that is sterile. Treat the outside as dirty and clean with ethanol.
8. Label EVERYTHING. Minimal labeling includes your initials, the date, and sample identification.

The major advantage of working in a laminar flow hood is that the working environment is protected from contamination by a constant flow of filtered air. A vertical flow hood is where air blows down from the top of the hood onto the work surface. Follow these guidelines when using the laminar flow hood. Keep this direction of flow in mind when setting up your work area.

Start-up in the hood

1. Turn on UV light 15 minutes prior to using biosafety cabinet.
2. Turn off UV light.
3. Turn on task lights.
4. Put sash in operating position (not more than a 9" opening).
5. Check air intake and exhaust grilles to ensure they are unobstructed.
6. Turn on the hood blowers and allow them to run for 5-10 minutes to clean the air in the hood.
7. Remember that everything that goes INTO the hood must be cleaned with 70% ethanol. This includes your hands. Spray them down before starting.
8. Swab down the work surface liberally with 70% ethanol. Wipe with a Kimwipe, starting from the back of the hood and moving forward. Wipe off anything you intend to use in the hood (pipettor, pipette tips, beakers, etc).
9. Bring stuff into the hood that you intend to use – pipets, tips, etc. Each of these items needs to be cleaned with 70% ethanol (unless doing so will compromise the sterility of the contents, i.e. paper wrapped pipettes). In addition, if you plan to use tips or microcentrifuge tubes, be sure to keep an autoclaved stock that is kept for hood use only.
10. Dry media bottles thoroughly if they have been taken out of the water bath. This water is a great source of contamination. Swab with 70% ethanol, especially at the neck and bottom before placing in hood.
11. Ironically, the greatest source for contamination comes from the cell culture flask itself. If you notice that you have dripped media onto a flask, either replace the lid or carefully wipe down with 70% ethanol before returning to the incubator.

Working in the Hood

1. As stated above, **everything** that goes into the hood must be wiped with 70% ethanol before putting it onto the bench in the hood. This means your hands, new boxes of tips, new beakers of tubes, the

exterior of bottle-top filter units, etc. **Everything** (unless doing so will compromise the sterility of the contents, i.e. paper wrapped pipettes).

2. Keep the air intake (the vent in the bottom of sash, underneath your elbows) clear of **all** items at all times. If this vent is blocked, it allows room air to enter the hood, which is a great source of contamination! Also, keep items from directly blocking the vent in the back of the hood.
3. Bring only the items you need for a particular procedure into the hood to prevent cluttering your working space. Having a clear working space will significantly reduce the chance of contamination! Ensure easy access to items in the hood and maintain plenty of clear space in the center of the hood to work in.
4. This is a vertical laminar flow hood, which means that air flows straight down from the top of the hood. Do not work directly over any open vessels, or contaminants from your hands could be blown into your vessel. Always work at an angle, off to one side.
5. If you spill anything in the hood, clean up immediately to prevent cross-contamination and damage to working surface. Stop what you are doing and wipe up the spill – salts in particular can corrode the metal if left. Wipe the area with 70% ethanol before returning to work.
6. Styrofoam is not recommended in the hood – it often flakes and is difficult to keep out of the vents. Use plastic racks instead (if you need more racks, be sure to clean with ethanol before putting into the hood).

When You Are Finished

1. Trash must be disposed of properly- sharps/pipettes in the sharps waste bins, non-sharps that are contaminated must be disposed of in autoclave bins, and all other non-sharp/non-biohazard waste goes in regular trash.
2. Remove all of your media/solution bottles (tightly capped), tubes, etc from the hood.
3. Wipe down the bench with 70% ethanol.
4. All waste media and/or cell cultures should be placed in the appropriately labeled tub. **ALL BIOHAZARD WASTE MUST BE PROPERLY DISPOSED OF BEFORE YOU LEAVE FOR THE DAY!**
5. Pull down sash; turn off hood blowers and lights.
6. Turn on the UV light for 15 min.
7. Turn off the UV light.

Incubators and Microscope

These are shared equipment, so they present a great method to spread contamination!

1. Before using the microscope, spray a Kimwipe with 70% ethanol and wipe down the stage. Do this also when you are done to prevent media spills from spreading between plates.
2. If you need counter space to set plates down on by the microscope, clean area with 70% ethanol.
3. The incubators are not technically sterile- however, every effort must be made to maintain their cleanliness to prevent contamination from spreading. If media has spilled in the incubator, clean the spill with Ethanol. Spills into the water bath MUST be immediately taken care of- talk to the lab manager.
4. Put plates carefully into incubator- be sure not to bump other people's plates, minimize stacking as much as possible, and keep your own plates set up to allow you easy access to what you need next.

Detailed Aseptic Technique

There are tons of ways to contaminate your sample, and this list is not exhaustive but includes many general guidelines. Don't worry- this will quickly become second nature.

1. Solids (tips, etc) are autoclaved by the lab helpers. The indicator stripes on the autoclave tape should turn black if an object has been properly autoclaved.
2. Bottles should always be tightly capped when outside the hood (i.e., they should have been tightly capped the last time they were in the hood).

3. Never pour from one sterile container to another. Pouring will generate a liquid path to introduce infection from the outside to the inside. Always pipette or use filters when transferring from one bottle to another.
4. Do not fill a dish/flask so full or swirl it such that the medium spills over the edge. This will introduce a path of infection via liquid and may cause cross-contamination.
5. Avoid working too closely to the front, or the non-sterile area, of the hood. Keep working area at the center or towards the back. Keep the objects needed for the current procedure within reach; keep the others in the back.
6. Avoid working above an open bottle or dish in vertical laminar flow. Always work around them unless they are capped or covered.
7. Avoid leaving bottles, dishes, and flasks open when they are not in use. If the cap must be laid down, place it face-up/face-down towards the back of the hood where there is less traffic and less chance of being touched or crossed over. Correct cap placement has been debated. Having a cap facing up can potentially introduce airborne particles and drive non-sterile lid liquid onto the interior face of the cap, where contaminations can fall into the bottle upon recapping. If face-down placement is preferred, then make sure to swab the area specifically and thoroughly before the cap is placed down there. Conversely, if hood surface sterility cannot be absolutely guaranteed due to high traffic or cluttering, then face-up is a better option. The best placement, however, is to place the cap on its side and towards the back of the hood. This way the interior is not in contact with the air flow or with the work surface. However, this is not possible with dishes. Therefore, exercise good judgment in light of individual operating style and the hood setup.
8. Withdraw pipettes from wrappers in the center of the working area. Ensure that the tip does not come into contact with anything (including the outside of the wrapper). Dispose of wrapper immediately outside of the hood.
9. Avoid contact between the tip of the pipette and the mouth of the bottle. The mouth and neck of the bottle (both inside and out) present a potential source of contamination.
10. Handle the pipette with a steady hand. Avoid large motions and do not let the tip touch anything non-sterile. Keep the tip away from the front and far above the objects in the hood.
11. To keep the hood from being cluttered, do not leave any trash in the hood. Immediately discard uncontaminated wrappers in the regular trash. Put all pipette tips and biologically contaminated sharps in the sharps biohazard waste container. Put all biologically contaminated tissue culture plates, flasks, and other non-sharps in the non-sharps biohazard waste container. However, an effort to minimize entry/exit from the hood should be made to minimize disturbances in the laminar flow at the entrance, which may create the potential to waft in contaminants.
12. You are responsible for maintaining/removing old plates. If you repeatedly fail to do so, the lab manager may have to remove them without asking you. To prevent confusion please label well and let others know if you have long term culture experiments.

Appendix 10 – Chemical Sign Out Log for the Storeroom

1. Barcode #	2. Chemical Name on Barcode	3. Your Name	4. Room #	5. Date Out	6. Date In	7. Amount Used	8. Storeroom Use ONLY

You must complete blanks 1 through 5 before removing a chemical from the storeroom

1. The barcode is on the bottle.
2. Use the chemical **name (not the formula or an abbreviation) that is on the barcode** as it corresponds to our database.
3. Put your own name and not that of your research group. Multiple people from the same group may be signing out chemicals.
4. List the room number where you will be taking the chemical.
5. List the date you are taking the chemical.
6. Sign the chemical back in. Make sure the container is tightly capped. If the container is empty, put it in the "For Disposal" bin under the prep table. If it is not empty, put it in the "For Re-shelving" bin under the prep table or you may re-shelve it.
7. Please enter the amount you used.
8. The "Storeroom Use Only" area is used to keep track of what has been re-shelved and the changes to the computer inventory. Please leave this area blank.

Special Circumstances

1. *Not returning a chemical*
   If you will not be returning the chemical and are adding it permanently to your lab store, just cross out the "Date In" and "Amount Used" sections. Write in "Relocated" and a new barcode with the **new** location will be printed.

2. *Taking a portion while in the storeroom*
   If you are just taking a portion of the chemical, you can scratch through the "Date Out /Date In" sections and just put the container in the "For Disposal" or "For Re-shelving" bins.

3. *Not using a chemical you had written in the log*
   If you change your mind about using a chemical that you have already written in, put the amount used as "0" (zero) and place the container in the "For Re-shelving" bin.

Appendix 11 – Hazard Communication Poster

Northwest Missouri State University **Hazard Communication**	
In Case of Emergency Call 660-562-1254	
Building: Garrett-Strong	**Room**: 2350

CONTACTS

Name	Office Location	Office Phone	Emergency Phone
Michelle Allen	GS 2330	660-254-0938	660-254-0938
Jim Campbell	CIE 1422	660-562-1196	865-243-0006
Redempta Kegode	Chemical Safety Manager	660-562-1215	660-616-4948
Scott Walk	Health & Safety Manager	660-562-1475	660-562-9595

ADMITTANCE TO AUTHORIZED PERSONNEL ONLY

CAUTION: The following hazards are present within this area:

☒ 
Flammables
Self Reactives
Pyrophorics
Self-Heating
Emits Flammable Gas
Organic Peroxides

☐ 
Oxidizers

☐ 
Explosives
Self Reactives
Organic Peroxides

☒ 
Corrosives

☐ 
Carcinogen, Mutagenicity
Respiratory Sensitizer
Reproductive Toxicity
Target Organ Toxicity
Aspiration Toxicity

☒ 
Irritant
Dermal Sensitizer
Acute toxicity (harmful)
Narcotic Effects
Respiratory Tract Irritation

☐ 
Acute Toxicity (severe)

☐ 
Gas Under Pressure

☐ Strong Magnetic Field ☐ Laser (Class _____) ☐ Electrical/High Voltage

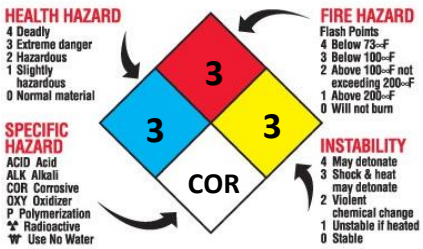
☒ **Biohazards**

BSL 2

Special Procedures required for entry or exit:

- **No food or drink in lab**
- **Remove PPE and wash hands prior to exiting**

NFPA Rating



Safety Data Sheets are Located in GS2350 & GS3400

Appendix 12 – Lab Safety Contract

Generic Lab Safety Contract

(Term, Year)

The following contract must be signed and returned to the instructor before you can participate in lab.

I _____(print name), have read and agree to follow all of the safety guidelines on (*pp.* ##) of the (*Course)* Laboratory Manual. I realize that I must obey these rules to insure my own safety, and that of my fellow students and instructors. I will cooperate to the fullest extent with my instructor and fellow students to maintain a safe lab environment. I will also closely follow the oral and written instructions provided by the instructor. I am aware that any violation of this safety contract that results in unsafe conduct in the laboratory or misbehavior on my part, may result in my being removed from the laboratory, receiving a failing grade, and/or dismissal from the course.

Do you wear contact lenses?

Are you color blind?

List all allergies that you suffer from.

Do you have any specific conditions or concerns that the instructor should be aware of before you begin working in a laboratory environment?

Student Signature: _____

Date: / /

Appendix 13 – Hazard Communication Standard, Safety Data Sheets

The Hazard Communication Standard (HCS) requires chemical manufacturers, distributors, or importers to provide Safety Data Sheets (SDSs) (formerly known as Material Safety Data Sheets or MSDSs) to communicate the hazards of hazardous chemical products. As of June 1, 2015, the HCS will require new SDSs to be in a uniform format, and include the section numbers, the headings, and associated information under the headings below:

Section 1, Identification includes product identifier; manufacturer or distributor name, address, phone number; emergency phone number; recommended use; restrictions on use.

Section 2, Hazard(s) identification includes all hazards regarding the chemical; required label elements.

Section 3, Composition/information on ingredients includes information on chemical ingredients; trade secret claims.

Section 4, First-aid measures includes important symptoms/ effects, acute, delayed; required treatment.

Section 5, Fire-fighting measures lists suitable extinguishing techniques, equipment; chemical hazards from fire.

Section 6, Accidental release measures lists emergency procedures; protective equipment; proper methods of containment and cleanup.

Section 7, Handling and storage lists precautions for safe handling and storage, including incompatibilities.

Section 8, Exposure controls/personal protection lists OSHA's Permissible Exposure Limits (PELs); Threshold Limit Values (TLVs); appropriate engineering controls; personal protective equipment (PPE).

Section 9, Physical and chemical properties lists the chemical's characteristics.

Section 10, Stability and reactivity lists chemical stability and possibility of hazardous reactions.

Section 11, Toxicological information includes routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity.

Section 12, Ecological information*
Section 13, Disposal considerations*
Section 14, Transport information*
Section 15, Regulatory information*

Section 16, Other information, includes the date of preparation or last revision.

*Note: Since other Agencies regulate this information, OSHA will not be enforcing Sections 12 through 15(29 CFR 1910.1200(g)(2)).