LABORATORY SAFETY MANUAL

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ARS Laboratory Safety Manual
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Signature Page

The undersigned have read this Safety Plan and understand the requirements set forth in it. By signing this document, these individuals acknowledge their responsibility to follow the procedures outlined. The Laboratory Manager (PI) will initialize ascertaining the Safety Plan has been read by the individuals.

The annual review of this manual is mandatory for all laboratory workers and will be construed as training for all matters contained within.

Name (Please Print)	Signature	Date	Title	PI Initial

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Introduction

Laboratories provide services in support of the various research programs at the Agricultural Research Station (ARS). The ARS is committed to providing a safe laboratory environment for its faculty, staff, students and visitors. The purpose of this Laboratory Safety Manual is to promote safety awareness and safe work practices that minimize the risk of injury or illness to laboratory personnel by ensuring that they have the training, information, support and equipment needed to work safely in the laboratory.

General Safety Considerations

- It is the responsibility of everyone working in the laboratory to make sure that the laboratory is left clean after work has been completed.
- Spills shall be cleaned immediately, following emergency spill tactics provided in the **Emergency Response** section of this manual.
- Be alert to unsafe conditions and actions; notify the Laboratory Manger or appropriate authority so that corrections can be made promptly. Become familiar with the appropriate measures to take when individuals are exposed to substances and materials that are corrosive, toxic, flammable, reactive, combustible, carcinogenic, and/or biohazard.
- Never perform hazardous work alone in a laboratory or chemical storage area, and minimize unattended procedures for extended periods of time.
- If an accident occurs causing any form of personal injury, the Incident Report Form (see Appendix B) must be completed and submitted to the Laboratory Manager or, if unavailable, to an ARS Administrator. The Incident Report Form is further discussed in another section.
- A list of general safety considerations can be found in Appendix A in the form of a Laboratory Safety Checklist, which must be conspicuously posted in the laboratory work areas. Bound copies of Material Safety Data Sheets (MSDS) will be readily available in the laboratory work area as a reference manual to laboratory chemicals.

All staff must know the location of the following:

- Safety shower located near the door in the main laboratory
- Eyewash station located near the door in the main laboratory
- Fire alarms located in the hallways just outside the laboratories
- Fire extinguishers located in hallways
- Fire extinguishers located near the doors in the laboratories
- Spill cleanup kits located near the doors in the laboratories
- First aid kit located near the door in the laboratories
- Well-marked evacuation routes in hallways

Housekeeping

- Eliminate safety hazards by maintaining laboratory areas in good working order, clean and free from clutter. Paths of egress must be free from obstruction. Attend to spills of chemicals/water immediately, and notify other lab staff of potential slipping hazards.

- Equipment should be inspected prior to use and cleaned and properly stored following each use. Unused equipment or chemicals should be properly removed/ disposed.
- Chemicals and hazardous wastes should be stored and disposed in accordance with regulatory procedures as per the Chemical Hygiene Plan in this manual.
- If mats are being used on floors, they must be removed, cleaned and sprayed with disinfectant, and the floor underneath should be swept and mopped free of stain and dirt.
- Appropriate types of refrigerators must be used to store samples in the laboratory; sample containers must not leak inside the refrigerator, and periodic cleaning of refrigerators should be practiced.
- Laboratory hoods are not designed for storage; therefore, they must be kept clean and uncluttered at all times.
- Laboratory benches must be kept clean, and sinks and troughs must be kept free of debris to allow free drainage.
- All glassware must be cleaned and properly stored in cabinets.
- Management supports the use of Friday afternoons for general laboratory cleaning and straightening out. There will be drop-in inspections by management on Mondays to ascertain laboratory cleanliness.

Personal Hygiene

- Wash hands often--especially before leaving the laboratory and before eating, drinking and/or smoking.
- Never eat, drink, smoke, or apply cosmetics in the laboratory or chemical storage areas.
- Never use lab equipment as a food or drink container.
- No food items should ever be stored or cooled in a laboratory refrigerator. Food and beverages can become contaminated within a very short period to a life-threatening level by absorbing harmful vapors or by coming in direct contact with chemicals. Any food/beverage found in inappropriate areas shall be removed without notice.
- Do not use ice from laboratory ice machines in beverages.
- Avoid "Sniff-testing". Inhalation is one of the four modes of chemical exposure.
- Do not put your head in the fume hood when contaminants are being generated.
- Store hazardous chemicals in an approved safety cabinet.
- Launder clothing worn in the laboratory separately from other clothing.
- Never use your mouth to pipette chemicals.
- Exposed long hair and jewelry, loose clothing, etc. can present a variety of hazards in the laboratory when in close proximity to open flames and chemicals, reactive substances, or when operating equipment.
- Keep exposed skin covered; be mindful that wearing shorts, skirts, or open-toed shoes can be a dangerous practice.
- Clothing worn in the laboratory should offer protection from splashes and spills, should be easily removable in case of accident, and if possible, it should be fire resistant.

Personal Protective Equipment (PPE)

Eye Protection

Laboratory policy requires that all persons wear safety glasses equipped with side shields or goggles for eye protection in the laboratory when chemicals are in use, when handling compressed gases, and when performing operations such as sample grinding. Eye protection, and at times face protection, is required wherever the potential for eye injury exists. Particular care must be exercised when handling potentially corrosive, combustible and explosive materials, in order to prevent catastrophic accidents from occurring. No personnel may enter laboratories without eye protection when chemicals are being handled or automated processes are in operation. The Laboratory Manager should refer to the appropriate Standard Operating Procedure to determine the type(s) of eye and/or face protection necessary. Various types of eye protection are commercially available including:

- Safety glasses with side shields
- Protective goggles, which can be worn over spectacles
- Face shields, which can be worn over spectacles
- Head shields, which can be worn over spectacles, to protect the head and throat
- The laboratory provides safety glasses and goggles, and enhanced PPE can be purchased upon request.

Dermal Protection

Hazardous chemical substances can adversely react on unprotected skin in various ways, and acute skin damage can be caused by corrosive substances or chemicals after prolonged or repeated exposures. Absorption of chemicals through the skin can be particularly harmful or lethal. Given time, all chemicals will permeate through clothing and any glove materials. To protect against dermal exposure, it is important to assure that closed-toe shoes, lab coats and the appropriate type of gloves are worn. Shorts and sandals should not be worn under a lab coat. Spillage on shoes and clothes should be cleaned to minimize/avoid damage to apparel and or the skin. Wearing the appropriate gloves is of utmost importance and should be selected as follows:

- Disposable latex and PVC gloves are suitable where there is NO direct contact with aggressive or highly toxic chemicals.
- Layering disposable gloves is a practice that provides the most protection and should be used whenever possible.
- Reusable gloves are suitable if they are properly cleaned between uses, but they should be discarded when they become discolored or show signs of damage or contamination.
- Store gloves away from chemicals, and never reuse disposable gloves.

Fume Hoods

- Fume hoods provide constant respiratory protection when used properly; they prevent hazardous, offensive, or flammable gases and vapors from mixing with the general room air. A hood, especially with the sash down, acts as a shield between the laboratory workers and chemical reactions. At a minimum, all hoods should be operated at the recommended sash height. Typical fume hoods are best designed to have airflow between 60 and 120 ft/min (linear). Avoid creating strong cross drafts as much as possible by

minimizing traffic in the vicinity of the hood because drafts can draw contaminants from the hood and into the laboratory. When not in use, the sash of the hood should be kept closed.

- Work should be performed as near to the center of the hood as possible, being careful not to block the rear baffle. Excessive equipment, reagents, and glassware could increase air turbulence and, therefore, the possibility for gaseous escape into the lab. The purpose of a hood is NOT to store chemicals or unused items.
- The laboratory hoods are designed for ventilation of most chemicals, with the exception of corrosive acids and infectious or radioactive materials.
- Check the MSDS, appropriate *Standard Operating Procedure*, or chemical label for special ventilation requirements, such as:
    - Use with adequate ventilation
    - Use in a fume hood
    - Avoid inhalation of vapors
    - Provide local ventilation
    - Ventilation recommendations must be adapted to the work site and the specific process.
- Each fume hood is equipped with a Safety Monitor/Alarm System that monitors facial air velocity and provides audible and/or visual alarm if the facial air velocity drops below safe levels. This system should be checked each time the fume hood is used.
- When the hood is not functioning properly, all work inside the hood should cease immediately until it is repaired and re-certified for use.

Compressed Gases

Laboratory operations require the use of compressed gases for analytical instrumentation, and this can present a variety of hazards, both mechanical and chemical. Carefully read the label before using or storing compressed gas. The MSDS will provide any special hazard information. Safety procedures are necessary for handling various compressed gases and the accessories used to control flow, containment and storage. Gases may be combustible, explosive, corrosive, poisonous, inert, or a combination thereof. In particular, any compressed gas contained in a pressurized metal cylinder can potentially act as a rocket or bomb. Consequently, strict adherence to safety procedures is critical.

- Always use PPE when handling and using compressed gases, especially when connecting and disconnecting compressed gas regulators and lines.
- The contents of any compressed gas cylinder shall be clearly identified for easy, quick, and complete determination by any laboratory worker. If the labeling on a cylinder becomes unclear or an attached tag is defaced to the point that the contents cannot be identified, the cylinder should be marked "contents unknown" and returned directly to the manufacturer. Labels should distinguish hazardous gases (such as flammable, toxic, or corrosive substances), and signs should be conspicuously posted in areas where flammable compressed gases, such as hydrogen, are used and stored.
- Each cylinder should be securely fastened to a stationary object, such as a bench or a pole, at all times to prevent tipping.

- New cylinders should be inspected to ensure that they are labeled correctly, have a securely fitting cap and are not leaking. If any of these conditions are not met, the vendor should be contacted immediately; under no circumstances should any attempt be made to repair a cylinder or valve.
- Cylinders shall not be stored in close proximity to open flames or other ignition sources. Those containing flammable gases should also be stored in a well-ventilated area.
- Do not expose cylinders to temperature extremes.
- Always use the correct regulator. Do not use a regulator adapter.
- Cylinders of toxic, flammable or reactive gases should be stored and used in a fume hood or with local ventilation.
- Never bleed a cylinder completely empty. Leave a slight amount of pressure to keep contaminants out.
- Oxygen cylinders are an extreme combustion hazard and must not be stored in the same vicinity as other flammable gases, such as hydrogen or acetylene, or in the same vicinity as greasy/oily materials. At minimum, a fire wall or reasonable separation (50 feet is preferred) is required between oxygen cylinders and combustion sources.
- CGA standard valves and fittings should be used to deliver supply of compressed gases and to protect against mixing of incompatible gases. CGA components should be examined to ensure proper fittings. In general, right-handed threads are used for non-fuels (e.g. air, helium, nitrogen), while left-handed threads are used for fuels (e.g., hydrogen, acetylene).
- Main cylinder valves should be opened slowly with the opening pointing away from people and obvious hazards. Wherever possible, main valves should be closed when cylinders are not in use.
- Piping/tubing should be compatible with the gas being supplied. Copper shall not be used for acetylene or plastic for high pressure systems. Supply lines and their outlets should be clearly labeled as to the type of gas contained.
- Cylinders should be replaced if they:
    - have pressures below 172 kPa/25 psi/in^2.
    - are damaged or defective.
    - contain contaminated gas.

Safe procedures include:

- Close all valves, remove the regulator, and affix the valve cap;
- Label/mark the cylinder as appropriate (e.g. “empty,” “MT,” “damaged,” “contaminated,” etc.;
- Fasten the cylinder to a cylinder cart and return to safe storage for pick up by the vendor.

Hazards and Prevention: Fire, Explosion, and Chemical

Electrical Equipment

All equipment should be in good working condition and properly grounded to avoid electrical arcing and sparking. Care must be exercised not to spill flammable liquids around electrical equipment.

Flammable and Combustible Materials
As a general rule, flammable materials are characterized as having flashpoints at or below 73°F, and combustible materials are characterized as having flashpoints at or above 100°F. Consequently, caution must be exercised when handling such materials near ignition sources such as open flames and electrical and heating equipment.

Chemical Hygiene Plan

The purpose of the Chemical Hygiene Plan is to familiarize students and laboratory workers with safety and health policies and to inform employees of their rights and obligations under federal and state regulations. The Laboratory Manager continually provides a learning, teaching and research environment free from recognized hazards. It is the intent of ARS laboratories to protect the health and safety of students and employees by providing access to information regarding the safe handling of chemicals and biological agents that are present in the workplace.

The OSHA standard for laboratories is defined in 29 CFR 1910, section 1450 of subpart Z, "Occupational Exposures to Hazardous Chemicals in Laboratories". All ARS laboratories have adopted applicable elements of this standard and included them in their Chemical Hygiene Plan (CHP). Given that the large majority of work performed in most laboratories involves chemical applications, this plan establishes uniform practices for staff to follow in order to assure work place safety.

Responsibilities

Facility as well as Faculty/ Laboratory Managers bear responsibility for administering environmental and safety programs in the laboratory and for ensuring that all individuals working in the laboratory have the materials and training necessary to work safely. Outlined below are key areas of responsibilities:

Laboratory Manager/Chemical Hygiene Officers

- Ensure a safe and compliant working environment.
- Establish and implement a Chemical Hygiene Plan.
- Review and update the Chemical Hygiene Plan at least once a year.
- Ensure that all laboratory workers receive proper safety training; understand how to work with chemicals safely and provide chemical- and procedure-specific training, as needed.
- Provide laboratory workers with appropriate engineering controls and personal protective equipment needed to work safely with hazardous materials.
- Ensure such equipment is used correctly.
- Review and approve work with hazardous materials.

Laboratory Workers

All laboratory employees assume great responsibility in assuring protection for themselves, for co-workers and for the facility. Although regular and reasonable training is provided and taken regarding chemical and physical hazards, it is the employee's responsibility to ask for guidance and/or further training before undertaking potentially unfamiliar and dangerous tasks. Each employee should:

- Review the Chemical Hygiene Plan and the Laboratory Safety Manual.
- Follow procedures and laboratory practices outlined in the Chemical Hygiene Plan and Laboratory Safety Manual and as provided by facility administrators, the Laboratory Manager or Chemical Hygiene Officer.
- Report all incidents, accidents, potential chemical exposures and near miss situations to the Laboratory Manager and Chemical Hygiene Officer. Records of employee exposures to hazardous chemicals are maintained in employee files as mandated in 29 CFR 1910.20. Records should include measures taken to monitor exposures, if any, as well as any medical consultations and examinations. Ensure incoming hazardous chemicals are adequately labeled. Do not allow the removal or defacement of these labels.
- Ensure MSDS for incoming hazardous chemicals are kept on hand and readily accessible.
- Maintain an accurate inventory of all chemicals.
- Document specific operating procedures for work with particularly hazardous substances, including carcinogens, and chemicals with high acute toxicity.
- If the hazardous properties are not known, treat the chemical as though it is hazardous.
- Perform regular chemical hygiene and housekeeping inspections including routine inspections of emergency equipment.
- Know the current legal requirements concerning regulated substances.
- Understand the contents of the CHP, adhere to stipulated CHP rules, and suggest ways to improve the Chemical Hygiene Program.

Exposure

All exposure incidents are to be documented using the Incident Report Form. Whether the incident is an "isolated" instance (e.g., a spill) or requires an investigation to reveal the source of the problem, it must be corrected prior to resuming work in the laboratory. The Incident Report Form not only documents any personal injuries sustained but also the extent of an exposure (if more than one person is affected), and it identifies the hazardous chemical or chemicals involved.

Revealing detailed facts associated with an exposure incident will not only assist medical personnel in their treatment efforts but the information may be used to use control measures for preventing future incidents. Some points to consider include:

- Interview all personnel in the vicinity of or associated with the incident to obtain essential information about the circumstances pertaining to the incident including:
    - The chemical under suspicion, as well as other chemicals being used in and around the area
    - Signs of exposure and/or symptoms exhibited or claimed by the victim(s)
    - Comparison to those stated in MSDS
    - Proper use of chemical in question
    - Proper use of PPE, hoods and other control measures

Medical Emergencies

When signs and/or symptoms are indicative of overexposure to a hazardous chemical or chemicals, EMS personnel should be dispatched immediately by **DIALING 9-911** and/or **Extension 5411 for VSU Campus Police** and providing as much information as possible. When appropriate, the University Safety Office may be contacted through ARS Administration. Do not attempt to treat any victim unless you are certified as a medical professional to do so. The appropriate medical professional should be knowledgeable with tests or techniques to perform "differential diagnoses" and determine if there has been an actual overexposure.

Medical Records

Medical records including exposure incidents must be kept on file for a minimum of thirty years in accordance with OSHA regulation 29 CFR 1910.20, *Access to Employee Exposure and Medical Records*.

Chemical Safety

Knowledge of chemical safety is of the utmost importance when working in a laboratory setting with potentially hazardous chemicals. A detailed understanding of this section is vital to minimize chemical accidents and exposures.

Material Safety Data Sheets (MSDS)

OSHA regulations require chemical manufacturers/distributors to provide Material Safety Data Sheets (MSDS) about chemical products purchased. They provide a wealth of information regarding chemicals, as well as a format for describing what chemical or product you are working with, potential hazards and ways of minimizing these hazards. These sheets should be consulted whenever questions/concerns arise about a particular chemical or class of chemicals. This information is also useful for worker safety and for emergency responders. Typically, it includes the name and chemical composition of the product, hazards, first aid measures, firefighting measures, information regarding the proper steps to take with spills, handling and storage, personal protection to be used, physical and chemical properties, and information about stability and reactivity, toxicology, disposal, transporting, and regulatory requirements. Each laboratory maintains notebooks containing MSDS stored in the laboratory area. As materials are exhausted/expired/discarded, MSDS will be removed and replaced with corresponding new sheets.

Laboratory Managers must keep a record of all chemicals that have been purchased for use in the laboratory. Inter-laboratory borrowed chemicals (name and amount) must also be recorded by both parties.

Labeling

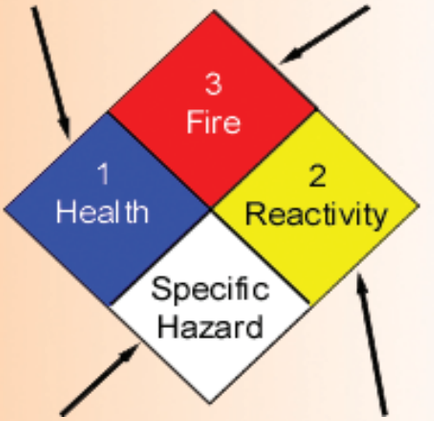
In accordance with the procedures outlined both in this manual and in the Quality Assurance Manual (QAM), hazardous chemicals must be properly labeled to assure chemical integrity and the safety of those working in the laboratory, as well as for emergency responders during potentially catastrophic events such as fires, spills, etc. The QAM describes the labeling requirements for reagents and standards for the purpose of maintaining quality assurance. All

working solutions and reagents prepared for experimental use in the laboratory must be labeled using the chemical name of the reagent and mixtures of reagents from which they are prepared. **Chemical formulas and/or abbreviations must not be used on the reagent bottle**. Any reagent solution containing more than one chemical should indicate the percentage of each chemical component in the solution. Each laboratory must adhere to the National Fire Protection Agency (NFPA) *704M* labeling system for identifying and classifying hazardous materials. This system generally applies to containers and locations of hazardous materials, with the exception of secondary containers of standards and reagents specifically and promptly used in test procedures. Figure 1 below describes this quadrant-based labeling system, which uses color-coding and a numbering system in the top three quadrants to characterize the type and severity of hazards. Note that top quadrant (color-coded red) is for fire hazards, the left quadrant (color coded blue) is for health hazards, the right quadrant (color coded yellow) is for reactivity hazards and the bottom quadrant (no color) is for describing specific hazards. The numbering system also describes the relative severity of the hazard increasing from 0 to 4. Chemical manufacturers employ this system, or a modified version thereof, to indicate the various color codes and/or associated number codes.

FIGURE 1. Classification of chemical hazards

HEALTH HAZARD
(Color Code: Blue)
4 - Extreme
3 - Severe
2 - Moderate
1 - Slight
0 - None, N/A

FIRE HAZARD
(Color Code: Red)
Flash Points:
4 - Below 73° F
3 - Below 100° F
2 - Above 100 F°, Not > 200° F
1 - Above 200° F
0 – Will not burn



SPECIFIC HAZARD
(Color Code: White)
OXY- Oxidizer
CORR - Corrosive
~~W~~ - Use no water

REACTIVITY HAZARD
(Color Code: Yellow)
4 - Unstable; may detonate
3 - Unstable; shock/heat may detonate
2 - Unstable; violent chemical reactions
1 - Stable unless heated
0 – Stable

Exposure paths

Generally chemical exposure occurs through one or more of four paths: inhalation, dermal absorption, injection and ingestion. Inhalation and skin absorption are the predominant occupational exposures. Accidental injection of chemicals can be eliminated by good laboratory safety practices. Accidental ingestion of chemicals can be eliminated by a combination of good laboratory and hygienic practices such as washing hands and prohibiting foods, drinks, and tobacco products in the laboratory workplace. MSDS lists all potential exposures for each chemical or product and should be referred to where issue of handling, use health hazards, etc. are concerned.

Basic Chemical Classifications

- **Volatile Solvents**
  Organic solvents are perhaps the most ubiquitous chemicals found in the laboratory setting and require special attention. The primary route of exposure is inhalation. They are generally categorized into chlorinated and non-chlorinated varieties.
  - Chlorinated solvents in general are not flammable; however, when burned, these solvents decompose releasing toxic vapors, such as phosgene and hydrogen chloride.
  - Non-chlorinated solvents are often flammable.
- **Acids and Bases**
  All acids and bases are corrosive to human tissues. Minor exposures are generally reversible depending on the duration of exposure, the concentration of the substance, and the first aid methods applied. Skin/eye contact is the most common route of exposure and can cause serious burns. Upon skin/eye exposure, flush with copious amounts of water for 15 to 30 minutes and summon medical assistance if needed. If inhalation exposure occurs, remove the individual from the exposed area and summon medical help.
- **Toxic Solids**
  Solid toxic substances should be treated as any other hazard where multiple exposure routes are possible as indicated in the respective MSDS.
- **Unstable Chemicals**
  Stability refers to the susceptibility of the chemical to decomposition. Ethers, liquid paraffins, and olefins can form peroxides, particularly upon exposure to air and light. Unless an inhibitor has been added, containers of ethers MUST be discarded in the original container after one year.
- **Shock-Sensitive Chemicals**
  Shock-sensitive refers to the sensitivity of the chemical to decompose rapidly or explode when struck, vibrated or otherwise agitated. Nitrate-, nitro-, nitrile-compounds are typical shock-sensitive chemicals and should be purchased only as needed to minimize storage problems.

Chemical Incompatibilities

When certain hazardous chemicals are stored or mixed together, violent reactions may occur because the chemicals are unsuitable for mixing, or are *incompatible*. The chemical label and MSDS will contain specific information on incompatibilities. In general, classes of incompatible chemicals should be segregated during storage based on hazard class, as indicated in the guidelines below:

- Flammable/Combustible Solvents/Liquids and Organic Acids
- Flammable Solids
- Mineral Acids
- Caustics
- Oxidizers
- Perchloric Acid
- Compressed Gases

TABLE 1 illustrates classes/sub-classes, where "X" denotes storage incompatibility. A partial list of specific incompatible chemicals is furnished in Table 2. The list in Table 2 is not comprehensive; always consult the MSDS for incompatibilities

TABLE 1: Chemical Incompatibility Chart

	Acids, Inorganic	Acids, Oxidizing	Acids, Organic	Alkalis (Bases)	Oxidizers	Poisons, inorganic	Poisons, organic	Water reactive	Organic solvents
Acids, Inorganic			X	X		X	X	X	X
Acids, Oxidizing			X	X		X	X	X	X
Acids, Organic	X	X		X	X	X	X	X	
Alkalis (Bases)	X	X	X				X	X	X
Oxidizers			X				X	X	X
Poisons, inorganic	X	X	X				X	X	X
Poisons, organic	X	X	X	X	X	X			
Water reactive	X	X	X	X	X	X			
Organic solvents	X	X		X	X	X			

Table 2: Partial List of Specific Chemical Incompatibilities

CHEMICAL	KEEP OUT OF CONTACT WITH
Acetic Acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetone	Concentrated nitric and sulfuric acid mixtures, and strong bases
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali Metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, the halogens
Ammonia, anhydrous	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium Nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenic materials	Any reducing agent
Azides	Acids
Bromine	Same as chlorine
Calcium Oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials
Chromic Acid and Chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, glycerin, turpentine, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Chlorine Dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene Hydroperoxide	Acids, organic or inorganic
Cyanides	Acids
Flammable Liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Hydrocarbons	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic Acid	Nitric acid, alkali
Hydrofluoric Acid	Ammonia, aqueous or anhydrous
Hydrogen Peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids

Hydrogen Sulfide	Fuming nitric acid, other acids, oxidizing gases, acetylene, ammonia (aqueous or anhydrous), hydrogen
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric Acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic Acid	Silver, mercury
Oxygen	Oils, grease, hydrogen; flammable liquids, solids, or gases
Perchloric Acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease and oils
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate and perchlorate	Sulfuric and other acids
Potassium Permanganate	Glycerin, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium Peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric Acid	Potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium, etc.)
Tellurides	Reducing agents

(From Manufacturing Chemists' Association, *Guide for Safety in the Chemical Laboratory*, pp. 215-217, Van Nostrand Reinhold, 2nd Edition.)

Chemical Storage

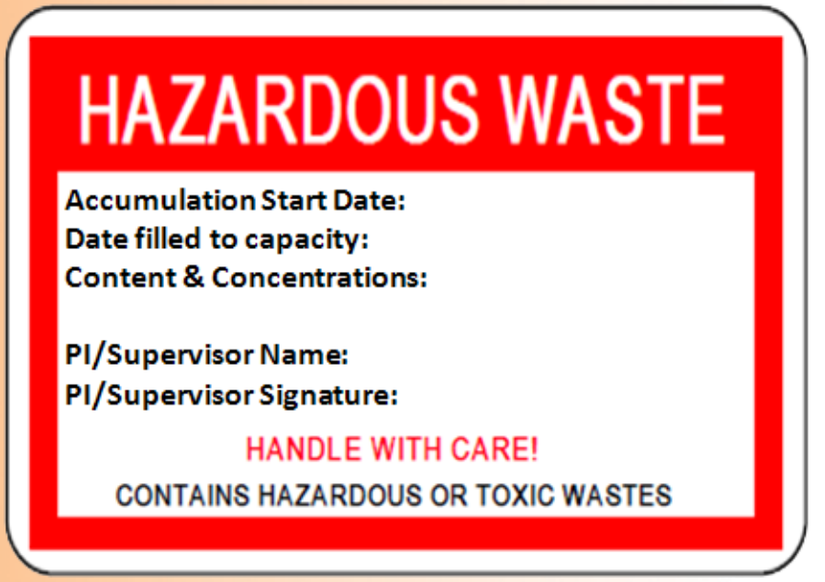
- Chemicals should be stored in well-marked locations and should conform to the storage compatibility restrictions discussed in Table 1 and Table 2.
- Hazardous chemicals should be stored in appropriate containers, tightly capped, upright, and on the lowest shelves of cabinets that are NFPA approved for those chemicals. Refer to the respective MSDS for specific information.
- "Reasonable" quantities of chemicals should be kept on hand in the laboratory. The outside storage building can house chemicals that are not subject to deterioration from extreme climate conditions
- Metal drums containing flammable chemicals are prohibited in laboratories as they present a particular hazard if not properly grounded.
- Flammables should be dispensed for use then immediately returned for storage in OSHA approved cabinets; under any circumstances no more than five gallons of combined flammables and combustibles should be outside of storage at any time in the laboratory.
- Small quantities of chemicals can be dispensed in well-labeled secondary containers for prompt use at individual work stations, as long as they do not pose a health, spill or fire hazard/risk.
- Expired hazardous chemicals should be appropriately stored in designated locations until a sufficient quantity of waste is collected for cost-effective disposal through a licensed facility. (See "Chemical Waste" section)

Chemical Waste Disposal

Laboratories follow the guidelines and regulations for handling, transportation and disposing of chemical substances and waste set forth by the State, Local and Federal regulations. Materials that are non-hazardous either by virtue of their chemical nature or by regulated level can be disposed through sanitary sewer, which may require initial pH adjustment, or through the solid waste sanitation services. Under no circumstances is any hazardous substance to be disposed down the sanitary sewer drain or with normal refuse.

Basic Procedure

- Hazardous samples, chemicals and materials are collected in original or other suitable primary container, properly labeled and stored in designated locations until sufficient material has been collected for cost-effective disposal through a licensed facility.
- Containers shall be in good condition, appropriate for the material contained and equipped with a properly fitting cap or other closure so as to avert any leakage. Containers shall be compatible with substances contained therein.
- Plastic bags, where use as containers is acceptable, shall be without punctures or tears and shall be tightly sealed; double bagging is always preferred.
- Labeling:
    - All hazardous waste containers must include the words "Hazardous Waste."
    - .All other information that is not relevant to the waste contents must be eliminated.
    - Labels for hazardous waste containers must include dates when the waste container was started and filled to capacity as shown in the following template:



- Follow any additional instructions of the waste disposal that are outlined in the MSDS.
- All hazardous waste manifests are required to be kept on-site for three years per VADEQ. Land Disposal Restriction forms (part of the manifest) must also be retained on-site for three years. Copies of manifests will be stored and readily accessible in the physical plant building for potential VADEQ inspections.

Chemical Container Disposal

- Prior to disposing of empty or near-empty chemical containers in normal refuse, they must be sufficiently rinsed using a solvent capable of removing the chemical; the resulting rinsate thus becomes waste and must be disposed of accordingly. If the container has not been cleaned as stated above, the container shall become hazardous waste.

Mixing and Storage of Waste Chemicals

Waste chemicals are stored in a similar manner as reagent chemicals, with the exception of instances when mixed waste classes cannot be avoided. As a rule of thumb, chemicals should be segregated by the classes listed below, although Table 1 and Table 2 above indicate specific incompatibilities when mixing and storing.

- Acids
- Caustics
- Chlorinated Solvents
- Non-chlorinated Solvents
- Mercury Wastes
- Oxidizing Agents
- PCB Wastes
- Reactive Chemicals
- Waste Oil
- Wastes with Heavy Metal Contamination

Chemical Spills

Prevention

A hazardous chemical spill means that an unexpected "release" of a hazardous chemical has occurred. The release may be a gas, liquid or solid, requiring mitigation to control the release and further spreading of the chemical. Different approaches to mitigating the spill are required depending on the chemical's toxicity, reactivity and flammability, routes of entry into the body, the promptness of action and the magnitude of the release. First and foremost, proper techniques for handling, transporting and storing hazardous chemicals will help prevent spills.

Handling and Transportation of Chemicals

The following practices can help prevent spills or minimize the spread of a spill:

- Place containers of hazardous chemicals in secondary containment, such as a tray, bucket, basin or plastic tub. The use of trays for containers is advisable in the hazardous waste storage building.
- Line bench tops with absorbent paper.
- When carrying bottles through the laboratory, carry one bottle at a time. Use both hands, one on the neck of the bottle and the other underneath. Avoid hooking a finger through the glass ring on top of the bottle, allowing it to dangle while being transported. Never carry or attempt to pick up a bottle by the cap.
- When transporting bottles through the laboratory with a laboratory cart, be sure that the containers are secure enough to withstand uneven surfaces and sudden stops. Bottles should not be placed near the edge of the cart, nor should they be touching each other or other glassware during transport. Incompatible chemicals should not be transported on the same cart.
- Use of "bottle carriers" is prudent for transport of any kind.
- Use "chemical carriers" when carrying chemicals through hallways.
- Move chemicals through the building on carts with lips to prevent the container from sliding off.

See "Compressed Gases" section above for safety information.

Emergency Spills

These spills are characterized by any of the following:

- Causing personal injury or chemical exposure that requires medical attention
- Causing a fire hazard or uncontrollable volatility
- Contaminating a public area, land or water
- Causing a spill that cannot be controlled or isolated by laboratory personnel
- Causing damage to university property that will require repairs
- Involving any quantity of metallic mercury
- Requiring prolonged or overnight cleanup

Minor Spill Management

- Minor spills are those which do not fit the criteria for Emergency Spills.
- Attend to any persons who may have been affected.
- Notify persons in the immediate area around the spill.
- Evacuate all nonessential personnel from the spill area.
- If the spilled material is flammable, turn off electrical, ignition and heat sources.
- Avoid breathing vapors of the spilled material.
- Increase ventilation by turning on fume hoods and opening the sashes to full open position.
- Secure supplies to effect cleanup.
- Put on appropriate PPE.

Emergency Spill Management

- Don't panic but send for help first, *if possible*!
- Notify the **Police (x 5411 and/or 9-911)** of the incident.
- If the spill presents an immediate danger, evacuate the spill site, warn others, control entry to the spill site, and wait for first responders.
- Remove contaminated clothing. Flush skin/eyes with water at least 15 to 30 minutes; use soap for intermediate and final cleaning of skin areas.
- Protect yourself; then remove injured person(s) to fresh air, if safe to do so.
- If flammable vapors are involved, do not operate electrical switches unless to turn off motorized equipment. Try to turn off or remove electrical, ignition and heat sources, where safe to do so.
- Do not touch the spill without appropriate PPE.
- Where the spill does not present immediate personal danger, try to control the spread or volume of the spill. This could mean shutting a door, moving nearby equipment to prevent further contamination, mitigating the source including the use of the spill kit. Never assume gases or vapors do not exist or are harmless because of lack of smell.

Spill Control Materials

Spill pads, waste bags, loose absorbents and personal protective equipment are sufficient to control most spills, with the exception of hydrofluoric acid and mercury. EHS supplies general use kits for this purpose.

Appendix A: Quarterly Safety Checklist

Inspector_____ Date_____

Housekeeping

- ❑ Broken Glass Disposal box is available; used for discarding broken but "uncontaminated" glassware.
- ❑ Aisles are free of clutter and obstructions; there is a free path of egress to the exit.
- ❑ Food and beverages are not consumed in the laboratory nor stored in the laboratory refrigerators.
- ❑ Equipment is in good operating condition.
- ❑ Equipment logbooks are maintained for maintenance, troubleshooting and repair.

Safety Devices

- ❑ Fume hoods are functioning properly, as evidenced by flow indicator (Kim Wipe).
- ❑ Eye Wash Stations, Safety Showers, Fire Blanket are properly functioning.
- ❑ First Aid Kit is available and adequately stocked with supplies.
- ❑ Spill cleanup kits are readily available and complete.
- ❑ PPE is readily available and is appropriately used by laboratory staff.

Fire and Electrical Safety

- ❑ Evacuation routes are clearly marked.
- ❑ Fire extinguishers are available (not blocked by boxes or equipment) and certifications are current (< 1 year).
- ❑ Flammables are stored in proper cabinets and refrigerators (explosion-proof).

Chemical and Waste Safety

- ❑ Chemical containers are in good condition (including closures) and labeled.
- ❑ Chemicals are appropriately used and stored according to compatibility.
- ❑ Compressed gas tanks are securely fastened.
- ❑ Malodorous chemicals are properly ventilated.
- ❑ Waste containers are properly labeled and stored for disposal.

VIRGINIA STATE UNIVERSITY
AGRICULTURAL RESEARCH STATION
PETERSBURG, VA. 2380
PHONE: (524) 524-5596 FAX: (524) 524-5950

Appendix B: Incident Report Form

The completed form must be returned to the laboratory manager/ ARS Administration. In their absence, the matter should be referred to the University Safety Office **within 24 Hours of the incident. Please print clearly, complete all sections and submit originals only. Privacy: This information will be stored securely and only used or released in accordance with the University's Privacy Policy**

Involved/Injured Person
Name (of Injured): Family Name: _____First Name: _____M.I.__
Sex: □ Male □ Female
Date of Birth: _____
Address: _____City & State: _____Phone _____
Position: _____
Location of Incident: Building_____ Room Number: _____
Type of Incident: Fire: _____ Chemical Spill: _____ Personal Injury: _____Other____

Details of Incident
Date of Incident: _____/_____/_____ Time of Incident: _____ AM or PM
Incident Occurred: During Research: _____Other:_____
Incident reported to: _____Date Reported_____
Describe the task/processes being undertaken at the time of the incident and explain what happened and how the incident occurred. Note any chemicals/equipment involved. (Attach sketch/additional information if req.) _____
_____
Describe the **Personal Injuries** and/or details of any damage to **Property/ Environment**.
_____
_____
Was there a witness? □ No □ Yes Name: _____ Phone: _____
Treatment provided: □ None □ First Aid □ Doctor □ Hospital □ Other (specify) _____
_____
Overnight stay in hospital required? □ Yes □ No If yes, where _____
Name of Attending Physician _____
Additional comments _____
Signature of Person Involved: Name: _____Signature:_____ Date_____
(If Person Involved is unavailable, Witness signature required)

Lab Supervisor Signature: Name: _____Signature: _____ Date_____
THIS ACCIDENT/INCIDENT REPORT IS **NOT** REQUIRED FOR MINOR ACCIDENTS OF A SHORT- TERM NATURE (E.G. MINOR SCRAPES, BRUISES, ETC.). THE FORM IS INTENDED TO DOCUMENT SERIOUS OR POTENTIALLY SERIOUS INCIDENTS INCLUDING WORK-RELATED ILLNESSES, SIGNIFICANT BEHAVIORAL PROBLEMS OR ACCIDENTS INVOLVING INJURIES SUCH AS LACERATIONS, FRACTURES, EYE/ INNER EAR/TEETH INJURY, INJURIOUS FALLS AND ANY INCIDENTS WHICH REQUIRE TREATMENT BY MEDICAL PERSONNEL.

Appendix C: Safety Information Resources

American Conference of Governmental Industrial Hygienists
1300 Kemper Meadow Drive
Cincinnati, OH 45240
Phone: (513) 742-2020

American Society of Safety Engineers (ASSE)
1800 East Oakton Street, Des Plaines, IL 60618
Phone: (708) 692-4121

American Industrial Hygiene Association (AIHA)
2700 Prosperity Ave., Suite 250
Fairfax, VA 22031
Phone: (703) 849-8888

Bureau of Microbiological Science
Division of Consolidated Laboratory Services
Commonwealth of Virginia
Box 1877, Richmond, VA 23215
Phone (757) 786-3756

Centers for Disease Control and Prevention (CDC)
1600 Clifton Rd., N.E., Atlanta, GA 30333
Phone: (404) 639-3535

Chemical Abstracts Service
Division of American Chemical Society
BOX 3012, Columbus, OH 43210
Phone: (614) 421-3600

Chemical Health and Safety Division
American Chemical Society (ACS)
1155 16th. St., N.W. Washington, DC 20036

Chemical Manufacturers Association (CMA)
2501 M Street, NW, Washington, DC 20037
Phone: (202) 887-1100

Compressed Gas Association, Inc.
1235 Jefferson Davis Highway, Arlington, VA 22202
Phone: (703) 979-0900

Fisher Scientific
711 Forbes Avenue, Pittsburgh, PA 15219
Phone: (412) 562-8300

Health Education Programs, Inc. (HEP)
808 Busse Highway
Park Ridge, IL 60068
Phone: (312) 696-1824

J.T. Baker Chemical Co.
222 Red School Lane, Phillipsburg, NJ 08865
Phone: (201) 859-2151

Mallinckrodt, Inc.
Science Products Division
P.O. Box M, Paris, KY 40361
Phone: (314) 982-5000

The Merck Index
An Encyclopedia of Chemicals, Drugs, & Biologicals
Merck and Co. Inc.
Rahway, NJ 07065

National Fire Protection Association (NFPA)
Batterymarch Park, Quincy, MA 02269
Phone: (617) 770-3000

National Institute for Occupational Safety and Health (NIOSH)
4676 Columbia Parkway, Cincinnati, OH 45226
Phone: (513) 533-8236

National Safety Council
1121 Spring Lake Drive
Itasca, IL 60143-3201
Phone: (708) 775-2281

National Animal Disease Center
U.S. Department of Agriculture
Ames, IA 50010
Phone: (515) 862-8258

Occupation Safety and Health Administration (OSHA)
Health Standards
200 Constitution Ave., Washington, DC 20210
Phone: (202) 523-7075

Sigma Aldrich Corporation
PO Box 355, Milwaukee, Wisconsin 53201
Phone: Sigma- (314) 771-5765 Aldrich - (414) 273-3850

U.S. Environmental Protection Agency (EPA)
401 M. Street SW, Washington, DC 20460
Phone: (202) 382-4700

U.S. Department of Health and Human Services
330 Independence Ave., SW, Washington, DC 20201
Phone: (202) 475-0257

Virginia Occupational Safety and Health Administration (VOSHA)
2600 Eltham Ave.
Norfolk, VA 23513
Phone: (757) 858-6700

Virginia Department of Environmental Quality
Pembroke IV
Virginia Beach, VA 23462
Phone: (757) 552-1251

Useful Links:

School Chemistry Laboratory Safety Guide (*October 2006).* U.S. Consumer Product Safety Commission, Department of Health and Human Services Centers for Disease Control and Prevention National Institute for Occupational Safety and Health. http://www.cpsc.gov/cpscpub/pubs/niosh2007107.pdf

World Health Organization 2004, Laboratory Biosafety Manual - Third Edition Geneva 2004, http://www.who.int/csr/resources/publications/biosafety/

U.S. Department of Labor | Occupational Safety & Health Administration | 200 Constitution Ave., NW, Washington, DC 20210 Telephone: 800-321-OSHA (6742) | TTY: 877-889-5627, www.OSHA.gov, http://www.osha.gov/SLTC/laboratories/index.html

The National Toxicology Program The National Institute of Environmental Health Sciences, National Institutes of Health (NIEHS), U.S. Department of Health and Human Services. http://ntp.niehs.nih.gov/

EPA Hazardous and Toxic Chemical Search - Environmental Protection Agency, http://www.epa.gov/enviro/html/emci/chemref/index.html

Toxic Substances and Public Health - The Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services, http://www.atsdr.cdc.gov/

Laboratory Survival Manual - The University of Virginia, http://ehs.virginia.edu/ehs/ehs.chemicalsafety.html.

US National Institute of Health's, http://bioethics.od.nih.gov/

Appendix D: Definitions of Terms

In complying with these standards, it is vital that all employees have a basic understanding of all criteria which define chemical safety and hazardous chemicals including the following terms:

Action level – A concentration for a specific substance, calculated as an eight (8) hour time-weighted average (TWA), which initiates such activities as exposure monitoring and medical surveillance. Typically it is one-half that of the Permissible Exposure Limit (PEL).

Acute – Severe, often dangerous conditions in which relatively rapid changes occur.
Carcinogen - Any substance that is known to induce cancerous growths in humans or animals.

Ceiling – A maximum exposure limit which should not be exceeded under any circumstances.

Corrosivity – A hazardous property for chemicals which can burn, irritate or destructively attack living tissue
.
Designated Area – An area which may be used for work with "select carcinogens, reproductive toxins, or substances which have a high degree of acute toxicity." A designated area may be the entire laboratory, an area of a laboratory, or under a laboratory hood.

Employee – An individual employed in a laboratory work place who may be exposed to hazardous materials.

Flammability – A hazardous property for chemicals measured by the ease of ignitability of a gas, liquid, or solid.

Hazardous Substances – Materials which pose hazards based on flammability, corrosivity, reactivity, and toxicity.

Health Hazard – A substance for which there is statistically significant evidence from studies conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. This term includes carcinogens, toxins/toxic agents, sensitizers, agents, etc. which adversely act on the organs and anatomical systems.

MSDS – Material Safety Data Sheet

Permissible Exposure Limit (PEL)
– The level of exposure deemed to be the maximum safe concentration; generally the same value as the threshold limit value (TLV). It is enforceable by OSHA as a legal standard and may be either a time-weighted-average (TWA) exposure limit (8 hour), a 15-minute short term exposure limit (STEL), or a ceiling (C) (or maximum). The PELs can be found in Tables Z-1, Z-2, or Z-3 of 29 CFR 1910.100.

Personal Protective Equipment (PPE) – Any device or clothing worn by the worker to protect against hazards in the environment. Examples are safety goggles/glasses, laboratory coats, respirators, gloves, etc.

Poisons – Substances that causes death or serious injury after exposure to relatively small amounts. All such substances have the potential of being poisonous in given quantities.

Reactivity – A hazardous property of chemicals that causes a sudden, and oftentimes, explosive/instantaneous release of large or small amounts of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Short Term Exposure Limit (STEL) – Represented as STEL or TLV-STEL, the maximum concentration to which workers can be exposed for short periods of time, usually 15 minute increments, four times throughout the day, with at least one hour between exposures.

Threshold Limit Value (TLV) – An advisory exposure guideline – not a legal standard – that defines the conditions under which it is believed that nearly all workers may be regularly exposed to an airborne substance with no adverse effect. They are categorized into time weighted average (TLV-TWA), short term exposure limit (TLV-STEL) and ceiling (TLV-C).

Time Weighted Average (TWA) – The time weighted average for a normal 8 hour work day and a 40 hour work week to which nearly all workers may be regularly exposed to airborne substances with no adverse effect.

Toxicity – A hazardous property of chemicals such as carcinogens, irritants, or poisonous gases, liquids, and solids which are irritating to or affect the health of humans.

Thanks to those who served on the Laboratory Safety Manual Committee:
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Michael Hickham
Eric Minar
David Weddle

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