MTSU

Middle Tennessee State University
Chemical Hygiene Plan

Environmental Safety and Health Services
March 10, 2023

MTSU CHEMICAL HYGIENE PLAN (CHP)
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1.0 MTSU CHEMICAL HYGIENE PLAN INTRODUCTION

1.1 Purpose

Middle Tennessee State University, MTSU or University, is committed to protecting employees from the health and physical hazards associated with chemicals in University laboratories. Every effort is made to ensure that risks, including those from hazardous chemicals, are mitigated to an acceptable level through appropriate engineering controls, specific procedures, and policies instituted by the University. While MTSU administration has provided significant resources to ensure that the vital research performed is done in full compliance with applicable federal state and local regulations, the responsibility for ensuring a safe workplace must truly be a shared responsibility between faculty, staff, students. MTSU Environmental Health and Safety Professionals are here to serve as a resource to assist faculty, staff, and students in meeting this responsibility for laboratories, laboratory equivalents, and any other possible areas where chemical hazards may exist. The MTSU Chemical Hygiene Plan and Compliance Guide (MTSU CHP) was developed to maintain compliance with the OSHA Laboratory Standard 29CFR1910.1450.

1.2 Background on Regulatory Compliance

The Occupation Safety and Health Act of 1970 established the Occupational Safety and Health Administration (OSHA). The mission of OSHA is to save lives, prevent injuries, and protect the health of America's workers. Beginning in the early 1970s, a variety of groups and individuals representing laboratories contended that the existing OSHA standards were designed to protect workers from exposure conditions in industry and were inappropriate for the different exposure conditions in laboratories. To correct this situation, OSHA developed a special regulatory section specific for laboratories. This standard, Occupational Exposure to Hazardous Chemicals in Laboratories, is often referred to as the OSHA Laboratory Standard (29 CFR 1910.1450). The Tennessee Occupational Safety and Health Administration (TOSHA) has adopted the Laboratory Standard as part of its regulatory framework, applicable to all state agencies and employees

The OSHA Laboratory Standard has the following requirements:

- Protecting employees from physical and health hazards associated with hazardous chemicals in laboratories;
- Keeping chemical exposures below specified limits;
- Training and informing workers of the hazards posed by the chemicals used in the laboratory;
- Providing for medical consultations and exams, as necessary;
- Preparing and maintaining a written safety plan (Chemical Hygiene Plan); and
- Designating personnel to manage chemical safety.

Other agencies, including the U.S. Environmental Protection Agency (EPA), U.S. Department of Transportation (DOT), Tennessee Department of Environment and Conservation (TDEC), Tennessee Department of Transportation (TDOT), National Fire Protection Association (NFPA), International Building Codes (IBC), and the Murfreesboro Fire and Rescue Department also impose obligations on users of hazardous chemicals, including:

- Specific storage requirements
- Limitations on the quantities of hazardous chemicals;
- Handling, storage, and disposal requirement for hazardous waste; and
- Restrictions on the shipping and transportation of hazardous chemicals.

1.3 Scope and Applicability

The Chemical Hygiene Plan, including the MTSU CHP and Laboratory-Specific CHP, describes the necessary protection from risks posed by the laboratory use of hazardous chemicals is limited to laboratory settings (where small amounts of hazardous chemicals are used on a laboratory-scale on a non-production bases). This plan also outlines the roles and responsibilities for key personnel, defines expectations and practices, and provides an understanding the applicability of various regulations and guidelines for this plan to work. **All campus laboratories must comply with the requirements outlined in this document.** While certain organizations within or associated with the University have the option of adopting their own CHP, those plans must, at a minimum, meet the elements outlined within this document and the Laboratory-Specific CHP template,(LS-CHP) located in Appendix A of this document. **The LS-CHP must be readily available in the specific laboratory it was written for, and a copy will be submitted to the appropriate department as well.**

This plan does not specifically address protection needed against radiological, biological, or other hazards such as electrical, laser, or mechanical. These elements may be covered in other lab-specific SOP's. Questions on the applicability of this plan can be addressed to Environmental Health and Safety Services at 615-898-5831.

1.4 Chemical Hygiene Overview

This document, in and of itself, is not sufficient to maintain compliance with OSHA regulations. The complete Chemical Hygiene Plan for each laboratory consists of two components:

1. MTSU Chemical Hygiene Plan, MTSU CHP – this document outlines roles and responsibilities for key personnel and contains policies and practices applicable to the entire campus and provides an understanding of applicability of various regulations to operate various Campus laboratories.

2. The laboratory-Specific Chemical Hygiene Plan (LS-CHP) – Each Principal Investigator or Laboratory Manager (PI) must prepare a laboratory specific CHP that contains standard operating procedures (SOP's), personal protective equipment (PPE) requirements, engineering and administrative controls, and training prerequisites for the laboratories they are in charge of.

   A template for laboratory-specific CHP can be found in Appendix A of the Plan and on the EH&S website, MTSU.EDU/EHS/Industrial/manuals.php. The template includes directions on how to complete each section. This template provides an organizational framework for ensuring that Principal Investigators (PI) are compliant with OSHA laboratory safety regulations. The LS-CHP template contains the following sections:

   Section 1: Personnel
   - Safety Personnel
   - Laboratory Staff and Students

   Section 2: Locations of Laboratories
   Section 3: Laboratory Specific Policies
   Section 4: Standard Operating Procedures
   Section 5: Orientation Checklist
   Section 6: Training
   - Master List of Required Training
   - Training Records

Section 7:	Prior Approvals for to perform a certain procedure
Section 8:	Complete list of hazardous chemicals and their corresponding Safety Data Sheets (SDS)
Section 9:	Exposure Monitoring Records
Section 10:	References related to a chemical or procedure

1.5 Implementation of the Plan

The OSHA Laboratory Standard requires the designation of personnel responsible for implementation of a CHP. Specifically, it calls for the assignment of a Chemical Hygiene Officer (CHO). This individual has the responsibility for development and implementation of the MTSU CHP and for ensuring the implementation of the requirement for LS-CHPs.

The CHO works with the MTSU EH&S Committee (EHSC) on the development of a campus-wide chemical safety and compliance program, including the MTSU CHP. The EHSC approves this plan and aids in its implementation. For laboratories on campus, the University designates the Principal Investigator (PI) as the individual responsible for developing and implementing the LS-CHP for laboratories under his/her control. While the PI can delegate health and safety responsibilities to a trained and knowledgeable individual, ultimate responsibility for compliance still resides with the PI. Other helpful constituents in the program would be Department Heads, Directors, Department Safety Officers or Managers, lab instructors, research administration and students.

Other department laboratories on campus having or containing hazardous chemicals should create a CHP with designated laboratory supervisor, facility manager, or departmental safety officer implement and maintain the CHP.

1.6 Availability of the Plan

All elements of the Chemical Hygiene Plan (including the MTSU CHP and LS-CHPs) must be readily available to employees or employee representatives, students, and staff.

1.7 Annual Review and Evaluation of Plan

The MTSU Chemical Hygiene Officer (CHO) shall review and evaluate the effectiveness of the MTSU CHP at least annually and update if necessary. The Environmental Health and Safety Committee (EHSC) will review and approve all changes to the plan. Updates to the CHP will be posted on the EH&S and Department of Chemistry websites.

For the LS-CHP to be useful it must reflect the work that is currently being performed in the laboratory. The PI must formally review the LS-CHP at least annually to ensure that its contents are appropriate and adequate for the current operations. If changes are necessary before the review date, the LS-CHP must be amended, and the changes approved by the respective PI. The University Chemical Hygiene Officer (CHO) and Environmental Health and Safety Committee (EHSC)

2.0 ROLES AND RESPONSIBILITIES

In order to maintain an effective chemical safety program, it is important for all parties to clearly understand the responsibilities inherent in their roles. Below are assigned roles and responsibilities that are necessary to remain compliant with chemical safety regulations.

2.1 Environmental Health and Safety Department

The Director of EH&S will provide the necessary staffing and resources for maintaining an effective chemical safety program including the MTSU CHP.

2.2 University Chemical Hygiene Officer

The University Chemical Hygiene Office (CHO) has the primary responsibility for ensuring implementation of the MTSU CHP and overall compliance with chemical safety regulations. The CHO will:

- Review and update the MTSU CHP
- Maintain and update guidance documents;
- Informing Faculty/Laboratory Supervisors of chemical-related health and safety requirements and assisting with the selection of appropriate safety controls, including engineering controls, laboratory and other workplace practices and procedures, training, and personal protective equipment;
- Provide technical guidance to Principal Investigators (PI's) on the development and implementation of the LS-CHP.
- Working with Departments and lab groups to develop and review SOPs for processes using hazardous chemicals;
- Conducting periodic inspections and immediately taking steps to abate hazards that may pose a risk to life or safety upon discovery such hazards;
- Provide guidance for the safe handling, storage, and disposal of chemicals used on campus;
- Facilitate waste minimization by re-distributing surplus chemicals;
- Facilitate efforts to implement processes that are environmentally friendly; and
- Provide the EH&S staffing resources necessary to ensure that activities related to the use of hazardous chemicals in University laboratories are conducted in a safe manner.

2.3 Environmental Health and Safety Services (EH&S) Staff

Environmental Health and Safety Services has extensive expertise covering all areas of safety and regulatory compliance. Environmental Health and Safety Services will be available to :

- Develop, implement, and manage a comprehensive safety program for the University;
- Develop campus safety policies in conjunction with the appropriate campus faculty committees;
- Develop and prepare safety training specific to laboratory operations:
- Perform laboratory hazard assessments upon request;
- Inspect laboratories and identify hazards and issues of non-compliance;

- Inspect campus safety showers, eyewash station; and fire extinguishers annually to ensure their proper operation;
- Coordinate campus chemical emergency response with the Murfreesboro Fire and Rescue Department's Hazardous Incident Response Team;
- Maintain website containing easily accessible information, guidance, forms, etc.

2.4 Principal Investigator

The Principal Investigator (PI) has the primary responsibility for provide a safe work environment and for ensuring compliance with all elements of the Campus Safety Handbook (CSH), Chemical Hygiene Plan(CHP) and the Laboratory-Specific Chemical Hygiene Plan (LS-CHP) within their own assigned laboratory space. While the PI can delegate health and safety responsibilities to a trained and knowledgeable individual (referred to as the Laboratory Manager), the PI must ultimately assure that the duties are being performed.

The Principal must do the following:

- Develop and implement the LS-CHP
- Develop and approve SOPs, and ensure that PPE, engineering controls, and administrativecontrols described within the SOPs provide adequate protection to staff and students;
- Maintain compliance with federal, state, and local regulations related to the use of hazardous chemicalsin their laboratory (as outlined in this document);
- Provide access to manufacturers' SDSs, the Campus CHP and LS-CHP, and other safety-related information for laboratory staff and students;
- Ensure that laboratory participants understand and follow the chemical safety practices, procedures,and regulations related to their laboratory's operation;
- Assess individual roles of their staff, students and faculty colleagues and hazards associated with those roles;
- Ensure that PPE and required safety equipment are available and in working order and that laboratorypersonnel are trained in their use;
- Determine training requirements for laboratory workers based on their duties and tasks and ensureappropriate training specific to laboratory operations;
- Ensure that staff and students are knowledgeable about emergency plans, including fires, equipment failure, chemical exposures, and chemical spills;
- Utilize EH&S-provided tracking software to manage chemical inventories, lab equipment, corrective actions tracking, lab-specific documentation (SOPs, LS-CHP, licenses & permits) and training;
- Maintain up-to-date chemical inventories.
- Complete and keep the laboratory door placard(s) up to date;
- Stop work when hazards or conditions exist that pose an immediate danger to the life or health of thelaboratory (or adjacent) occupants;

- Correct any unsafe conditions identified within the laboratory through either self-inspections or inspections by EH&S or other authorized safety professionals;
- Maintain documentation on training, exposure monitoring, approvals, and other safety related issues, as outlined in this document;
- Ensure proper disposal of hazardous materials according to University procedures;
- Initiate laboratory commissioning/decommissioning procedure when appropriate (see https://ehs.utk.edu/index.php/table-of-policies-plans-procedures-guides/laboratory-decommissioning-commissioning/);
- Report any lab-related injury or significant exposure to EH&S as quickly as possible;
- Submit accident reports to the EH&S and Office of Risk Management within 24 hours of the incident.

2.5 MTSU Environmental Health and Safety Committee (EHSC)

The MTSU Environmental Health and Safety Committee (EHSC) is comprised on university faculty and staff from many organizations and departments. The EHSC conducts its operations and construct and maintain its facilities in a manner conducive to the creation of a healthy and safe environment for the campus community. To help maintain the safety of the campus community the EHSC will :

- Develop, maintain, review, and provide improvements to campus procedures and guidelines on issues related tothe purchase, use, storage, and disposal of chemicals;
- Review compliance with campus policies, plans, and procedures and recommend methods to promotecompliance;
- Review the MTSU CHP, and other university plans related to hazardous chemical use;
- Review and approve, where necessary, the University's CHP, Hazard Communications Plan, Biennial Stormwater Report (to the WDNR), Pesticide Use Policy, and other University plans related to hazardous chemical use brought forth by the University CHO.
- Evaluate the broad needs for an effective campus-wide chemical hygiene plan. Make recommendationsto EH&S and, if necessary, to the campus administration, on such areas as staffing needs, funding sources, and required resources;
- Review incidents, accidents, and injuries related to the use of hazardous chemicals as reported by the campus CHO and recommend additional corrective and preventative actions;
- Serve as a forum to review laboratory practices and procedures to ensure that these are compatible for the protection of laboratory personnel and the environment. Promote methods and procedures to minimize production of hazardous waste and prevent pollution from research, maintenance, patient care, teaching and other university activities;
- Collaborate with other committees, including but not limited to the Institutional Biosafety Committee, the Animal Care and Use Committee, and Radiation Safety Committee, to ensure that chemical safety concerns are properly addressed.

2.6 Laboratory Personnel

The individuals working under the supervision of the PI must:

- Follow campus and laboratory practices, policies, and SOPs and as outlined in the MTSU CHP and LS-CHP;
- Attend all safety training as required by the PI and the department;
- Understand the inherent risk of any laboratory procedure;
- Perform only procedures and operate only equipment that they have been authorized to use and trained to use safely;
- Check relevant information on the chemical reactivity, compatibility, and physical and toxicological properties of hazardous materials (such as SDSs, Prudent Practices in the Laboratory, the MTSU Safety Handbook and related articles found during a thorough literature search) prior to use of hazardous chemicals;
- Have knowledge of emergency procedures prior to working with hazardous chemicals;
- Incorporate safety in the planning of all experiments and procedures;
- Use the PPE and hazard control devices provided for his/her job;
- In accordance with EH&S guidance, ensure that equipment is safe and functional by inspection and preventative maintenance, including glassware, electrical wiring, mechanical systems, tubing and fittings, and high energy sources;
- Proactively report laboratory equipment or building infrastructure (e.g., eyewashes, outlets, benchtops, etc.) that is in poor repair or not working properly to the PI and/or EH&S;
- Keep work areas clean and orderly;
- Dispose of hazardous waste according to university procedures;
- Avoid behavior which could lead to injury;
- Do not have unauthorized visitors while working;
- Report any unsafe condition immediately to the PI or other safety personnel;
- Stop work when hazards or conditions exist that pose an immediate danger to the life or health of thelaboratory (or adjacent) occupants;
- Dispose of hazardous waste according to University procedures;
- Report incidents involving chemical spills, exposures, work-related injuries, and illnesses or unsafeconditions to PI;
- Consult with the PI or with EH&S staff on any safety concerns or questions; Complete Lab Safety Agreement Form Located in Appendix A, Section 5.0.

2.7 Department Heads and Directors

Department heads and institute directors will:

- Promote a culture of safety within his/her area of responsibility;
- Provide support and enforcement for the policies and procedures contained in the MTSU CHP, the , MTSU Safety Handbook, university safety policies, and any other applicable safety and health rules and regulations;
- Per departmental discretion, supplement the MTSU CHP with departmental procedures andrequirements (i.e., create a D-CHP);
- Communicate safety requirements to departmental faculty, staff, and students;
- Provide the resources needed to train employees in all aspects of their jobs relative to safety and health;
- Establish and implement any needed operational procedures for safety and health;
- Stop work when hazards or conditions exist that pose an immediate danger to the life or health of thelaboratory (or adjacent) occupants;
- Investigate accidents and chemical exposures within the department;
- Monitor corrective action plans following laboratory assessments;
- Appoint a Departmental Safety Officer (DSO) and empower him/her to assist in the implementation and maintenance of chemical hygiene (and other safety standards) within thedepartment.

2.8 Departmental Safety Officers*

Department Safety Officers (DSO) are to be a liaison between the department(s) and EH&S for laboratory safety issues. DSO can:

- Assist the department in maintaining compliance with the MTSU CHP;
- Assist in developing, maintaining, and updating the D-CHP (as applicable) and LS-CHPs, particularlyfor departmental instructional laboratories;
- Assist the department in monitoring the procurement, use, storage, and disposal of chemicals;
- Assist in hazard assessments and the development of laboratory-specific SOPs as necessary;
- Stop work when hazards or conditions exist that pose an immediate danger to the life or health of thelaboratory (or adjacent) occupants;
- Assist EH&S in investigating accidents and chemical exposures within the department;
- Monitor corrective action plans following laboratory assessments;
- Attend meetings, communicate updates, and action items to departmental leadership.

  *May also include laboratory supervisors/managers, institute safety officers or building safety coordinators asappointed and commissioned by the department or institute.

3.0 <u>GENERAL LABORATORY RULES AND POLICIES</u>

MTSU Environmental Health and Safety Committee (EHSC) has the ability to develop, review, and approve University Policies on issues related to the purchase, use, storage, and disposal of chemicals. All university personnel are subject to these policies in addition to federal, state, and local regulations and codes.

Each Principal Investigator (PI) has the right to set policies for laboratories under their control as long as these are, at a minimum, compliant with regulations and campus-wide policies. Laboratory specific policies should be included in the Laboratory-Specific Chemical Hygiene Plan (LS-CHP).

The following general policies apply for all laboratory operations involving hazardous chemicals:

It is University Policy - that appropriate PPE must be *worn at all times*. At a minimum, closed-toed shoes and safety glasses must be worn whenever hazardous chemicals are present in the laboratory. Avoid wearing eye contacts if at all possible.

It is University Policy – no eating and/or drinking is allowed in laboratories where hazardous chemicals are present. Thoroughly wash hands after handling chemicals. Storage, handling and consumption of food or beverages shall not occur in chemical storage areas, nor with glassware or utensils also used for laboratory operations.

It is University Policy – that unnecessary exposure to hazardous chemicals via any route will be avoided through proper use of engineering controls, personal protective equipment, and other administrative controls listed below:

- A chemical mixture shall be assumed to be as toxic as its most toxic component. Possibilities for substitution will be investigated.
- Laboratory employees shall be familiar with the symptoms of exposure for the chemicals with which they work and the precautions necessary to prevent exposure.
- Label all chemicals to identify the container contents and appropriate hazard warnings.
- Dilute acids by pouring concentrated acids into water.
- Never mix incompatible chemicals that would cause an explosive reaction.
- Recap bottles tightly (but do not over-tighten or the cap may break) and clean any residue off the outside of the bottle. Loose caps and drips on the outside of the bottle create unexpected chemical exposures.
- Refrigerators used to store reagents and samples cannot be used to store food and drinks for human consumption. Ensure that they are clearly labeled to indicate their function such as with signage that says either “No food or drink” or “For Food Only.”

- Ice from a laboratory ice machine is not to be used for human consumption.
- Hallways, corridors, and exit ways must be kept clear. Do not allow equipment to block the exit pathway (even temporarily).
- Mouth suction for pipetting or starting a siphon is prohibited. This also includes smelling, tasting or touch a chemical with your bare hands.
- Skin contact with all chemicals shall be avoided. Employees shall wash exposed skin prior to leaving the laboratory.
- Dispose of chemicals in the proper waste stream.
- When handling contaminated disposable needles, place the plastic cover over it before taking off the syringe(s). Please see Appendix XXX for further information on Bloodborne Pathogens and Sharps containers.
- Make sure no flammable solvents are in the surrounding areas when lighting a flame.
- Never leave a lit burner unattended.
- Additional specific precautions based on the toxicological characteristics of individual chemicals shall be implemented as deemed necessary by the lab supervisor.

It is University Policy – that the use of audio headphones (over-the-ear or in-ear) is prohibited when performing chemical procedures and highly hazardous operations.

It is University Policy – that no unsafe behavior (horseplay and /or distractions that may startle other personnel) will be tolerated within the laboratories.

It is University Policy – that good housekeeping practices by upheld in all laboratories and that all passageways, exits, utility controls, and emergency equipment always remain accessible at all times. Always clean work area following all experimentations. Turn off all heating apparatus, gas valves, water faucets when not in use.

It is University Policy – that any procedure or operation identified by laboratory or EH&S staff as imminently dangerous (i.e., the operation puts individual at immediate serious risk of death or serious physical harm) must be immediately stopped until corrective actions are/is taken.

Additional specific policies for the use of high hazard compressed gases and for the use of cryogenic liquids are found in Appendix M of this plan. The Chemical Safety Guide also provides general laboratory safety rules a well recommendations for safe work practices. Additional policies are outlined in subsequent sections of this plan.

3.1 – Laboratory Equipment Overview

The following rules hall apply to the use of all laboratory equipment:

- All laboratory equipment shall be used properly and only for its **intended purpose**.
- All laboratory equipment shall be **inspected** on a periodic basis and receive maintenance, repair or replacement, as necessary.
- Seek training or read literature before using instrumentation or unfamiliar laboratory equipment.
- Ask the instructor, faculty, or staff member in charge of a laboratory space before removing any equipment or chemicals from it.
- Do not defeat, remove, or override equipment safety devices.

IMPORTANT: Disconnect any equipment that is unsafe or does not work properly and remove it from service. Notify other users of the problem. Specific information on certain pieces of laboratory equipment is listed in <u>Appendix P.</u>

4.0 <u>HAZARDOUS CHEMICAL IDENTIFICATION AND CONTROLS</u>

4.1 Risk Assessments

Many chemicals can cause immediate health problems as well as long-term health effects. Examples include carcinogens, highly toxic or toxic agents, various toxins, irritants, corrosives, sensitizers, agents which act on various systems of the body, agents which damage the lungs, skin, eyes, or mucous membranes, etc. Hazardous chemicals (such as flammable and combustible liquids, compressed gases, and unstable and water-reactive materials) can also pose inherent physical dangers. MTSU is committed to minimizing work exposure to the hazards imparted by the use of hazardous chemicals and takes a risk-based approach in determining means of mitigating risk, accounting for the characteristics of the chemical, the amounts used, the method in which a chemical is used, and the location. Definitions for all the general classes of hazardous chemicals are located in Section 19.2 of this document.

The University requires that each Principal Investigator (PI) review all operations involving laboratory use of hazardous chemicals. Whenever possible the hazard should be eliminated or substitution of a hazardous chemical or procedure with a substance or process with lower inherent risk should be undertaken. Additionally, control measures commensurate with the risk must be implemented. Control measures include engineering controls (such as fume hoods and glove boxes), administrative controls (such as policies against working alone), and personal protective equipment (gloves, eye protection, respirators, etc.). EH&S can provide tools to perform this risk assessment, including the laboratory safety guidelines and other guidance documents. Additionally, EH&S staff can provide consultation services if there are any questions on this process.

4.2 Exposure Limits

It is the responsibility of the PI to communicate and collaborate with the CHO (and EH&S support staff), and DSOs to ensure that laboratory staff members do not exceed exposure limits established for the chemicals that are used within the laboratory. OSHA has the regulatory authority to set specific exposure limitsfor chemicals. These permissible exposure limits (PELs) are listed in 29 CFR 1910.1000 TABLE Z-1.

For chemicals that do not have a PEL listed in the OSHA standards, exposure limits established by the American Conference of Governmental Industrial Hygienists (ACGIH), e.g., threshold limit values (TLVs), should be referenced.

OSHA PELs and ACGIH TLVs were not created with a university laboratory setting in mind. These values reflect levels to which it is believed nearly all workers may be exposed during a 40-hour workweek over a working lifetime without harmful effects. Most laboratory workers perform non-routine operations over a shorttime span. In these instances, short-term exposure limits (STELs), as established by OSHA and/or ACGIH, are often more appropriate. Many chemicals do not have any published exposure limits. For assistance with exposure monitoring, contact EH&S at 615-898-5831 or EH&S more information. For more information on PELs,TLVs, and STELs, see Appendix C.

4.3 Hierarchy of Hazard Controls

To reduce risk, the OSHA hierarchy of hazard controls Figure 1 should be followed. Whenever possible, elimination or substitution of a hazardous Chemical or procedure with a substance or process with lower inherent risk should be undertaken. Additionally, control measure commensurate with the risk must be implemented. Control measures include engineering controls, (e.g., fume hoods, glove boxes, or intrinsically safe equipment), administrative controls (e.g., policies against working alone), and PPE (e.g., gloves, eye protection, respirators, etc.). EH&S can provide tools to perform this risk assessment including the laboratory safety guidelines and other guidance documents. Additionally, EH&S staff can provide consultation services if there are any questions.

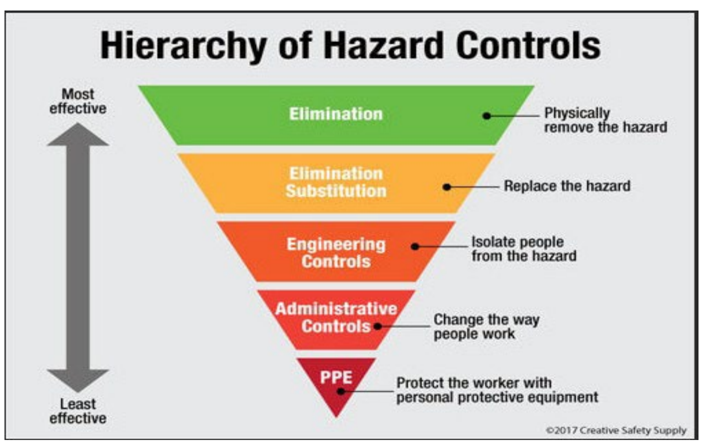


Figure 1 OSHA Hierarchy of Hazard Controls

4.3.1. Elimination

When feasible, this is the best and preferred method of controlling risk as it completely removes the hazard from the work area. It also reduces the usage of hazardous chemicals and supports MTSU's Hazardous Waste.

4.3.2. Substitution

Another form of elimination is substitution. Substitution replaces the hazard with a safer alternative. Substitution my include the chemical(s) and/or specific procedural steps.

4.3.3. Engineering Controls

A direct way of reducing exposure can be accomplished by isolating the source or removing the contaminants through various ventilation methods. Engineering controls must be implemented within the laboratory whenever practical to minimize exposure to hazardous chemicals. Engineering controls should be inspected and maintained so that they meet regulations and manufacturer standards. No modification of the engineering controls well be made unless testing indicates that worker protection will continue to be adequate.

Chemical Fume Hoods
By far the most common engineering controls in laboratories is the chemical fume hood. Fume hoods are especially effective when handling gases, vapors, and some powders (risk-dependent). Laboratory workers rely heavily on these, often while performing the most hazardous tasks. Appendix D provides information on proper use of fume hoods.

Due to the importance place on fume hoods, the following requirements are emphasized:

- Laboratory workers must understand how to use chemical fume hoods properly. PIs need to ensure thatworkers have received the proper training, and document that training for laboratory safety records;
- It is important that laboratory workers ensure their fume hoods are compatible to the type of chemical that will be used in the fume. For example, hot concentrated acid work may need to be performed in a high-density polyethylene fume hood equipped with a scrubber unit; whereas cold concentrated acid can be handled in a conventional fume hood.
- Fume hood inspection, testing, and maintenance are performed annually by MTSU EH&S. After inspection, a certification sticker is affixed to each fume hood, which lists the most recent certification date. Fume hoods with a certification date greater than one year must be put out of service until recertification is complete (if fume hood inspection date is more than one year old, contact EH&S for recertification.
- Fume hoods must be tested by the user(s) prior to any hazardous operations. In many instances, fumehoods are alarmed and provide an audible warning when the airflow is outside normal parameters. If the fume hoods are not working properly in the laboratory, chemicals in the hood should be secured and the work stopped. Contact the appropriated department office and EH&S at 615-898-5883 or 615-898-5831 if any issues with the fume hoods have been detected.
- Fume hood alarms should never be disarmed.

Depending on the risk(s), other ventilation methods, including general room ventilation, point source exhaust (such as snorkels), and gas cabinets may be used to provide protection to workers. Glove boxes, glove bags, pressure relief valves, automatic shutoffs, and air monitors are routinely used as well.

Due to the reliance placed on these engineering controls, laboratory personnel need to incorporate regular inspections and/or testing of the controls into their standard operating procedures. At a minimum, ensure that air is flowing, or gauges are working. Some controls are more complicated and may require routine maintenance or calibration by outside vendors.

Contact EH&S at 615-898-5831 for assistance in determining (or verifying) appropriate engineering controls, operational concerns, and/or equipment malfunction.

4.3.4. Administrative Controls

Administrative controls consist of policies and procedures developed to improve the safety of laboratory operations. **Typical examples include restrictions on working alone, nighttime work hours, and experimental scale-up reactions.** Since administrative controls require lab personnel to follow appropriate procedures, they are generally not as reliable as engineering controls. These controls must be set by individual PIs or departments. If not already documented in departmental safety plans, then administrative controls must be documented in LS-CHPs or within an SOP for procedure-specific controls. Below are some common administrative controls to be incorporated into the LS-SHP or SOP's. All laboratory members must be informed of these controls.

4.3.4.1 – Protective Measures in the Lab

Below is a list of protective measures that should be taken into consideration and incorporated in to specific LS-CHP or SOP's.

A. Develop and encourage safe habits in the lab.
B. Assume any chemical mixture is as toxic as its most toxic component.
C. Before using a chemical for the first time, rad over the Safety Data Sheet (SDS) of the chemical to determine the dangers of the chemical, routes of exposure, proper PPE, treatment of exposure and any other safety information included.
D. Be vigilant of unsafe conditions and see that eye are corrected when detected.
E. Determine hazards in the laboratory by using safety literature on the topic of standards and codes. Seeking advice from knowledgeable persons is also advised.
F. When working with chemicals that are very hazardous, use proper techniques developed to minimize the danger.
G. Never work alone in a laboratory when the procedures being conducted are hazardous. When performing experiments, make sure your presence in the laboratory or prep room is known to another individual. It is advisable to have someone check in routinely to determine that you are safe.

4.3.5. Personal Protective Equipment

Elimination, substitution, engineering, and administrative controls are the primary lines of defense within the hierarchy of hazard controls. When these methods are not enough, then these exposures can be minimized or even eliminated through proper selection of PPE. Typical examples of PPE include chemical splash goggles, face shields, safety glasses*, lab coats, and gloves. The PI has primary responsibility to determine the appropriate PPE, ensure that it is made available, and train personnel on its proper use. (Appendix E provides a checklist for PPE training and documentation). Currently MTSU does not have a respirator program at this time, therefore all precautions must be made to substitute or eliminate the need for respirators all together.

Details are also important in the proper selection of PPE, especially with glove selections. There are several different types of gloves on the market for hazardous chemical usage. Latex, nitrile, and vinyl are just to name a few. The MTSU Safety Handbook can provide guidance for the proper PPE as well as the chemical's SDS which most times list the proper selection of gloves and other PPE need for handling this chemical. If you need assistance in selecting the proper PPE, the staff at EH&S can be reached at 615-898-5831.

At a minimum, closed-toe shoes, eye protection, and a lab coat are required PPE in any lab with hazardous chemicals on campus. The PPE required for general lab requirements, specific procedures and tasks must be established through hazard assessment and/or laboratory requirements and be reflected in the LS-CHP.

***Note** – Safety glasses provide frontal protection only from particulate projectiles. Side shields, which are necessary for side protection from flying particles, are available with the glasses. These do not provide adequate eye and face protection from chemical splashes or vapors.

4.4 Safety Showers, Eyewashes, and Fire Extinguishers

Safety showers and eyewashes are essential protective elements for laboratories. The Occupational Safety and Health Act of 1970 was enacted to assure that workers are provided with “safe and health working conditions.”

The primary regulation is contained in 29 CFR 1910.151, which requires that…”where the yes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the yes and body shall be provided within the work area for immediate emergency use.” MTSU as well as TOSHA has adopted the ANSI standard Z358.1, Emergency Eyewash and Shower Equipment for compliance with OSHA’s safety statement for Eyewashes and Showers.

The ANSI Z358.1 has some specific requirements for eyewashes and safety showers. According to the standard, emergency eyewashes and showers must have the following:

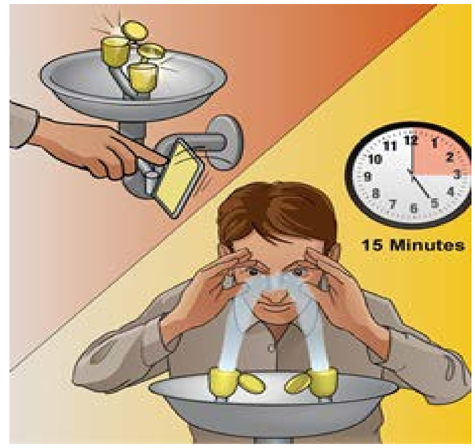
<u>EMERGENCY EYEWASH COMPLIANCE REQUIAREMENTS (ANSI GUIDANCE ANSI z358.1)</u>

Location:	Install eyewash units within 10 seconds (approximately 55 feet) of hazard, on the same level as hazard and with unobstructed travel path. Where strong acids or caustics are being handled, the eyewash shall be located immediately adjacent to the hazard (Section 5.4.2;B5)
Identification	Identify eyewash with highly visible signage. Area around eyewash shall be well-lit. (Section 5.4.3)
Water Temperature	Water delivered by the eyewash shall be tepid (60-100°F), (Section 5.4.6)
Maintenance/Inspections	Activate eyewash at least weekly. (Section 5.5.l2). Inspect annually for compliance with standard. (Section 5.5.5).

Below are some examples of eyewashes available on campus:


Emergency
Eyewash/Drench Hose

Steps to using the eyewash



- **In the event of an incident, go directly to the eyewashstation.**
- **Pull the lever to activate the eyewash.**
- **Get your eyes directly in the stream of the flushing fluid.**
- **Hold your eyes open with your fingers.**
- **Keep your eyesopen holding your eyelids apart with your fingers.**
- **Gently roll your eyes from left to right and up and down tobe sure the fluid is flushing all of the areas of your eye.**
- **Continue flushing your eyes for 15 minutes.**

Note:

If you have contact lenses in your eyes, you can gently take them out while you are flushing. Do not delay the flushing to take out your lenses but make sure that you takethem out because they could trap the chemical in your eyes.

STEP 1: Pull the lever

STEP 2: Eyes directly in the water

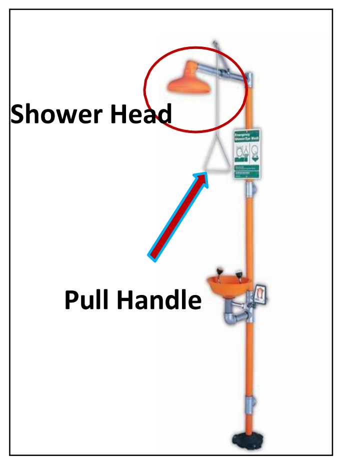
STEP 3: Keep eyes open holding eyelids apart with fingers.

STEP 4: Gently roll eyes from left to right and up and down. Flush for 15 minutes.

EMERGENCY SHOWER COMPLIANCE REQUIREMENTS

Location:	Install eyewash units within 10 seconds (approximately 55 feet) of hazard, on the same level as hazard and with unobstructed travel path. Where strong acids or caustics are being handled, the eyewash shall be located immediately adjacent to the hazard (Section 4.5.2;B5)
Identification	Identify eyewash with highly visible signage. Area around eyewash shall be well-lit. (Section 4.5.3)
Water Temperature	Water delivered by the eyewash shall be tepid (60-100°F), (Section 4.6.4)
Maintenance/Inspections	Activate eyewash at least weekly. (Section 4.6.2). Inspect annually for compliance with standard. (Section 4.6.5).

Examples of safety showers present on MTSU Campus



Steps to using the safety showers:

- **In the event of an incident, go directly to anemergency safety shower.**
- **Pull the lever to activate the safety shower.**
- **Remove all clothing and personal item; do not let modesty slow you down. Some else can provide cleanclothing or a clean lab coat for privacy.**
- **Separate your legs and arms, so that there are no"hidden" parts or crevices of your body.**
- **Stay in the shower for at least 15 minutes or as long as it takes to remove all contamination.**

Employees must be instructed in the location and proper use of the equipment. Personal eyewash equipment such a drench hoses may support but not replace approved eyewashes and showers. Eyewashes and safety showers are to be inspected annually by EH&S. Please contact EH&S at 615-494-7743, 615-898-5689 or 615-898-5831 if your eyewash or safety shower is not working correctly, needs an inspection or other questions regarding the safety station.

EH&S Fire Safety section inspects and manages over 12,000 fire extinguishers on campus. This group provides, installs, and inspects all necessary fire extinguishers on campus on a daily basis. While provided fire extinguishers work for most situations, specific laboratory operations (e.g., those involving flammable metals) may require special extinguishers.

4.5 Particularly Hazardous Substances (PHS)

OSHA regulations require that provisions for additional employee protection be made for work with Particularly Hazardous Substances (PHS), which include carcinogens, reproductive toxins, and substances that have a high degree of acute toxicity. As part of the required risk assessment for any work involving hazardous materials, all PHS must be identified by the PI or laboratory worker designing the experiment or procedure. See Appendix F for more information on PHS. Use of any PHS requires:

- Establishment of a designated area;
- Use of appropriate containment devices such as fume hoods or glove boxes dedicated for PHS use only;
- Procedures for safe removal of contaminated waste;
- Decontamination procedures;
- An SOP detailing the material and/or procedural controls.

The room or area where work with PHS is performed must be posted with a ***Designated Area*** sign to identify higher health risks. In many laboratories, it is appropriate to establish the entire room as a designated area, whereas in other laboratories a workbench or fume hood is more appropriate.

The controls used to minimize exposures to PHS must be documented in the LS-CHP. The SOP template foundin the LS-CHP template (see Appendix A) provides a means to document the controls.

4.6 Standard Operating Procedures (SOPs)

An SOP as defined by the Lab Standard is a document that identifies the hazards and risks associated with a process, chemical, equipment, or practice, and the controls and countermeasures employed to eliminate or mitigate the hazards(s).

SOPs must be prepared for PHS and highly reactive chemicals (substances), including:

- Carcinogens
- Reproductive toxins/teratogens
- Acutely toxic chemicals
- Air-reactive (pyrophoric) chemicals
- Water-reactive chemicals
- Self-reactive chemicals
- Explosives

Additionally, high-risk procedures that require special work practices and safety considerations require an SOP. Examples include, but are not limited to, working with large volumes of highly flammable (Class IA or Class IB) or corrosive chemicals, scale-up procedures, working with pressurized vessels or vacuums, etc.

There are many ways to incorporate safety practices into the lab SOPs. The objective is to identify the hazards, describe necessary safety practices (e.g., "work with tamoxifen will only be done in the fume hood") and personal protective equipment (e.g., "nitrile gloves will be worn any time you work with osmium compounds"). To assist with this, a SOP Procedure Form is available in the LS-CHP template (see Appendix A). Other formats may be acceptable provided that they emphasize the hazards, risks, and controls as required by the Lab Safety Standard.

SOPs involving PHS, reactive chemicals, and/or high-risk procedures may require review and approval from EH&S and/or EHS Committee.

4.7 Prior Approvals

The nature of the work performed in laboratories on campus varies widely. Principal Investigators (PIs) must ensure that a risk assessment is performed for all activities involving hazardous substances. Certain procedures may be considered hazardous enough that these should only performed with prior approval of the PI. While typically these may involve with PHSs, other procedures, such as those involving pyrophoric, highly reactive, or flammable compounds, may appropriately fall within this category.

5.0 HAZARD COMMUNICATIONS

5.1 OSHA Regulations

OSHA regulations require the development of a Chemical Hygiene Plan or CHP, which sets forth procedures, equipment, PPE, and work practices that capable of protecting employees from health and physical hazards presented by hazardous chemicals used that particular workplace. The MTSU CHP and the OSHA Laboratory Guide meet many of the requirements. However, work practices are laboratory specific, and the University requires that Principal Investigators (PIs) prepare the Laboratory Specific Chemical Hygiene Plan (LS-CHP) to be in full compliance. Additionally, the entire Chemical Hygiene Plan, CHP, (including MTSU CHP, LS-CHP, and the MTSU Safety Handbook) must be readily available to laboratory workers, staff, students, teachers, and faculty. These documents should be placed in a location that is readily available and accessible to everyone. This can include hard copies in each laboratory and/or available on MTSU EH&S Website or MTSU Chemical Department Website.

5.2 Safety Data Sheets and Other Safety Information

A Safety Data Sheet, SDS, is prepared by the manufacturer and summarizes the physical and chemical characteristics, health and safety information, handling, and emergency response recommendations related to its products. The SDS must be reviewed before beginning work with a chemical to determine proper use and safety precautions.

OSHA regulations require that once a chemical is present in the laboratory, the SDS must be made available either electronically or as a hardcopy. Personnel must have ready access in case of emergencies. SDS's must be kept for every chemical within the department and be made available in the stockroom and in the laboratory. The Murfreesboro Fire and Rescue Department (MFRD) has adopted 18th Edition of The International Fire Code (IFC), International Building Codes (IBC) and the National Fire Protection association (NFPA) standards and regulations. All these standards and regulations require that SDSs shall be readily available in a conspicuous space on the premises.

SDSs alone may not provide sufficient information on the hazards of a chemical. Laboratory personnel should review other sources of information on the chemical, such as chemical literature or chemical safety references such as the National Research Council's Prudent Practices in the Laboratory, as necessary. These resources should be made available to laboratory staff.

5.3 Exposure Monitoring Results

In certain instances, MTSU EH&S may measure laboratory worker exposure to a chemical regulated by a specific OSHA standard. The PI must notify the laboratory staff of monitoring results in writing, either individually or by posting results in an appropriate location that is accessible to employees, within 15 working days. Additional information on exposure monitoring is provided in Sections 4.2 and 13.0.

5.4 Labeling Chemical Containers

Labels must be attached to all chemical containers, identifying the contents and related hazards. Chemicals received from outside vendors are, by law, required to have labels indicating the chemical identity and common name, manufacturer name, address and phone number, pictograms, signal words, hazards statements, and a precautionary statement. All container labels should face forward for any recognition.

Manufacturers' labels on chemical containers shall not be removed or defaced.

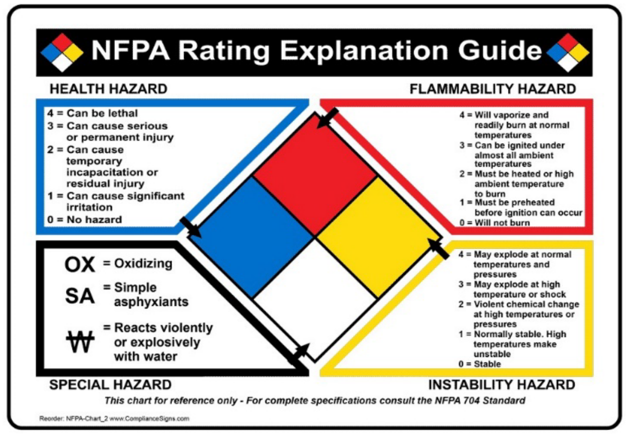
Frequently, chemicals are dispensed from the original shipping container to a smaller container or chemical mixtures are prepared for subsequent use. All secondary containers must be labeled with the following information:

- chemical name
- the primary hazard(s) associated with NFPA symbols and/or GHS pictograms.

Vials of samples and products should be labeled with enough information to identify the chemical composition of the material. The only exemption to labeling procedures is only given to containers that are used for transferring and will be used immediately.

The primary hazards can be present either in the form of GHS pictograms, GHS Hazards statements, the NFPA 704 Standard (Standard system for the Identification of the Hazards of Materials for Emergency Response or commonly referred to as the NFPA Diamond), or other similar hazard identification system. All lab personnel must be trained in the hazard communications method that is employed.

Examples of GHS Pictograms and NFPA 704 Diamond are below:



5.5 Laboratory Door Placards

It is not only necessary to provide workers with awareness of the hazardous chemicals present in a laboratory, but his information must also be provided to the first responders, such as fire fighters, police officers, paramedics, and anyone entering the laboratories. Laboratory door placards provide this valuable information. The Murfreesboro Fire and Rescue Department (MFRD) also relies on the Laboratory Emergency Information Cards (i.e., the "yellow door cards") to provide valuable information. These cards are also required by IFC, IBC, and NFPA for firefighting and hazard communication compliance. EH&S require that these cards be, at a minimum, reviewed annually and/or updated in the event of any change in the information. Door cards can be obtained by contacting EH&S 615-898-5831, 615-898-5689, or 615-494-7743. The form to be completed before contacting EH&S is located at https://mtsu.edu/ehs/industrial/docs/SignageInformationForm.pdf.

6.0 CHEMICAL STORAGE AND INVENTORY

Use and storage of hazardous chemicals is regulated by federal, state, and local regulations. These regulations, including OSHA worker protection standards, emergency response and planning regulations, and local building and fire codes, limit the amount of materials that can be used and where they can be used or stored. They also require chemical inventories to be available for emergency planning and response.

6.1 Chemical Storage and Use Limitations

The university must meet the requirements outlined in International Fire Code (IFC), by virtue of its adoption by the Murfreesboro Fire and Rescue Department (MFRD). MFRD also enforces sections of the National Fire Protection Association (NFPA) standards since these have been adopted by IFC reference. Finally, OSHA 29 CFR 1910.106 "*Flammable and Combustible Liquids*" is also enforceable. Together, these place limitations on use and storage of compressed gases, cryogenic fluids, highly toxic and toxic materials, flammable and combustible liquids, and water reactive solids, to name a few. The Murfreesboro Fire and Rescue Department can and does perform routine inspections of buildings on campus and has the authority to cite any situation that they deem in violation of the relevant codes.

The allowable quantities (both in use and in storage) per 2017 IFC are presented in tables found in Appendix G. Allowable quantities are based on control areas, defined as "spaces within a building which are enclosed and bounded by exterior walls, fire walls, fire separation assemblies and roofs, or a combination thereof, where quantities of hazardous materials not exceeding the exempt amounts are stored, dispensed, used or handled." Although the code limits appear straightforward, application of the code can be more complicated due to the following:

- While quantities are based on control areas, these may consist of more than one laboratory and the boundary of a control area is not obvious;
- Building features, such as the presence of sprinklers, can affect the allowable quantities;
- The quantities allowed are also dependent on the specific floor the laboratory is located. Generally, the higher the floor level the lower the allowable quantity per control area. Also, the number of allowable control areas decrease the higher the floor level;

Due to the complexities of the standards and the university's need to remain compliant with these regulations *it is the university's policy that every effort be made to minimize the quantity of hazardous chemicals within the campus laboratories*.

In addition to the IFC limits, other limitations to storage and use apply. Below are some of the **key policies and code requirements** for storage of chemicals at MTSU. This list is not comprehensive and does not include many of the prudent safety practices included in the Chemical Hygiene Plan or the guidance documents found on the EH&S website, mtsu.edu/ehs/industrial/manuals.php.

6.1.1. Chemical Compatibility and Safe Storage

In addition to chemical storage limitations imposed by regulations and codes, the PI is responsible for following prudent storage practices of chemicals. These include, but are not limited to:

- Storage area should have proper lighting and be accessible.
- Store liquid chemicals at eye level or below.
- Large bottles (2.5 L or more) must be stored on the bottom level of a cabinet.
- Hazardous chemicals must be segregated by compatibility and hazard classification in a well -identified area with local exhaust ventilation
- Flammable and combustible liquids must be stored in a yellow "flammable" cabinet(s), segregated by secondary trays depending on their compatibility
- Inorganic acids and based must be separated from flammable and combustible materials. Inorganic acids and based must be stored in a corrosives storage cabinet and segregated by secondary trays.
- Acid-sensitive materials, such as cyanides and sulfides should be separated from acids or protected from contact with acids.
- Solid chemicals should be stored on a shelf with a lip or inside a drawer designed for

chemical storage.

- Very volatile chemicals should be kept in an explosion-proof refrigerator or stored in a vented cabinet under a fume hood.
- Storage of chemicals at the lab bench and in the working space of the fume hoods is unadvisable. Amounts permitted should be limited to those necessary for one operation and the container size should be the minimum convenient.
- Chemicals in the workplace should be shielded from sunlight and heat as much as possible.
- Stored chemicals must be examined periodically by the Chemical Hygiene Manager or Laboratory Personnel for replacement, deterioration, and container integrity. The inspection should also include determining damage to the storage facility or cabinet due to chemicals leaking.
- Periodic inventories of the chemicals should be conducted by the Chemical Hygiene Manager. Unneeded items or contaminated chemicals should be discarded and any completely used chemicals should be taken off the inventory list.

The allowable quantities (both in use and in storage) per 2017 IFC are presented in tables found in Appendix G. Allowable quantities are based on control areas, defined as “spaces within a building which are enclosed and bounded by exterior walls, fire walls, fire separation assemblies and roofs, or a combination thereof, where quantities of hazardous materials not exceeding the exempt amounts are stored, dispensed, used or handled.” Although the code limits appear straightforward, application of the code can be more complicated due to the following:

- While quantities are based on control areas, these may consist of more than one laboratory and the boundary of a control area is not obvious;
- Building features, such as the presence of sprinklers, can affect the allowable quantities;
- The quantities allowed are also dependent on the specific floor the laboratory is located. The higher the floor level the lower the allowable quantity per control area. Also, the number of allowable control areas decrease the higher the floor level;

Due to the complexities of the standards and the university’s need to remain compliant with these regulations *it is the University’s policy that every effort be made to minimize the quantity of hazardous chemicals within the campus laboratories*.

For assistance in determining appropriate storage locations/conditions, chemical compatibility, etc., contact EH&S at 615-898-2879 or 615-898-5689.

6.1.2. Flammable Liquids

In addition to the IFC code requirements, the following University limitations have been set on flammable liquids (in stances where the building limits are more stringent, those limits will apply):

- No more than ten (10) gallons of flammable liquids per typical laboratory may be stored outside a flammable storage cabinet (with the exception of materials stored in approved safety cans). Exception(s) can be made by the Chemical Safety Office for larger laboratory suites, though this cannot exceed fire code limits;

- Further limitations are placed on the quantities that can be placed in an individual container based on the type of container (glass, metal, etc.). See Table G3 in Appendix G.
- Flammable liquids, if they need to be refrigerated, must be stored in laboratory-safe refrigerators. All the electrical components in this type of refrigerator are outside the refrigerator. UL-approved laboratory–safe refrigerators can be purchased from a variety of vendors.

6.1.3. Compressed Gas Cylinders

Below are a few general requirements for gas cylinder usage. Additional requirements for safe handling of gas cylinders can be found on the Chemical Safety Office website. Due to the hazards posed by highly toxic, corrosive, and pyrophoric gases, all procedures involving these gases must be reviewed by EH&S staff, EH&S Safety Committee, and Principal Investigator prior to use. Please reference the MTSU Safety Handbook concerning storage and use of compressed gas cylinders on Campus and in policy for the Purchase and Initial Use of High-Hazard Gas Cylinders located in Appendix N.

In order to ensure safe use and storage, all gas cylinders must be:

- Stored within a well-ventilated area, away from damp areas, salts, or corrosive atmospheres, and away from exit routes;
- Stored in an upright position with full cylinders separated from empty cylinders;
- Secured with a chain or appropriate belt above the midpoint but below the shoulder. Laboratory cylinders less than 18” tall may be secured by approved stands or wall brackets. Make sure gas cylinder is strapped tight so there is minimal movement.
- Capped when not in use or attached to a system (if the cylinder will accept a cap);
- Kept at least 20 ft. away from all flammable, combustible or incompatible substances. Storage areas that have a noncombustible wall at least 5 ft. in height and with a fire resistance rating of at least 30 minutes may be used to segregate gases of different hazard classes in close proximity to each other
- Show great caution when handling gas cylinders, It is advisable to seek help when changing out a gas cylinder for the first time.
- Never transport or move a gas cylinder without the protective cap affixed over the valve.
- When transporting a gas cylinder to another lab, use carts specifically designed for that purpose.
- Remember to order a replacement gas cylinder of the same type of gas when acquiring a new gas cylinder from current supply.

6.1.4. Cryogenic Liquids

Cryogenic liquids may displace oxygen, leading to oxygen-deficient atmospheres. Safety precautions forhandling or storing cryogenic liquids include:

- Storage areas for stationary or portable containers of cryogenic liquids in any quantity must be stored inareas with adequate mechanical ventilation or natural ventilation. If it can be demonstrated that there is no risk of oxygen depletion or harmful vapors then ventilation may not be required, contingent upon EH&S approval.

- Indoor areas where cryogenic liquids in any quantity are dispensed in areas with adequate mechanical or natural ventilation. Vapors should be captured at the point of generation whenever feasible. If it can be demonstrated that there is no risk of oxygen depletion or harmful vapors then ventilation may not be required, contingent upon EH&S approval.

- If a review of cryogenic usage indicates that there is a possibility of creating a hazardous situation then additional signage, ventilation, and monitoring may be required. See MTSU Safety Handbook for additional information on the campus cryogenic liquid policy. You can also contact EH&S at 615-898-2879 or 615-898-5689. The MTSU Safety Handbook is located at https://mtsu.edu/ehs/docs/Employee-Safety-Handbook.pdf and in the Policy for the Use and Storage of Inert Cryogenic Liquids in Appendix M.

6.2 Chemical Inventories

As stated throughout this document, the university is subject to numerous regulations above and beyond the OSHA Laboratory Standard. Below are some of the codes and regulations requiring that laboratory staff have knowledge of their chemical inventories:

Emergency Planning and Community Right-to Know Act (EPCRA)
EPCRA is a federal statute that requires all entities that store, use or process hazardous chemicals to report this information to the State Emergency Response Commission and Local Emergency Planning Committees and in some cases the local fire department. EPCRA has four major provisions which are largely independent of each other and involve different chemical lists with different threshold reporting quantities.

Department of Homeland Security (DHS) Chemicals of Interest
The DHS has issued regulations related to security of high-risk chemical facilities. These regulations, released in 2007, require facilities to determine if they have specific chemicals above screening threshold quantities. 300 chemicals (and respective thresholds) were identified. While most of the thresholds were set at thousands of pounds, some of the threshold amounts were significantly lower. The university completed the initial security screening but must report any change to DHS.

Murfreesboro Fire and Rescue Department (MFRD) Codes
The MFRD requires entities that use hazardous materials to maintain inventories and to provide them upon request.

While maintaining a complete inventory of chemicals is highly recommended (it prevents unnecessary purchases and reduces inventory), ***at a minimum****, Principal Investigators must maintain an up-to-date chemical inventory for the following:*

- All quantities of Class IA flammable liquids;
- Class IB and IC flammable liquids greater than 100 milliliters;
- Water reactive chemicals in quantities greater than 50 grams;
- All organic peroxides, unstable compounds, and pyrophoric compounds;

- All gas cylinders;
- Highly toxic materials greater than 50 grams;
- Corrosive liquids greater than 2 liters;
- All EPCRA extremely hazardous substances listed in Appendix H, Table 1;
- All DHS Chemicals of Interest listed in Appendix H, Table 2.
-

Appendices F has information that would be useful in determining whether a chemical would fall under the inventory requirement. NFPA fire diamond information commonly available can also help. Liquids with a flammability rating of 3 are considered Class IB and IC liquids while those with a flammability rating of 4 are Class IA. If in doubt whether a chemical would fall under one of the above categories, then maintain it on your inventory. Inventories must be made available to the Chemical Safety Office upon request.

7.0 CHEMICALS AND DRUGS USED TO ELICIT A BIOLOGICAL RESPONSE

Use of FDA-approved drugs or experimental drugs in a clinical setting is outside the purview of this document. However, the safe handling and use of drugs in a laboratory setting must be described in the lab-specific CHP if the drug has the characteristics of a hazardous chemical or is a carcinogen and is in a form that has the potential to lead to an exposure. More broadly, *usage of any hazardous chemical for the purpose of eliciting a biological response must be covered by the Laboratory CHP*.

For animal experiments involving hazardous chemicals, it is the responsibility of the Principal Investigator (PI) to provide hazard communication information to animal care staff. This information will include, at a minimum:

1. Identity of the chemical;
2. Hazards associated with the chemical;
3. Means that one should take to minimize exposure, including PPE and engineering controls;
4. Location of SDSs;
5. First aid response in the event of an exposure.

8.0 DEPARTMENT OF HEALTH AND HUMAN SERVICES (DHHS) AND BIOLOGICAL TOXINS

The *Public Health Security and Bioterrorism Preparedness and Response Act of 2002, Subtitle A of Public Law 107–188* requires the Department of Health and Human Services (HHS) to establish and regulate a list of biological toxins (and biological agents) that have the potential to pose a severe threat to public health and safety. The biological toxins, listed in Table 1 below, are regulated if inventory levels exceed – at any time – the amounts indicated. Users that anticipate exceeding the listed thresholds must register with the university's Select Agent Program. Users who maintain quantities below the listed threshold are still required to maintain inventory logs containing the date of access, name of individual accessing the toxin, the quantity used, the purpose of use and the amount remaining. The toxins must be kept in a locked area with access limited to those who need it. The biological inventory logs must be sent on a quarterly basis to the MTSU Biosafety Manager. Unregistered individuals exceeding these limits face severe federal penalties. Use of biological toxins must also be included in **ALL** biosafety protocols. Questions concerning biological toxins should be directed to the MTSU Biosafety Manager.

Table 1. Toxin Regulation Level

DHHS Toxins [§73.3(d)(3)]	Amount
Abrin	100 mg
Botulinum Neurotoxins	0.5 mg
Short, paralytic alpha conotoxins	100 mg
Diacetoxyscirpenol *DAS)	1000 mg
Ricin	100 mg
Saxitoxin	100 mg
Staphylococcal Enterotoxins (Subtypes A, B, C, D, And E)	5mg
T-2 Toxin	1000 mg
Tetrodotoxin	100 mg

Questions concerning biological toxins should be directed to MTSU Biosafety Program Manager. A copy of the MTSU Biosafety Safety Manual by be accessed at the EH&S Website under Biosafety and at this link: https://mtsu.edu/ehs/industrial/biosafety.php.

9.0 DRUG ENFORCEMENT AGENCY (DEA) SCHEDULED DRUGS

The Congress of the United States enacted into law the Controlled Substances Act (CSA) as Title II of the Comprehensive Drug Abuse Prevention and Control Act of 1970. Use of controlled substances in animal research is common where pain medication is required.

Use of controlled substances for research requires obtaining both federal (DEA) and state (TN State Board of Pharmacy) approvals. Penalties for using such drugs without proper registration can be severe. The regulations strictly limit who can handle or administer the drugs and imposes both physical security requirements as well as inventory requirements. Some key points concerning the regulations include:

- The permitting process is between an individual researcher and the DEA and State;
- Registrants cannot share controlled substances with non-registered users who are not under theirsupervision (e.g., another research laboratory in their department);
- Possession of expired drugs also poses a risk since administration of expired controlled substances isnot disallowed per the U.S. Department of Agriculture Animal Welfare Act (and other animal welfareagencies);
- Disposal is strictly regulated. Only the DEA Special Agent in Charge can authorize the disposal ofcontrolled substances.
- Sewer disposal of any DEA drug is prohibited. Contact EH&S for additional guidance regarding disposal.

EH&S has no role in the permitting process or compliance with issued approvals, though it can provide limitedguidance and facilitate disposal coordination upon request. EH&S ***may not*** take possession of controlled substances waste for disposal on behalf of the researcher.

10.0 SURPLUS CHEMICAL AND HAZARDOUS WASTE MANAGEMENT

The Resource Conservation and Recovery Act (RCRA), enacted in 1976, is the principal Federal law in the United States governing the disposal of hazardous waste. RCRA is administered by the U.S. Environmental Protection Agency (EPA) and is promulgated in Tennessee by the Tennessee Department of Environment and Conservation (TDEC).

Because MTSU is not allowed to treat hazardous chemical waste onsite, all chemical waste must be submitted to the EH&S Waste Management Program for disposal through a hazardous waste contractor. MTSU EH&S does waste disposal on a semi-annual basis. The waste collection information and other management details are located in Appendix K and at https://mtsu.edu/ehs/industrial/docs/WasteManagement.pdf.

10.1 Hazardous Waste Reduction

The University strives to maintain compliance with all regulations regarding hazardous wastes while at the same time minimizing waste. Our waste minimization efforts include chemical redistribution and inventory reduction programs. Our waste minimization efforts include recycling, fuel-blending, thermal recovery, and waste-to-energy programs. To the extent feasible, researchers should assist with waste minimization through experimental planning, reduction of experimental scale, and procurement management (see the American Chemical Society's "*Less is Better*" guidance document).

10.2 In-Lab Chemical Management

As part of the chemical disposal process, Principal Investigators and laboratory staff are allowed to perform In-Lab Chemical Management of their inventories. In-Lab Chemical Management includes simple disposal and treatment methods that can be done in a lab, such as solvent commingling and neutralization. Approved disposal procedures are described in detail in Appendix I and J and in MTSU Disposal of Hazardous Waste on the Department of Chemistry Website: https://mtsu.edu/chemistry/docs/Disposal%20of%20Hazardous%20Waste.pdf, and In Appendix K as well as the MTSU EH&S Industrial Hygiene web-page: https://mtsu.edu/ehs/industrial/docs/WasteManagement.pdf. The MTSU Chemical Safety Office and EH&S can advise you regarding the disposal of specific chemicals and wastes and, in some cases, can demonstrate treatment and neutralization procedures. Below are the accepted Waste Disposal Guidelines for Chemicals and Equipment.

10.2.1 – Disposal of Chemicals and Equipment

A. Deposit chemical waste into appropriately labeled receptacles.
   1) Labeled amber bottles will be used to dispose of halogenated and non-halogenated organic liquid waste.
   2) Labeled clear bottles or carboys will be used for non-halogenated organic liquid waste and aqueous metals waste.
   3) Organic soldi waste should be disposed of into a labeled glass container.
   4) Non-organic solid waste must be deposited into a solid waste container fitted with a beg designed specifically for solid hazardous materials.

B. For the disposal of concentrated acids and based, dilute the chemical to a low concentration and pour down the sink with running water.

C. Fume hoods should not be used as a means for disposal of volatile chemicals.
D. Recycling or chemical decontamination of chemical waste should be used instead of disposal if possible.
E. Use SDS sheets and other literature to determine the proper procedure for disposing of hazardous chemicals used in an experiment.
F. Before an employee or student end their laboratory work, chemicals used in the experimentation must be discarded or returned to storage.

10.2.2 – Storage of Waste

A. Hazardous chemical waste should be stored in a hood towards the back and out of the way if possible. If there is no hood that can be used, place hazardous chemical waste in well ventilated area out of the way of other laboratory activities.
B. A secondary tray must be underneath the chemical waste containers to capture leakage.
C. A waste container must be closed when chemicals are not being deposited in it.
D. When chemical waste containers are full, place the containers in a cabinet with a tray (secondary containment) underneath. It is advisable to store the containers in a cabinet underneath the fume hoods. For solid waste, close the bag off and acquire a Hazardous Waste label from the stock room and label the contents of the bag.

10.2.3 – Procedure for Waste Collection

A. Waste Collection for Chemicals
   1) Collection of waste happens twice a year and will be coordinated the Laboratory Hygiene Manger and EH&S.
   2) When prompted to, gather a list of chemical waste containers that need to be collected and their location.

10.2.4 – Waste Container Replacement

A. Recycle empty glass containers to be used for chemical waste container and must have a Hazardous Waste label form the stockroom
B. Solid waste bags can be found in the stockroom
C. Broken glass containers and sharps containers can be replaced by notifying the Laboratory Hygiene Manager or EH&S.

10.3 Sanitary Sewer Disposal

The EPA does not allow the University to sewer hazardous waste. Hazardous waste is usually classified as belonging to one of two groups: (1) characteristic hazardous waste (ignitable, corrosive, reactive or toxic) or (2) listed hazardous waste (K, F, P, U are the four lists published by EPA). However, the university is able to perform elementary neutralizations and dispose of the product into the acid pits where they are further neutralized.

<u>All</u> materials that damage the pipes (corrosive), create an unsafe atmosphere (ignitable or toxic) in the line access points, block flow or interfere with the treatment process are prohibited for sewer disposal.

10.4 Laboratory Cleanouts and Clean Sweeps

The Chemical Safety Manager and EH&S can perform laboratory cleanouts and departmental clean sweeps upon request. Clean sweeps provide opportunities for old and expired chemicals that may pose unnecessary risk to be removed. Information on cleanouts and moves can be obtained on the EH&S website.

11.0 EMPLOYEE INFORMATION AND TRAINING

The OSHA Laboratory Standard is clear on the requirement that all laboratory personnel receive the necessary information and training so that they understand the hazards of the chemicals present in their work area. EH&S can provide various courses and classes to meet these needs. EH&S staff can also help by providing guidance on common techniques and the use of common chemicals. However, the lab-specific training must be provided by the PI (personally or by a designated staff member or outside source). The PI must ensure that the information and training is presented before laboratory workers are allowed to use or handle chemicals in their laboratory.

11.1 Information

Laboratory personnel must be informed of:

- The contents of the Laboratory Standard and its appendices. The OSHA Laboratory Standard can be accessed at https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1450;
- The location and availability of the MTSU CHP, the LS-CHP, and the MTSU Safety Handbook;
- The permissible exposure limits for OSHA-regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard (see Appendix C of this document for more information);
- Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory;
- The location and availability of known reference materials on the hazards, including, but not limited to, SDSs received from the chemical supplier;
- Safe handling, storage, and disposal of hazardous chemicals found in the laboratory.

11.2 Training

MTSU EH&S offers annually scheduled training on general laboratory safety. This covers details of the OSHA Laboratory Standard as well as campus safety policies (including the MTSU CHP), resources, and services. For additional training information, contact the EH&S office.

Laboratory staff must also receive training from their PI, or designee, on the laboratory-specific operations. This must include:

- The specific physical and health hazards (e.g., corrosive, carcinogenic, flammable, water-reactive chemicals) associated with the hazardous chemicals staff may come in contact within the laboratory where they work;
- The methods that are to be used to control these hazards, including engineering and administrative controls, and personal protective equipment;
- Any laboratory-specific emergency procedures and the location and proper use of safety equipment (e.g., fume hood, fire extinguisher, emergency eyewash, and shower);
- Methods and observations that may be used to detect the presence or release of a

hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance, or odor of hazardous chemicals, etc.).

- Students who are in laboratory course(s) should be given the Student Laboratory Safety Contract before they begin their first lab experiment. The student and instructor need to read and discuss as need any or all of the portions of the "Safety Contract" for clarity and understanding. These "contracts" will be signed by the student and retained in the appropriate department office. This "contract" is available in Appendix B. Additional safety information should be given to the student(s) before each experiment throughout the semester.

Training must be communicated in a manner readily understood to those being trained. This may require written as well as oral transmission of information. Unless otherwise indicated by EH&S, the frequency of refresher training and information can be determined by the PI. Refer to the LS-CHP template for information on laboratory-specific documentation requirements.

12.0 EMERGENCY REPSONSE

Each PI must ensure that laboratory staff are knowledgeable and trained on emergency procedures. Many of the procedures are covered in the MTSU Safety Handbook under Chapters 6 and 7. Other emergency procedures can also be found within each Department Heads office. Each building may have a specific guidance to building occupants in the event of an emergency, such as a tornado, active shooter, gas leak or bomb threat. Contact your building manager or department chair for location of this document. Assess the hazards present in your workspace and tailor your emergency equipment and response plans accordingly. Emergency response plans should be developed covering lab-specific procedures, including:

- Procedures for handling small and large chemical spills (see Appendix L);
- Procedures for responding to fires;
- Procedures for responding to power failures;
- Procedures for handling instrument failures;
- Procedures for handling ventilation failures;
- Procedures for responding to local alarms, such as oxygen or toxic gas sensors.

In case of an emergency, be prepared to follow the planned emergency procedures for your workplace and building. Before an emergency strikes, there are several things that can be done to improve preparedness:

- Review your building's emergency plans, taking note of proper exit and reentry procedures and emergency contacts. Make sure these procedures and contacts are visibly posted and that all employees are familiar with them.
- Check your laboratory door placard ("Yellow Card" located near the laboratory entrance) and make sure the information is up to date. Keep your SDS files updated and easily accessible.
- Locate and become knowledgeable with important emergency equipment in the laboratory such as fire extinguishers, eyewash stations, and spill kits. Have several of the laboratory employees trained on proper use of first aid and fire extinguishers.
- EH&S periodically checks the emergency equipment to make sure it is properly maintained, appropriate for the hazard and ready for use. For example, eyewash stations are flushed weekly to make sure the water is clean and adequately dispensed. Also,

ensure that emergency spill kits are appropriate for the chemical hazards in the lab (e.g., flammable solvent spill kits are inadequate for neutralizing caustic acid or base spills).

- Have emergency contacts posted
    - University Police: 615-898-242
    - 911 from any campus phone or cell phone
    - EH&S 615-898-2879 or 615-898-5831

12.1 Emergency Procedures for Fires

Below are the approved emergency procedures for fires within the laboratories:

12.1.1 If a fire is too large to be smothered or be put out by a fire extinguisher, activate emergency procedures. DO NOT endanger yourself or others by trying to extinguish or control a fire that is too large for you to handle

a. Evacuate the room and close and lock all the doors after everyone is out.
b. Activate the nearest fire alarm system to the laboratory.
c. Evacuate via stairways, **DO NOT USE ELEVATORS**
d. Move and congregate at the meeting place designated in the laboratory emergency evacuation plan.
e. Stay outside at meeting place until the all clear is given by either fire department, University Fire Marshal, and/or faculty and EH&S staff.

12.2 Emergency Procedure for Vapor and Gas Leaks

12.2.1 In case of vapor leaks within the fume hoods, close the fume hood doors, evacuate the room, and follow the newly accepted fume hood recommendations located in Appendix D.

12.2.2 In gas of a natural gas leak within the laboratory, open up all the fume hood doors, evacuate the room, and follow the accepted fume hood recommendations located in Appendix D.

12.3 Emergency Procedures for Major Injury in a Laboratory

In case of a major injury in the laboratory, determine the extent of the injury and proceed accordingly:

12.3.1 – First Call University Police Department at 615-898-2424 or 911 to have police, fire, and ambulance to respond to the emergency.

12.3.2 – A victim of chemical burns can be treated with first aid laid out by the chemical's SDS information. Following initial treatment, allow first responders (EMTS's or Paramedics) follow-up with further treatment, as necessary.

12.3.3 – To treat a victim that inhales toxic fumes, they must be removed to clean air and resuscitated by a person trained in CPR if needed. Following initial treatment, allow first responders (EMTS's or Paramedics) follow-up with further treatment, as necessary.

12.3.4 – For any injury caused by toxic or hazardous chemicals, a person should never put themselves endanger to rescue another person. By putting yourself in danger you are adding to the problem.

12.4 – Emergency Procedures for Accidental Exposure to Chemicals

Below are general procedures for Accidental Exposure to Chemicals in the laboratory settings.

12.4.1 – Eye Contact – Promptly flush eyes with cold water at eye wash stations for prolonged period (15 minutes or more) and seek medical attention.

12.4.2 – Ingestion – Immediately drink large amounts of water and seek immediate medical attention.

12.4.3 -Skin Contact – Promptly flush the affected area with cold water either under the sink or if more than 6 square inches of skin is affected, remove the effected clothing, rinse the whole body under the emergency showers located in the laboratories. If symptoms persist after washing the skin or body, seek medical attention.

12.4.4 – Inhalation - Quickly move to an area away from the fumes or vapors and immediately seek medical attention. If person is unconscious, call 911 for police, fire, and ambulance response.

13.0 EXPOSURE MONITORING

The State of Tennessee regulations require exposure monitoring where exposure may occur at or above a published exposure value of OSHA or ACGIH (American Conference of Governmental Industrial Hygienists). Examples of such values could include the action level, permissible exposure level, threshold limit value, short-term exposure limit or ceiling limit. If you believe that you are being exposed to levels above the permissible limits, contact EH&S. EH&S will ensure the necessary exposure monitoring is performed. The affected university staff will be notified by EH&S of the results within 15 days of receipt of the results (see Section 5.3).

14.0 RESPIRATORY PROTECTION

Whenever possible, exposures to hazardous chemicals must be minimized through prudent experimental design and engineering controls. Examples include eliminating the hazard by substituting for a less hazardous alternative or containing the hazard through ventilation or other controls. If no alternatives can be found, then respiratory protection may be required. The EH&S office shall be contacted to determine the need for and the proper selection, training, and use of respirators. Currently, MTSU does not have a Respirator Program as defined in OSHA 29 CFR 1910.134 (a)(2).

Respirators include filtering face pieces (N95), half-face and full-face cartridge respirators, powered air purifying respirators (PAPR)or self-contained breathing apparatus to prevent or limit exposure to airborne hazards. It is essential to evaluate the type and amount of the exposure to assure proper use and protection. There are several regulatory requirements associated with the use of respirators, including the development of a respiratory protection program, conducting a medical evaluation and respiratory fit testing, and receiving training on the proper use of respirators.

15.0 LABORATORY INSPECTION PROGRAM

The laboratory inspection program is an ongoing program that provides laboratories with EH&S assistance and consultation to help create a safe work environment. As part of the visit, EH&S staff will help ensure that the obligations of all institutional policies and governmental regulations are met. EH&S performs a review of all safety documentation and physical hazards, which include fire safety, chemical safety, engineering controls, and safety training. Upon completion of the laboratory visit, a report is issued to each PI and/or designated laboratory manager. Department heads and Department Safety Officers (DSOs) will be copied on the report as requested. This report outlines laboratory successes, opportunities for improvement, safety/compliance findings and respective corrective actions. Guidance documents or other reference materials will be included in the report, as necessary. EH&S staff are available to assist in making improvements.

EH&S staff visit laboratories semi-annually by department (or building, if appropriate) on a rotating basis. However, EH&S staff are available to visit any laboratory at any time upon request. A schedule of inspections is available on EHS Website at https://mtsu.edu/ehs/industrial/index.php. Click on Lab Safety Semi-Annual Safety Inspection Schedule for 2021.

16.0 INCIDENT/ACCIDENT NOTIFICATION INVESTIGATION

PIs and supervisors must report any incident involving personal injury, exposure or illnesses, unintended fire, property damage or incidents involving an environmental release of hazardous materials directly to EH&S by calling 615-895-2879 or through the EH&S website: https://mtsu.edu/ehs/industrial/docs/StudentAccidentReport.pdf.

A primary tool to identify and recognize the areas responsible for accidents is a properly conducted accident investigation. Accident investigations shall be conducted by the EH&S staff with the primary goals of 1) understanding why the accident or near miss occurred; 2) determining what actions can be taken to prevent recurrence; and 3) sharing lessons learned with stakeholders.

Procedures for investigating workplace accidents and hazardous materials exposures include:

- Visiting the accident scene as soon as possible;
- Interviewing injured workers and witnesses;
- Examining the workplace for factors associated with the accident/exposure;
- Determining the cause of the accident/exposure;
- Taking corrective action to prevent the accident/exposure from reoccurring;
- Tracking the findings to timely closure and recording corrective actions taken;
- Sharing lessons learned.

The investigation will be recorded in writing and will adequately identify the cause(s) of the accident or near miss occurrence. Documentation of the investigation and all follow-ups will be prepared and maintained by the EH&S staff performing the investigation. Where appropriate, findings and lessons-learned will be communicated with University administration, the Laboratory Safety Coordinator (LSC), DSOs, and/or faculty and Staff.

17.0 TRANSPORTATION AND SHIPPING OF HAZARDOUS MATERIALS

17.1 Shipping of Hazardous Materials

In order to protect the public at large, the US Department of Transportation (DOT) regulates the shipping and transportation of hazardous materials on roadways and airways. A hazardous material is defined as any substance or material that could adversely affect the safety of the public, handlers, or carriers during transportation. All DOT hazardous materials are listed in the DOT's Hazardous Materials Table.

The regulations for shipping hazardous materials apply to all individuals involved in the shipping process, including individuals who:

- Arrange for transport;
- Package materials;
- Mark and label packages;
- Prepare shipping papers;
- Handle, load, secure and segregate packages within a transport vehicle.

The requirements can be found in 49 CFR Parts 171-178, which covers the documentation, packing, marking, and labeling of hazardous materials. The International Air Transport Association (IATA) regulations also apply when shipping hazardous chemicals by common air carriers such as FedEx since these carriers require that IATA rules be met. In addition to proper packaging and labeling, the regulations require that the individual receive training that must be refreshed at a minimum of every three years (two years for IATA) or when the regulations change significantly.

Non-compliance with these standards is subject to civil penalties up to $50,000 per violation and up to $100,000 if death, serious illness, severe injury to any person or substantial destruction of property. Criminal penalties may result in up to 10 years imprisonment. **Consequently, EH&S must be contacted at 615-898-2879 or 615-898-5831 or prior to shipping any hazardous (or potentially hazardous material.** EH&S will assist with identification, packaging, labeling and paperwork to ensure compliance with applicable shipping regulations.

Important*: With few exceptions, no hazardous materials can be carried on or transported in checked luggage on any commercial airline flight. It is the responsibility of the PI to know which substances are hazardous and to communicate this information to laboratory members.*

17.2 Chemical Procurement and Receiving

Before any substance is purchased and received, information on the proper handling, storage, and disposal should be known to those involved. All chemicals and equipment being purchased will need to be approved by the Department Chair and will be purchased by the Laboratory Manager. All material will be received by the Laboratory Manager at a central location (stockroom) and will undergo proper procedures for receiving, handling, and storage of said chemicals or materials. If bulk materials or chemicals need to be ordered, only order what you know you will used regularly. For smaller amounts of materials and chemicals that are used less frequently should be ordered in smaller amounts. These can be ordered more often if need be. This will prevent waste of any material not needed or used.

Upon the chemical(s) arrival, it will be added to the Chemical Inventory log. No Chemicals will be accepted without proper and adequate identifying labels, Safety Data Sheet (SDS), and packed in accordance with all appropriate regulations.

Once any chemicals and/or equipment has been received and processed, they may then be distributed to their specific locations. Each chemical and/or equipment shall have the appropriate paperwork taped to the packaging verifying it has been processed.

17.3 On-Campus Transportation of Hazardous Materials

Under the current regulations, MTSU is considered a government agency and is exempted from some aspects of the DOT regulations; therefore, *with the approval of EH&S*, university employees may transport *some* types of hazardous materials for University-related purposes. Transport should be limited to short distances (between campus buildings or adjacent campuses) and small volumes and adhere to the following:

- The employees involved in moving the hazardous material should be trained and familiar with its hazards and basic handling properties;
- Before moving the material, an emergency plan and spill kit must be available in case of an accident or environmental discharge;
- When any chemicals that are carried by hand, the container should be placed into a secondary container to reduce the threat of spills. If any chemicals in glass containers of 1L or greater, need to be transported to other rooms by the chemical carriers provided the laboratories (i.e., carts).
- Primary and secondary containers must be appropriately labeled with the contents and appropriateprecautionary statements (e.g., flammable, corrosive, etc.);
- Large quantities of chemicals should be transported by carts provide and immediately stored in appropriate places.
- Only university vehicles (i.e., not personal vehicles) can be used for the transportation of hazardousmaterials;
- Items of a dangerous nature are not allowed on any University shuttle bus. These could include but are not limited to: flammable liquids; dangerous, toxic, or poisonous substances; or vessels containing caustic materials, acids, or alkalis.

  EH&S will coordinate the movement of large quantities of chemicals between buildings.

Hazardous waste is regulated by the US EPA in 40 CFR 260-265. The transportation of hazardous waste requires special marking(s), training, and documentation. Hazardous waste can only be transported by approved contractors.

18.0 RECORDS

PIs are required to maintain all records associated with their laboratories. These records include:

- Copies of LS-CHPs;
- Training records for laboratory personnel;
- Records of any internal audits or inspections;
- Results of any exposure monitoring.

19.0 ABBREVIATIONS AND DEFINITIONS

19.1 Abbreviations

ACGIH: American Conference of Governmental Industrial Hygienists
BBP: Bloodborne Pathogens
CHO: Chemical Hygiene Officer
CHP: Chemical Hygiene Plan
COI: Chemicals of Interest
CSA: Controlled Substance Act
D-CHP: Departmental Chemical Hygiene Plan
DEA: Drug Enforcement Agency
DHHS: Department of Health & Human Services
DHS: Department of Homeland Security
DOT: Department of Transportation
EH&S: Environmental Health & Safety
EPCRA: Emergency Planning and Community Right-to Know Act
HHCRC: High-hazard Chemical Review Committee
IATA: International Air Transport Association
IBC: International Building Code
IDLH: Immediately Dangerous to Life or Health
IFC: International Fire Code
LSC: Laboratory Safety Committee
LS-CHP: Laboratory-specific Chemical Hygiene Plan
MAQ: Maximum Allowable Quantity
MFRD: Murfreesboro Fire and Rescue Department
MTSU CHP: Middle Tennessee State University Chemical Hygiene Plan
MTSU EHSC: MTSU Environmental Health and Safety Committee
NFPA: National Fire Protection Association
OSHA: Occupational Safety and Health Administration
PEL: Permissible Exposure Level
PHS: Particularly Hazardous Substance
PI: Principal Investigator
PPE: Personal Protective Equipment
QLD: Qualified Laboratory Designate
REL: Recommended Exposure Limit
SDS: Safety Data Sheet
SOP: Standard Operating Procedure
STEL: Short Term Exposure Limit
STQ: Screening Threshold Quantity
TLV: Threshold Limit Value
TPQ: Threshold Planning Quantity

TWA: Time weighted average
WWEL: Workplace Environmental Exposure Level

19.2 Definitions

Combustible Liquid: A liquid having a closed cup flash point at or above 100°F (38°C). Combustible liquidsshall be subdivided as follows:

Class II. Liquids having a closed cup flash point at or above 100°F (38°C) and below 140°F (60°C).

Class IIIA. Liquids having a closed cup flash point at or above 140°F (60°C) and below 200°F (93°C).

Class IIIB. Liquids having a closed cup flash point at or above 200°F (93°C). The category ofcombustible liquids does not include compressed gases or cryogenic fluids.

Control Area: Spaces within a building that are enclosed and bounded by exterior walls, fire walls, firebarriers and roofs, or a combination thereof, where quantities of hazardous materials not exceeding the maximum allowable quantities per control area are stored, dispensed, used, or handled.

Corrosive: A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact. A chemical shall be considered corrosive if, when tested on the intact skin of albino rabbits by the method described in DOT 49 CFR, Part 173.137, such a chemical destroys or changes irreversibly the structure of the tissue at the point of contact following an exposure period of 4 hours. This term does not refer to action on inanimate surfaces. Highly acidic and basic compounds are typical examples of corrosive materials.

Cryogenic Fluid: A liquid having a boiling point lower than -150°F (-101°C) at 14.7

Flammable Liquid: A liquid having a closed cup flash point below 100°F (38°C). Flammable liquids arefurther categorized into a group known as Class I liquids. The Class I category is subdivided as follows:

Class IA. Liquids having a flash point below 73°F (23°C) and a boiling point below 100°F (38°C).

Class IB. Liquids having a flash point below 73°F (23°C) and a boiling point at or above 100°F (38°C).

Class IC. Liquids having a flash point at or above 73°F (23°C) and a boiling point below 100°F (38°C).

This category of flammable liquids does not include compressed gases or cryogenic fluids.

Flammable Solid: A solid, other than a blasting agent or explosive, that is capable of causing fire throughfriction, absorption or moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which has an ignition temperature below 212°F (100°C) or which burns so vigorously and persistently when ignited as to create a serious hazard. A chemical shall be considered a flammable solid as determined in accordance with the test method of CPSC 16 CFR; Part 1500.44, if it ignites and burns with aself-sustained flame at a rate greater than 0.1 inch

(2.5 mm) per second along its major axis.

Flash Point: The minimum temperature in degrees Fahrenheit at which a liquid will give off sufficient vaporsto form an ignitable mixture with air near the surface or in the container but will not sustain combustion. The flash point of a liquid shall be determined by appropriate test procedure and apparatus as specified in ASTM D56, ASTM D 93 or ASTM D 3278

Highly Toxic: A material that produces a lethal dose or lethal concentration as follows:

1. A chemical that has a median lethal dose (LD50) of 50 milligrams or less per kilogram of body weightwhen administered orally to albino rats weighing between 200 and 300 grams each.

2. A chemical that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with thebare skin of albino rabbits weighing between 2 and 3 kilograms each.

3. A chemical that has a median lethal concentration (LC50) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between200 and 300 grams each.

Mixtures of these materials with ordinary materials, such as water, might not warrant classification as highlytoxic. While this system is simple in application, any hazard evaluation that is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.

Organic Peroxide: An organic compound that contains the bivalent -O-O- structure and which may be considered a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have beenreplaced by an organic radical.

Organic peroxides can pose an explosion hazard (detonation or deflagration), or they can be shock sensitive. They can also decompose into unstable compounds over time.

Class I. Those formulations that are capable of deflagration but not detonation.

Class II. Those formulations that burn very rapidly and that pose a moderate reactivity hazard.

Class III. Those formulations that burn rapidly and that pose a moderate reactivity hazard.

Class IV. Those formulations that burn in the same manner as ordinary combustibles and that pose aminimal reactivity hazard.

Class V. Those formulations that burn with less intensity than ordinary combustibles or do not sustaincombustion and that pose no reactivity hazard.

Unclassified detonable. Organic peroxides that are capable of detonation. These peroxides pose an extremely high explosion hazard through rapid explosive decomposition.

Oxidizer: A substance capable of oxidizing a reducing agent. Oxidizers are chemicals such as oxygen, chlorine, perchlorate, and permanganates that support combustion but do not burn independently. Oxidizers can react violently with flammable and combustible materials. Oxidizers are subdivided as follows:

Class 1. An oxidizer whose primary hazard is that it slightly increases the burning rate, but which doesnot cause spontaneous ignition when it comes in contact with combustible materials.

Class 2. An oxidizer that will cause a moderate increase in the burning rate or that causes spontaneousignition of combustible materials with which it comes in contact.

Class 3. An oxidizer that will cause a severe increase in the burning rate of combustible materials with which it comes in contact or that will undergo vigorous self-sustained decomposition due to contamination or exposure to heat.

Class 4. An oxidizer that can undergo an explosive reaction due to contamination or exposure tothermal or physical shock. Additionally, the oxidizer will enhance the burning rate and can causespontaneous ignition of combustible.

Oxidizing Gas: A gas that can support and accelerate combustion of other materials.

Pyrophoric: A chemical with an auto-ignition temperature in air, at or below a temperature of 130°F(54.4°C).

Toxic: A chemical falling within any of the following categories:

1. A chemical that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram, but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
2. A chemical that has a median lethal dose (LD_{50}) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between2 and 3 kilograms each.
3. A chemical that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Unstable (Reactive) Material: A material, other than an explosive, which in the pure state or as commercially produced, will vigorously polymerize, decompose, condense, or become self-reactive and undergoother violent chemical changes, including explosion, when exposed to heat, friction, or shock, or in the absence of an inhibitor, or in the presence of contaminants, or in contact with incompatible materials. Unstable (reactive) materials are subdivided as follows:

Class 1. Materials that in themselves are normally stable but which can become unstable at elevatedtemperatures and pressure.

Class 2. Materials that in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This class includes materials that can undergo chemical change with rapidrelease of energy at normal temperatures and pressures, and that can undergo violent chemical change at elevated temperatures and pressures.

Class 3. Materials that in themselves are capable of detonation or of explosive decomposition or explosive reaction but which require a strong initiating source, or which must be heated under confinement before initiation. This class includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

Class 4. Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures. This class includes materials that are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.

Water-Reactive Material: A material that explodes; violently reacts; produces flammable, toxic or other hazardous gases; or evolves enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture. Water-reactive materials are subdivided as follows:

Class 1. Materials that may react with water with some release of energy, but not violently, include bromine, chlorine, and fluorine.

Class 2. Materials that may form potentially explosive mixtures with water.

Class 3. Materials that react explosively with water without requiring heat or confinement.

APPENDIX A

LABORATORY SPECIFIC CHEMICAL HYGIENE PLAN (LS-CHP) TEMPLATE

All campus laboratories must comply with the requirements outlined in the MTSU CHP (and departmental safetyplans as applicable).

To fulfill the objectives of the OSHA Laboratory Standard, **each laboratory is required to supplement the MTSU CHP with a Laboratory-Specific Chemical Hygiene plan (LS-CHP)**. **The LS-CHP must be readily available in the specific laboratory it was written for, and a copy will be submitted to the appropriate department as well.**

LS-CHPs must include the following elements:

- Standard operating procedures (SOPs);
- Personal protective equipment (PPE) requirements;
- Engineering and administrative controls;
- Provisions for handling Particularly Hazardous Substances (PHS);
- Provisions for designating specific operations that shall require prior approval before initiation;
- Training requirements.

The following template is suitable for generating a LS-CHP that meets the performance objectives of the OSHALaboratory Standard*. Completion instructions are provided at the end of the template.

**The LS-CHP may use an alternative template and/or format, but at a minimum, it must include the bulleted items in this appendix*

Instructions for Completing the MTSU Laboratory-Specific Chemical Hygiene Plan

This template is designed to provide an organizational framework for ensuring compliance with the OSHA Laboratory Standard. The template covers all the laboratory-specific elements of the Lab Standard and should be used in conjunction with the *MTSU Chemical Hygiene Plan and Compliance Guide*, any relevant departmental chemical hygiene plans, or procedures, and the MTSU Safety Handbook. MTSU EHS allows other formats to be used as long as they contain the necessary elements outlined in this document. Upon request, the Laboratory-specific Chemical Hygiene Plan (LS-CHP) must be submitted to MTSU EHS and/or applicable safety committees (Lab Safety Committee, Environmental Health and Safety Committee, etc.). Contact EHS for questions or assistance at 615-898-5689 or 615-898-2879.

The Principal Investigator (PI) has the primary responsibility for ensuring the health and safety of their staff and for overall compliance with safety regulations, including the completion of the laboratory-specific CHP. However, the PI can delegate health and safety responsibilities to a trained and knowledgeable individual, referred to as the Qualified Laboratory Designate (QLD).

Filling out the Template

Below are detailed instructions for completing each section of the template. The template is a fillable PDF file that can be saved to your computer and submitted directly to EH&S (if requested). Additional stand-alone SOP templates (see **Section 4**) are also available and work in a similar manner. This will allow you to generate and save multiple SOPs without having to complete the information for the other sections.

Certification Page

The name of the PI (or other indication of applicable ownership and/or location) should be placed on the top of this page (in the box). The PI and the QLD (if one has been appointed) must sign this page. Updates to the plan should be made whenever required by changes to the laboratory hazard or operational profile. The LS-CHP must be reviewed annually, at a minimum. If no changes are required, then the plan should be signed and dated by the reviewer (the PI or QLD).

Section 1

Key safety personnel should be identified in Section 1.1. The Principal Investigator may assign the role of Qualified Laboratory Designate (QLD), an individual delegated the responsibility for implementing the provisions of this plan, to a member of his laboratory staff. The QLD must be qualified by training or experience to provide technical guidance. You may also include other knowledgeable staff members, the DSO, the building manager, or other departmental personnel under this section.

All individuals covered by this plan must be listed in Section 1.2. This includes all staff and students working in the indicated labs under the direction of the PI.

Section 2

This section provides space for identifying the locations where operations identified in the LS-CHP are performed. The template allows for multiple buildings and rooms within buildings. Rooms can be lumped together on a single line for each building. A check mark should be placed under the “Room Assigned to the PI?” or “Shared Facility?” headings, as appropriate. “Shared Facility” denotes a space occupied or used by more than one PI (e.g., core facilities, community laboratories, etc.).

Section 3

The MTSU CHP outlines university requirements related to the laboratory use and storage of hazardous chemicals. PIs may implement their own rules and requirements for the laboratories under their control (as long as they are consistent with University requirements and building/department/institute requirements, as applicable). Section 3 provides a section to document these laboratory-specific requirements. Some examples may include “No working alone after 10:00 p.m.” or “Lab coats must be worn at all times in the lab regardless of whether work is being performed”.

Section 4

This is the most important section of the LS-CHP and includes specific safety procedures required in the laboratory for operations involving hazardous chemicals. It is broken up into two parts – the Procedure Form and the Task Table.

The Procedure Form: This is best utilized to describe safety requirements for procedures involving carcinogens, reproductive toxin, and highly toxic materials (i.e., Particularly Hazardous Substances), procedures for highly reactive chemicals, or other high hazard material or procedure. It is not expected that the detailed stepwise procedure be described in this form but only the safety aspects. Any written stepwise procedure should be attached or referenced. Where applicable, a single Procedure Form can be used to describe the safety aspect of similar procedures. Below is some guidance for completing the form:

- *Prior Approval:* As stated in the MTSU CHP, a PI can determine whether the procedure needs prior approval before an individual can perform the procedure. The prior approval requirement can be indicated by checking the appropriate box. Note: Section 7 provides a location to document an individual’s approval to perform the procedure. The PI can determine how long approval is valid, though typically once approved an individual can continue to perform the procedure.
- *Particularly Hazardous Substance (PHS):* Indicate whether this procedure involves the use of a PHS and the applicable category(ies). Appendix F of the Campus CHP provides information helpful in determining if a chemical is a PHS.
- *Highly Reactive Chemicals:* Indicate whether this procedure involves the use of a highly reactive chemical and the applicable category(ies).
- *Brief Description of Procedure:* A brief description should be provided. Limit this to a few sentences. If the procedure is not attached, it is appropriate to provide a reference to the procedure.
- *Hazardous Chemicals Involved:* Provide a list of all hazardous chemicals specific to the procedure(s), and briefly describe the hazards they pose (such as highly toxic, flammable, water reactive). It is not necessary to include chemicals that do not pose a significant risk (such as buffers).
- *Other Hazards:* In this portion include other hazards associated with the procedure, e.g., thermal hazards from hot plates or Bunsen burners, electrical hazards, laser hazards, to name a few.
- *Exposure Control:* This portion of the form allows you to enter the Personal Protective Equipment (PPE) and engineering controls needed for this procedure. This is a master list of controls for the covered procedure(s). The additional line can be used to describe other controls or for clarifying the controls that have been checked. For multistep procedures, you will have the option of breaking this down into the various tasks (see *Task*

Hazard Control Table below.)

- *Administrative Controls:* Administrative controls are changes in routine work procedures implemented to reduce the duration, frequency, and severity of exposure to hazardous chemicals orsituations. Provide a list of administrative controls specific to this covered procedure(s). Examples include requiring two people to be present during the procedure or not allowing the procedure to beperformed at night.
- *Task Hazard Control Table:* For some procedures that have multiple steps you can break the controlsrequired for each of the steps. If the PPE and engineering controls are the same throughout the procedure, then this can be left blank.
- *Waste Disposal:* Indicate how the hazardous waste is handled.
- *Accidental Spills:* Each procedure must include a description of how to handle a chemical spill. Thetype of spill kit used, and the location of the spill kit should be included.
- *Decontamination Procedures:* In this section, provide information on how to handle personnel exposure including any first aid measures that may be necessary. Laboratory staff should be trained inhandling common exposures. This section allows you to add chemical-specific procedures (e.g., for hydrofluoric acid skin exposures rinse and apply calcium gluconate). You can also provide information on equipment decontamination.
- *Training:* This portion allows you to indicate what training is needed prior to any laboratory staff performing the covered procedure(s). Include both in-lab training and training from EH&S or othersources.
- *Principal Investigator Approval:* The Procedure Form (or another acceptable SOP format) must besigned and dated.
- *Personnel Acknowledgment:* All personnel carrying out the SOP must acknowledge that they haveread and understood it and agree to adhere to its requirements.

<u>The Task Table:</u> This table allows you to itemize routine laboratory tasks and respective controls. This table issimilar to the “Task Hazard Control Table” found in the “Procedure Form” but is best used to describe the hazards and controls needed for the numerous small (and often unrelated) tasks where the use of chemicals islimited. For example:

Task	**Hazard Description**	**Required PPE and Engineering Controls**
Pouring cryogenic liquid fromone container to another	• Frostbite due to extreme cold • Asphyxiation due to oxygendeficient environment	• Thermal protective gloves • Eye and face protection with face shields and safety glasses • Lab Coats • Point of use ventilation system

It is not appropriate to use this table for high-hazard operations, such as procedures involving highly toxicmaterials, explosive compounds, or highly flammable or pyrophoric materials (use the Procedure Form inSection 4).

Section 5

This section provides an area to document that staff have received orientation on the basic OSHA regulatory requirements, laboratory procedures, and emergency practices. An orientation checklist should be completedfor all new laboratory workers and signed by the worker and PI (or the QLD). There is space allotted for the addition of laboratory-specific health and safety features and resources. Additional items are optional but caninclude such items as special engineering controls (such as monitors and alarms) and resources (location of reference books).

Section 6

This section provides space for documenting the training that is required for working in the laboratory. Thereare two parts:

The Master List of Required Training: This section provides a location for listing all the training that is required in order to work with hazardous chemicals in the laboratory. It is not assumed that everyone needs allthe training listed. Individual training requirements should be based on work assignments, so some individualswill require more training than others. The training listed can be general (such a proper handling of compressed gas cylinders) or very specific (such as performing a specialized lab procedure) and should include training provided in-lab and from other sources (such as training provided by EHS). Additional pages of this can be completed if there is not enough room to list the training.

Documentation of Training: This section provides a place to document individual safety training. A brief description should be provided that includes how the training was performed (hands-on, PowerPoint presentation, group discussion, etc.). While this should be used to document the laboratory training describedin the *Master List of Required Training*, it can also be used to document training such as annual laboratory safety refreshers or to document discussion of safety issues that occur during laboratory staff meetings

Section 7

As described above in the instructions for Section 4, as well as in the MTSU CHP, some procedures need prior approval from the PI (or EHS) before an individual can perform the procedure. Document the required approval in this section. A sheet should be prepared for every procedure that requires prior approval. It is up tothe PI to determine whether approval is required every time the procedure is performed or whether approval isfor all subsequent execution of the procedure.

Section 8

OSHA requires that Safety Data Sheets (SDSs) be maintained and readily accessible for all hazardous chemicals. Paper copies and electronic copies are both acceptable. Paper copies of particularly hazardous substances and high-volume hazards should be maintained for quick access when delivering to medical care providers. If electronic copies are used these are best stored on a hard drive, flash drive, intranet, or other similar local source. Simply having the ability to search the internet on-demand is not an acceptable method ofmaintaining compliance with the regulations since this method limits the accessibility of the SDSs. Likewise, the MTSU CHP requires maintenance of chemical inventories. Indicate the location and access instructions for SDSs and chemical inventories in this section.

Section 9

The purpose of exposure monitoring must be described if exposure monitoring is required for any laboratoryoperation. The results must be available to all lab workers. Provide the location and access instructions for monitoring results in this section.

Section 10

This section provides a convenient place to list or attach references related to chemical or laboratory safety related to procedures used in the lab. These can be articles, guidance documents, or links to relevant websites. This is optional but highly recommended.

MTSU Logo

Laboratory-Specific Chemical Hygiene Plan
Ls-CHP

Applicable to: Research Group

Certification, Annual Review and Updates

By signing and dating here, the Principal Investigator (PI) or Qualified Laboratory Designate (QLD) assigned by the PI (e.g., laboratory supervisor/manager, technician, or post-doctoral fellow) certify that this Laboratory-Specific Chemical Hygiene Plan is accurate and that it effectively provides for the chemical safety of employeesand students in this laboratory.

Principal Investigator:

Signature	Printed Name	Date

Qualified Laboratory Designate (if other than PI):

Signature	Printed Name	Date

By signing and dating here, the PI or QLD certifies that the required annual review (and update, if needed) ofthe Laboratory-Specific Chemical Hygiene Documentation has been completed, and that this document continues to be accurate and to effectively provide for the chemical safety of employees in this laboratory.

Reviewed By:		Reviewed by:	
Reviewed By:		Reviewed by:	
Reviewed By:		Reviewed by:	
Reviewed By:		Reviewed by:	
Reviewed By:		Reviewed by:	
Reviewed By:		Reviewed by:	

LS-CHP Table of Contents

SECTION 1: PERSONNEL

1.1 Safety Personnel

List the names of key safety personnel. In addition to indicating the PI, the QLD (e.g., laboratory manager/supervisor) and key staff, such as DSO, building manager or other important individuals, shouldbe included.

Name:	Position	Phone
	Principal Investigator	
	Qualified Laboratory Designate	
	Departmental Safety Officer	
	Department Head	
	University Chemical Hygiene Officer (EHS)	
	EHS Lab Safety Services Contact	

1.2 Laboratory Staff/Students

List all individuals who work in the laboratories and are subject to this plan.

Name:	Name:	Name:

SECTION 2: LABORATORY ROOM LOCATIONS

List all rooms in which use of hazardous chemical will occur:

Building	Rooms	Room Assigned tothe PI	Shared Facility
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No

This page can be copied to list more areas.

SECTION 3: LABORATORY SPECIFIC RULES AND REQUIREMENTS

Include below all laboratory-specific rules and requirements instituted by the PI (e.g., lab coats must be worn in the lab at all times, no working alone, etc.). This space provides the opportunity to document and place in one location the lab's safety rules and requirements related to the use of hazardous chemicals.

SECTION 4: STANDARD OPERATING PROCEDURES

This section will house all of your standard operating procedures (SOPs). You may use the following ProcedureForms to create SOPs for your lab unit. Examples of SOP's are in the back of this appendix.

4.1 Procedure Form

Title of Procedure: ______________________________

Procedure Control/Ref #: ______________________________

Principal Investigator (PI): ______________________________

Prepared By: ____________ **Revision Date:** ____________

Prior Approval: This procedure is considered hazardous enough that prior approval is needed from thePrincipal Investigator: ☐ Yes ☐ No

Note: Prior Approvals should be documented in Section 7 of this plan.

Involves Use of Particularly Hazardous Substance (PHS)? ☐ Yes ☐ No

☐ Carcinogen ☐ Reproductive Toxin ☐ High Acute Toxicity

Does this procedure require medical surveillance? ☐ Yes ☐ No

Does this require use of a respirator? ☐ Yes ☐ No

Involves Use of Highly Reactive Chemicals? ☐ Yes ☐ No

☐ Air-reactive (pyrophoric) ☐ Water-reactive ☐ Self-reactive ☐ Explosive

Brief Description of Procedure (100 words or less)

Note: written stepwise procedures should be attached or referenced. Procedures with similar hazards andcontrols may be grouped.

Location: *List the locations (buildings/rooms) where this procedure may be performed. For use of a PHS, indicate a more precise location within the room, if appropriate, as the designated area.*

PHS designated area signage posted? ☐ Yes ☐ No

All Hazardous Chemical Involved in This Procedure:

Chemical	Physical or Health Hazard (e.g., carcinogen, corrosive, flammable)

Other Hazards: *Include other hazards (e.g., pressurized vessels, reactions under vacuum, scale-up reactions) other than chemical that may be present during the operation of the procedure.*

Exposure Controls: (Check all that apply)

PPE:

☐ Lab Coat ☐ Face Shield ☐ Chemical Splash Goggles

☐ Flame-Retardant Lab Coat ☐ Gloves (type):______________________________

☐ Safety Glasses ☐ Chemical Apron

☐ Respirator (type) ________________________________

☐ Other:________________________________

____

____

____

Engineering Controls:

☐ Fume Hood ☐ Biosafety Cabinet ☐Glove Box ☐ Vented Gas Cabinet

☐ Other (include controls as local exhaust ventilation, pressure relief valves, intrinsically safe hot plates, automatic shutoffs, enclosures, machine guarding, alarms, etc.)

Administrative Controls: List any specific work practice need to perform this procedure (e.g., cannot be performed alone, must notify other staff members before beginning, etc.).

Task Hazard Control Table: For multistep procedures involving PHS or reactive materials, it may be convenient to indicate specific requirements for individual tasks in the table below:

Task:	Required PPE and/or Engineering Control

Waste Disposal: *Describe any chemical waste generated and the disposal method used:*

Accidental Spills: Describe procedure for handling small chemical spills that may occur during this procedure. The type of spill kit and its location should be indicated. For large spills, call MTSU Fire Marshal at 615-898-2879 or Call 615-898-2424 or 911 for emergencies.

Decontamination Procedures (required for PHS use): *Describe the procedure for decontamination of personnel and equipment.*

Training: *Describe any training needed prior to performing this procedure. Include training performed in-lab and any required demonstrations of competency.*

Principal Investigator Approval: *I have reviewed this procedure and approved it for use. Note: Modifications to the procedure may require updated to this form.*

Name: Signature: Date:

Personnel Acknowledgment: *I have read and understand the content of this procedure and agree to adhere to its requirements.*

Name (Print):	**Signature:**	**Date:**

4.2 Task Table

Prepared By:		Revision Date:	

*For many procedures, a simple description of the tasks, the associated hazards, and the PPE required to mitigate risks is acceptable. This table is **not appropriate** for work involving Particularly Hazardous Substances or for use of chemicals that pose a high risk due to reactivity or other properties. This table isappropriate for describing safety requirements for miscellaneous tasks performed in a laboratory.*

Task	Hazard Description	Required PPE and Engineering Controls

Section 5: LABORATORY SAFETY CONTRACT-ORIENTATION CHECKLIST

A Checklist/Safety Contract for all laboratory personnel listed in Section 1. Must be filled out by each person.

As part of my orientation with the laboratory operation, I acknowledge that I am familiar with the contents (and location) of:

☐ The OSHA Laboratory Standard https://www.osha.gov/laboratories

☐ The MTSU Safety Handbook https://mtsu.edu/ehs/index.php

☐ The MTSU Biosafety Manual (if applicable) *See link below Approved Protocols listed below.*

☐ The MTSU Blood Borne Pathogens Exposure Control Plan & Hepatitis B Vaccination Offer (if applicable) https://www.mtsu.edu/healthservices/clinic.php

☐ Approved Protocols (biosafety, NIH Guidelines, chemical safety, etc.) https://mtsu.edu/biology/laboratory-training/InstitutionalBiosafetyCommitteeForms.php

☐ The MTSU Chemical Hygiene Plan (CHP)

☐ The Laboratory Specific-CHP (LS-CHP)

☐ SDSs for lab chemicals

☐ PSDSs for biological agents (if applicable)

Spill Plans: ☐ Chemical ☐Biological (if applicable)

Biosafety in Microbiological and Biomedical Labs https://www.cdc.gov/labs/BMBL.html

I have been instructed on:

☐ Laboratory-specific safety rules and requirements, including but not limited to: No Food or Drink, No gum, no tobacco products (Including e-cigs), no application of cosmetics, and long hair must be up and out of the way of all lab functions.

☐ Any personnel working with potentially hazardous agents in the laboratory will adhere to proper PPE including closed toe shoes, appropriate shirts and pants, gloves, eye wear, and lab coat. The Principal Investigator (PI) will provide any need PPE for any personnel working in the Lab.

☐ The laboratory will be cleaned prior to and before leaving the laboratory. All hands and arms should be thoroughly washed with soap and water prior to leaving the laboratory for any reason.

☐ The chemical hazards of the laboratory and associated risks (corrosivity, flammability, reactivity, carcinogenicity, toxicity, etc.).

☐ Routes of chemical exposure, relevant exposure limits {PELs (OSHA), TLVs (ACGIH), etc.}, and signs/symptoms of exposure.

☐ The biological hazards of the laboratory (if applicable) and associated risks (infectious aerosol creation, biohazardous-sharps, ingestion risk, etc.)

☐ Routes of biological hazard exposure and the sign and symptoms associated with exposures.

☐ The physical hazards of the laboratory (heat, electrical, mechanical, pressurized vessels, etc.).

☐ All non-laboratory items (coats, backpacks, and personal items must be stored away from lab benches and all laboratory experiments.

☐ All Sharp items including razor blades, needles, and broken glass should be used with extreme caution and must be deposited in to appropriate containers following use.

☐ No removal of cultures, slides, or other biologically active materials from the labs without prior permission from lab supervisor and under specific safety measures.

Section 5: LABORATORY SAFETY CONTRACT-ORIENTATION CHECKLIST, (cont'd)

Reviewed the Laboratory's emergency procedures, Including:

- ☐ Emergency Phone Numbers
- ☐ Procedures for uncontrolled releases
- ☐ Location and use of emergency spill kits and safety devices.
- ☐ Safety Equipment failure procedures
- ☐ Reporting accidents, incidents, exposures, and near misses

The location(s) of emergency equipment:

- ☐ Fire Extinguishers
- ☐ Eye Wash Stations
- ☐ Spill Kits
- ☐ Safety Showers
- ☐ First-Aid Supplies

I have been made familiar with routine operations of the laboratory, including:

- ☐ Lab security requirements
- ☐ Chemical/biological storage policies for the lab
- ☐ Hazard Communication requirements
- ☐ Hazardous Waste Handling Procedures
- ☐ Lab cleaning, disinfection, and maintenance procedures
- ☐ The proper use of chemical fume hoods
- ☐ Proper use, cleaning, and storage of PPE
- ☐ The proper use of biological safety cabinets
- ☐ Chemical procurement practices
- ☐ Handwashing requirements and procedures

In addition, I have been made familiar with the following lab-specific health and safety features and safety resources:

- ☐ Please obtain prior permission from the appropriate University authority for any adult (>18 yrs) visitors to the laboratory. No children (<18 yrs) are allowed in the labs unless they are in compliance with MTSU Policy 101 "Minors Participating in University-Sponsored Programs or Programs Using University Facilities".
- ☐ It is the responsibility of anyone that may have a compromised immune system (including, but not limited to, undergoing chemotherapy, pregnancy, HIV/AIDS positive, coronavirus, taking medications for immunomodulatory treatment of lupus, multiple sclerosis, and sickle cell disease) to discuss laboratory activities and organisms used with their physician. If your physician has concerns about your participation in this laboratory and you decide or intend to participate in research, a waiver of liability must be completed
- ☐ You are required to follow all of the directives in this contract with or without accommodations. If accommodations are needed for you to meet any of the above requirements, please contact the MTSU Disability and Access Center (DAC) at office phone 615-898-2783 or by email at dacemail@mtsu.edu.
- ☐ Any lab work performed in the lab outside of normal lab hours must be done with the instructor's **written permission.** **Both** instructor and student are required to retain a copy of the document

I have completed orientation of all the above items:

Name (Printed) ____________ Signature ____________ Date: ____________

PI or QLD Name: ____________ Signature ____________ Date: ____________

SECTION 6: TRAINING

6.1 Master List of Required Training

List the training required to work with chemicals in your laboratory. This list should include training provided by the university, outside sources, and hands-on training of tasks and procedures providedin-lab. It is understood that the training below does not apply to all students or staff but will be based on eachindividual's work assignments.

Training Title	Description/Purpose	Frequency

6.2 Documentation of Training

Track required training using the table below. A separate sheet should be used for each training course and/or training session.

Training Title: ______________________________

Training Performed by: ______________________________

Description of Training: ______________________________

____

____

Name (Print)	Signature	MTSU M#	Date

SECTION 7: PRIOR APPROVALS

This section of the lab-specific CHP allows the PI to document approval for individuals to perform specific Standard Operating Procedures (as indicated in the SOP description) or other defined high-hazard procedures (e.g., working alone).

Standard Operating Procedure Tile or Activity Description:

____

Name of Approved Individual	PI Authorization Signature	SOP Reference #	Date of Authorization

SECTION 8: SDSs AND INVENTORY OF HAZAROUS CHEMICALS

Several regulations require that Safety Data Sheets (SDSs) be maintained and readily accessible for allhazardous chemicals. The MTSU Chemical Hygiene Plan also requires the maintenance of chemical inventories. Provide a description of where the SDSs are stored and how inventory records are maintained.

Safety Data Sheets

Location of SDSs and Access Instructions:

Format of SDS (Hard Copies, Electronic, etc.,)

Chemical Inventory

Method of Maintaining Inventory:

Location of Inventory Records and Access Instructions:

SECTION 9: EXPOSURE MONITORING RECORDS

In rare instances, it may be necessary to perform personnel exposure monitoring when working with a hazardous chemical. This can occur when chemical exposure levels approach or exceed the Permissible Exposure Limit (PEL) of OSHA and the Threshold Limit Value (TLV) of ACGIH (see Section 4.2, Section 5.3, and Appendix C of the MTSU CHP for details). Initial monitoring is required if there is reason to believe that the action level (or PEL if there is no applicable action level) for a substance is routinely exceeded. If the initial monitoring discloses employee exposure over the action level or PEL an exposure monitoring program may be initiated. Employees must be notified of the results within 15 working days after the receipt of the results by posting in an accessible location.

Describe any exposure monitoring requirement for laboratory operations:
Location of Exposure Monitoring Records and Access Instructions:

SECTION 10: REFERENCES

This section can be used to include chemical or laboratory safety information relevant to the operations of the laboratory. The references can either be appended to the end of this section or references can be cited below.

References:

APPENDIX B

MTSU STUDENT LABORATORY SAFETY CONTRACT

MTSU

MTSU STUDENT LABORATORY SAFETY CONTRACT

Instructor____ Course-Section_______________________________

To ensure an understanding of concepts and the safe execution of experiments in a research laboratory, it is essential that you follow the health and safety rules of proper laboratory conduct.

LABORATORY CONDUCT **Initial after you read and understand each item**

- The consumption of food or drinks is **NOT** allowed in any Biology laboratory at any time. ____________________________
- The use of **all** tobacco products (including e-cigs) is not allowed in the laboratory at any time.__________
- Chewing gum or the application of cosmetics is not allowed in the laboratory at any time. _____
- Appropriate gloves and eye protection must be worn when working with hazardous materials and removed before exiting the laboratory. _______________
- Closed shoes (shoe covering the toes and the top of the foot) are to be worn at all times. ______________
- Coats, backpacks, and other personal items are to be stored away from the work area. Keep only those items on the lab bench that are needed to perform experiments. ___________
- Clean the lab bench with disinfectant (microbiology) before you begin work and again before leaving the laboratory. ______
- Long hair must be tied back to avoid contact with flames of burners and potentially infectious or otherwise hazardous materials. ____
- Sharps (i.e., razor blades, broken glass) should be used with extreme caution and must be deposited in appropriate containers. ____
- Hands and arms should be thoroughly washed with soap and water prior to leaving the laboratory, including leaving for breaks. ____
- Cultures, slides, or other biologically active materials may not be taken from the laboratory without following additional, specific safety measures documented by your lab supervisor. ___________________
- Students are required to report all spills to the professor immediately. Treat all spilled chemicals or cultures as though they are hazardous/pathogenic. _____________________________
- Report any injury to your professor immediately. _______________
- Become familiar with the locations of all safety aids (eyewash and shower stations, first-aid kit, emergency door lock button, and emergency gas shut-off button), along with when and how to properly use them. ____________
- I understand that it is my responsibility to read the Safety Data Sheets (SDSs) **before** I handle any chemicals and/or specimens and follow the recommendations for safe handling of the specific chemical and/or specimen. ________
- Please obtain prior permission from the appropriate University authority for any adult (≥ 18yrs) visitors to the laboratory. No children (< 18yrs) are allowed in the laboratory for any reason. ___________________
- You are required to follow all of the directives in this contract with or without accommodations. If accommodations are needed for you to meet any of the above requirements, please contact the MTSU Disability and Access Center (DAC) at office phone 615-898-2783 or by email at dacemail@mtsu.edu. _
- It is the responsibility of anyone that may have a compromised immune system (including, but not limited to, undergoing chemotherapy, pregnancy, HIV/AIDS positive, coronavirus, taking medications for immunomodulatory treatment of lupus, multiple sclerosis, and sickle cell disease) to discuss laboratory activities and organisms used with their physician. If your physician has concerns about your participation in this laboratory and you decide or intend to participate in research, a waiver of liability must be completed. ____

The rules of laboratory conduct are for your safety and that of other students and laboratory personnel. I, the undersigned, have read the above rules, and agree to observe and abide by them. I understand that failure to do so can result in dismissal from MTSU, the course, if it is associated with my research, and/or a reduction in my course grade.

PRINT NAME: ____

SIGNATURE: ____

DATE: ____

Appendix C

Exposure Limits

Laboratories as workplaces pose unique hazards. There is the potential for exposure to a large number of chemicals; but exposures, if they do occur, tend to be of short duration. All prudent steps should be taken to minimize exposure, but the steps should be risk based. Occupational exposure limits have been set by various organizations such as OSHA, American Conference of Governmental Industrial Hygienists (ACGIH), and National institute of Occupational Safety and Health (NIOSH). Some of the limits are enforceable by law while others are recommendations only, with no legal basis. These limits still perform a needed function in aiding an informed risk assessment process. Below is a brief description of occupational exposure limits.

Permissible Exposure Limits (PELs):
OSHA sets enforceable permissible exposure limits (PELs) to protect workers against the health effects of exposure to hazardous substances. PELs are regulatory limits on the amount or concentration of a substance inthe air. They may also contain a skin designation that serves as a warning of potential cutaneous absorption that should be prevented in order to avoid exceeding the absorbed dose received by inhalation at the PEL. Most OSHA PELs are based on an 8-hour work shift of a 40-hour workweek time weighted average (TWA) exposure that an employee may be exposed to for a working lifetime without adverse effects. Some of the PELs are listed as ceiling values – concentrations above which a worker should never be exposed, or short-term exposure limits (STELs) – average concentrations that should not be exceeded over a 15-minute period. To locate PELs on specific chemicals go to: 29 CFR 1910.1000 TABLE Z-1.

Threshold Limit Value (TLV®):

Threshold Limit Value (TLV) are occupational exposure limit set by the American Conference of Governmental Industrial Hygienists (ACGIH). The time-weighted average TLV (TWA-TLV) is an airborne concentration of a gas or particle to which most workers can be exposed on a daily basis for a working lifetime without adverse effect (assuming an average exposure on the basis of an 8h/day, 40h/week work schedule). Additionally, ACGIHdefines:

- Threshold Limit Value Short-term exposure limits (TLV-STEL) which are concentrations above which a worker should not beexposed (averaged over 15 minutes). Exposures cannot be repeated more than 4 times per day;
- Threshold Limit Value Ceiling limits (TLV-C) which are concentrations above which a worker should never be exposed.

Recommended Exposure Limits (RELs)
Recommended Exposure Limits (RELs) were developed the National Institute for Occupational Safety and Health (NIOSH). NIOSH is the principal federal agency engaged in research, education, and training related tooccupational safety and health. The REL is a level that NIOSH believes would be protective of worker safety and health over a working lifetime if used in combination with engineering and work practice controls, exposure, and medical monitoring, posting, and labeling of hazards, worker training and personal protective equipment. RELs are not legally enforceable.

NIOSH is well known for its NIOSH Pocket Guide to Chemical Hazards. In addition to containing RELs, it alsohas information on incompatibilities and reactivity, exposure routes, symptoms of exposure, target organs, potential cancer site, PPE, and first aid. A searchable version of the guide can be found at http://www.cdc.gov/niosh/npg/. The pocket guide can also be downloaded from this site.

Immediately Dangerous to Life or Health (IDLH)
NIOSH also provides concentrations for chemicals that it considers Immediately Dangerous to Life or Health (IDLH). NIOSH defines an IDLH condition as a situation "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment." IDLH values can be found in the NIOSH Pocket Guide toChemical Hazards (see link above). The purpose for establishing this IDLH value was to determine a concentration from which a worker could escape without injury or without irreversible health effects. In determining IDLH values, the ability of a worker to escape without loss of life or irreversible health effects wasconsidered along with severe eye or respiratory irritation and other effects (e.g., disorientation or incoordination) that could prevent escape. As a safety margin, IDLH values were based on the effects that might occur because of a 30-minute exposure.

Workplace Environmental Exposure Levels (WEELs)
The American Industrial Hygiene Association (AIHA) developed worker exposure levels for health-based chemicals. Since most of the other worker protection limits are for commonly used industrial chemicals, AIHA began developing Workplace Environmental Exposure Levels (WEELs) to meet a specific need. WEELs are air concentration guide values for agents in a healthy worker's breathing zone. WEELs are not enforceable but provide a good guideline when no other guidance exists.

In 2003, the development of WEELs has been managed by the non-profit organization TERA/Occupation Alliance for Risk Science (OARS). Prior to 2013, the values for chemicals are listed in the column header ACGIH. Post 2013, chemicals with a WEEL are listed under the column heading OARS. This list may accessed at: www.tera.org/OARS/#reservations.

APPENDIX D
CHEMICAL FUME HOOD

Laboratory fume hood is a ventilated enclosure in a laboratory,in which harmful volatile chemicals can be used. It is a safety device designed to limit exposure to hazardous or toxic fumes, vapors, mists, and particulate matter generated with the hood interior.
The OSHA's Laboratory standard Laboratory Standard: (29 CFR 1910.1450) requires that fume hood be maintained and functionproperly before and when in use.

Before using a fume hood:

- Make sure that you understand how the hood works.
- You should be trained to use it properly.
- Know the hazards of the chemical you are working with; refer to the chemical's Safety Data Sheet (SDS) if you areunsure.
- Ensure that the hood is on.
- Make sure that the air gauge indicates that the air flow is within the required range.
- Make sure that the sash is open to the proper operating level, which is usually indicated by arrows on the frame.

When using the fume hood:

- Never allow your head to enter the plane of the hood opening. For example, for vertical rising sashes, keep the sash should be approximately equal to the height of the user's elbows; for horizontal sliding sashes, keep thesash positioned in front of you and work around the side of the sash.

- Use appropriate eye protection.
- Be sure that nothing blocks the airflow through the baffles orthrough the baffle exhaust slots.
- Elevate large equipment (e.g., a centrifuge) at least twoinches off the base of the hood interior.
- Keep all materials inside the hood at least six inches from thesash opening. When not working in the hood, close the sash. Do not permanently store any chemicals inside the hood.
- Keep materials stored in hoods to a minimum to reduce clutter.
- Place chemical/hazardous waste containers that are stored temporarily in the hood in secondary containment trays, tubs, etc.
- When working a fume hood, keep windows and door closed within the lab and minimize traffic in front of the hood.
- Minimize rapid movements while working in the hood, including opening and closing the sash. These will help to prevent air currents from forming, resulting hazardous vapors being pulled out of the of hood into the users breathing zone.
- Run equipment cords, hoses, and tubing under the fume hood foil and then up onto the fume hood's surface whenever feasible. This will allow you to fully close the sash and minimizes pinch points on cords and tubing/hoses.
- **Do not** use fume hoods to evaporate hazardous waste. This is illegal.
- Promptly report any hood that is not functioning properly to your supervisor. The sash should be closed, and the hood "tagged" and taken out of service until

All fume hoods must be inspected and certified annuallyto determine a proper face velocity of 100fpm ± 10%. EH&S will ensure that all hoods are certified annually. A current sticker would be placed on the fume hood after certification.

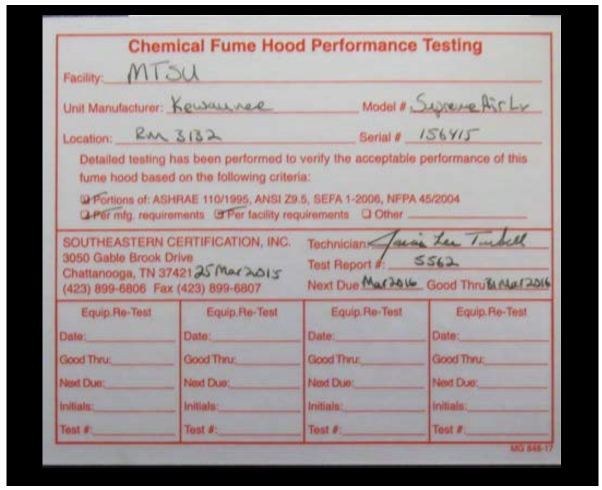
Contact EH&S at 615-898-8575 or EHS@MTSU.edu in case of emergency

repairs can be completed.

- When pouring flammable liquids, always make sure both containers are electrically interconnected to each other by bonding and grounding in order to prevent the generation of static electricity – which can cause the flammable liquid to ignite.
- As with any work involving chemicals, it is always good to practice good housekeeping and **cleanup all chemical spills immediately**. Be sure to wash both the working surface and hood sash frequently and always maintain a clean and dry work surface that is free of clutter.
- When using extremely hazardous chemicals, understand your laboratory's action plan in case an emergency, such as a power failure, occurs.

Annual Certifications

- Verify the hood has been tested and is within the compliance dates.
- Look for the "Chemical Fume Hood Performance Testing" sticker on the side of the hood for compliance.
- If no current signage, do not use and notify EHS for testing and recertification



Adopted Fume Hood Policy (October 2022)

If for whatever reason:

1. The Fume Hood should lose power and not work properly for more than 2 minutes:
   a. Sashes should be pulled down and Laboratory should be evacuated, and door(s) shut and locked.
   b. Please inform your research teams, Laboratory Primary Contact(s), Department Chairpersons, and Environmental Health and Safety Services as soon as possible.
2. If the entire building's fume hoods are down for more than 60-minutes (due to extended power outage), everyone is to evacuate the ENTIRE building and go to the fire escape plan meeting places.

Appendix E
Personal Protective Equipment Training Certification Form

Employee's Name:________________________________ MTSU Personnel Number __________________

Job Title/Work area: ____

Principal Investigator/Supervisor: ____

Trainer's Name (person completing this form):____

Date of Training:__________________________________

Types of PPE employee is being trained to use:

____ ____

____ ____

____ ____

The following information and training on the personal protective equipment (PPE) listed above were coveredin the training session:

- ☐ The limitations of personal protective equipment: PPE alone cannot protect the employee from on-the-jobhazards.
- ☐ What workplace hazards the employee faces, the types of personal protective equipment that the employee must use to be protected from these hazards, and how the PPE will protect the employee while doing his/hertasks.
- ☐ When the employee must wear or use the personal protective equipment.
- ☐ How to use the personal protective equipment properly on-the-job, including putting it on, taking it off, andwearing and adjusting it (if applicable) for a comfortable and effective fit.
- ☐ How to properly care for and maintain the personal protective equipment: look for signs of wear, clean anddisinfect, and dispose of PPE.
- ☐ How to store the non-disposable PPE so it is not contaminated or damaged during storage.

Note to employee: *This form will be made a part of your laboratory records. Please read and understandits contents before signing.*

(Employee) I understand the training I have received, and I can use PPE properly.

Employee's signature:____Date_______________________

(Trainer must check off)

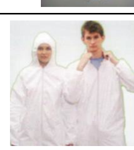
☐ Employee has shown an understanding of the training.

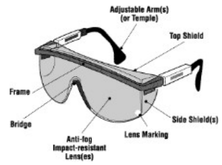
☐ Employee has shown the ability to use the PPE properly.

Trainer's signature:______________________________________Date: ______________________

Types and Examples of PPE

PPE	Specific Type	Characteristics	Applications
Light latex, vinyl or nitrile gloves	Disposable Latex Gloves 	Powdered or un-powdered	Working with biological hazards (known or potentially known infectious materials including work with animals)
	Disposable nitrile gloves 	Puncture, abrasion resistant, protection from splash hazards	Working with biological hazards and chemical splash hazards
	Disposable vinyl gloves 	Economical, durable, similar to latex	Working with biological hazards
Light chemical resistant gloves	Natural rubber latex 	Chemical resistant, liquid-proof	Working with small volumes of corrosive liquids, organic solvents, flammable organic compounds
Light to heavy chemical resistant gloves	Nitrile gloves 	Chemical resistant, good puncture, cut, and abrasion resistance	Apparatus under pressure, air or water reactive chemicals
Heavy chemical resistant gloves	Butyl gloves 	High permeation resistance to most chemicals	Large volumes of organic solvents, small to large volumes of dangerous solvents, acutely toxic or hazardous materials
	Viton II gloves 	High permeation resistance to most chemicals	Same as butyl gloves, plus hazardous material spills
	Butyl/Silver Shield gloves and apron 	Extra chemical and mechanical protection	Same as butyl and Viton II gloves, added mechanical protection, hazardous material spills

PPE	Specific Type	Characteristics	Applications
Insulated gloves	Terrycloth autoclave gloves 	Heat resistant	Working with hot liquids and equipment, open flames, water bath, oil bath
	Cryogen gloves 	Water resistant or water proof, protection against ultra-cold temperatures	Cryogenic liquids handling
Wire mesh gloves		Cut resistant	Working with live animals
Chemical resistant apron	Rubber-coated wash apron 	Chemical splash protection, good abrasion resistance	Working with apparatus under pressure, air or water reactive chemicals, large volumes of corrosive liquids
	Neoprene apron and sleeves 	Chemical resistant, tear resistant; splash protection	Water or air reactive chemicals, large volumes of corrosive liquids, small to large volumes of acutely toxic corrosives
Lab Coats	Knee length 	Protects skin and clothing from dirt, inks, non-hazardous chemicals, biohazards without aerosol exposure	General use; Chemical, Biological, Radiation, and Physical Hazards
	Flame resistant 	Flame resistant (e.g., Nomex or flame resistant cotton)	Working with water or air reactive chemicals, large volumes of organic solvents, potentially explosive chemicals
Gowns	Disposable gowns 	Clothing and skin protection	Working with biohazards
	Tyvek 	High tear resistance, protection from particulates	Working with biohazards with potential for exposure to airborne transmissible disease

PPE	Specific Type	Characteristics	Applications
Safety glasses		Polycarbonate lens, side shields for eye protection; meets ANSI and OSHA specifications	Working with physical hazards; laboratory work
Goggles		Tight fitting, protects eyes from impact, spray, paint, chemicals, flying chips, dust particles; polycarbonate lens, indirect ventilation, meets ANSI and OSHA specifications	Working with large volumes of corrosive liquids, small to large volumes of acutely toxic corrosives; working with large volumes of organic solvents, acutely toxic or hazardous chemicals, etc.
	Laser goggles 	Appropriately shaded goggles; optical density based on beam parameters	Working with Class 3 or Class 4 lasers
Face shield		Chemical resistant face shield	For use with mild acids, caustics, aromatic hydrocarbons, methylene chloride; splash hazard; air or water reactive or potentially explosive chemicals
Safety shield		Acrylic, weighted shield, three-sided, benchtop shield, frosted edges	Protects from chemical splash, beta radiation, exposure to bloodborne pathogens
Respirators	Surgical mask 	Used for bacterial filtration	Working with live animals; working with infectious material with potential aerosol exposure
	N-95 	Protects against dusts, fumes, mists, microorganisms	Working with live animals or infectious materials with known airborne transmissible disease; dusty environments

APPENDIX F
PARTICULARLY HAZARDOUS SUBSTANCES

When working with hazardous materials, laboratory personnel need to understand the risks associated with these chemicals. Once the hazards are known, then steps can be taken to minimize the risk associated with the hazard. Such steps include appropriate PPE and engineering controls, such as fume hoods. OSHA requires thatspecial provisions be taken when working with Particularly Hazardous Substances (PHS) since these substances potentially pose a higher health risk. PHS are, according to OSHA, select carcinogens, reproductive toxins, substances that have a high degree of acute toxicity.

The OSHA requirements for working with PHS are more a matter of degree than a clear-cut differentiation from other substances. Risk assessments must always be done. The Laboratory Standard simply requires that higher risk materials be identified and mandates that extra precautions be used, as necessary.

Laboratory personnel must do their due diligence in determining hazards when planning an experiment or procedure. This appendix provides some information and links to resources that help you identify PHS. It is impossible to provide a master list of all PHS so the information below should not be assumed to be comprehensive. This is especially true at a research institution where exotic materials lacking toxicological information are often used. Additionally, toxicity is often related to a chemical's physical state as well as how it is used. For example, compounds that are not considered highly dangerous may pose a much greater risk in the form of a nanoparticle. It is for this reason that prudent practices should always be taken to minimize exposures.

Carcinogens

Select carcinogens are any substances that meet one of the following criteria:

- It is regulated by OSHA as a carcinogen;
- It is listed under the category "known to be carcinogens," in the Annual Report on Carcinogenspublished by the National Toxicology Program (NTP; latest edition);
- It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research onCancer Monographs (IARC; latest edition);
- It is listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to becarcinogens" by NTP.

The National Toxicology Program has a website that provides the most recent list of materials known or reasonably anticipated to be carcinogenic. The website also provides a profile for each of the chemicals summarizing the carcinogenicity, properties, uses, and exposure routes for the substance. The website can be accessed at: https://ntp.niehs.nih.gov/whatwestudy/assessments/cancer/roc/index.html.

A list of all the materials for which the IARC has issued reports can be found at: https://monographs.iarc.who.int/wp-content/uploads/2018/09/ClassificationsAlphaOrder.pdf.

This site also indicates the category the material falls under, with Group 1, 2A, and 2B being the chemical of greatest concern.

Reproductive Toxins

Reproductive toxins, according to OSHA, are chemicals that affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). The Environmental Health and Safety Office at Iowa State University has compiled a list of carcinogens, reproductive toxins, and teratogens on their website. This can be accessed at: https://www.ehs.iastate.edu/publications/factsheets/CarcReproTerat.pdf.

Highly Toxic Compounds

OSHA defines substances that have a high degree of acute toxicity as substances that are "fatal or cause damageto target organs as a result of a single exposure or exposures of short duration". According to OSHA, a chemicalfalling within any of the following categories is considered highly toxic:

- Oral LD50 - A chemical that has a median lethal dose (LD50) of 50 milligrams or less per kilogram of body weightwhen administered orally to albino rats weighing between 200 and 300 grams each;
- Skin LD50 - A chemical that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with thebare skin of albino rabbits weighing between two and three kilograms each;
- Respiratory LD50 - A chemical that has a median lethal concentration (LC50) in air of 200 parts per million by volume orless of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

A complete list of all highly toxic compounds is impossible to compile. The compounds listed in **Table F1** wereobtained from Penn State University. This list is provided as an aid. Laboratory personnel must still do their due diligence when performing a risk assessment. Consult other sources, particularly the CHO/EHS, whenever possible. The SDS should also be consulted as it often has GHS or NFPA health ratings for the compounds.

Table F1
List of Highly Toxic Compounds

Compound Name	CAS #
ACETONE CYANOHYDRIN (DOT)	75-86-5
3-(ALPHA-ACETONYLBENZYL)-4-HYDROXYCOUMARIN	81-81-2
ACROLEIN, INHIBITED (DOT)	107-02-8
ACTIDIONE	66-81-9
ACTINOMYCIN D	50-76-0
AFLATOXINS	1402-68-2
ALDRIN (DOT)	309-00-2
ALLYL BROMIDE (DOT)	106-95-6
ALLYL ISOTHIOCYANATE	57-06-7
ALLYLIDENE DIACETATE	869-29-4
ALUMINUM PHOSPHIDE (DOT)	20859-73-8
AMINO PYRIDINE, 2-	504-29-0
AMINOPTERIN	54-62-6
AMINOPYRIDINE, 4-	504-24-5
ANTU (NAPHTHYLTHIOUREA, ALPHA-)	86-88-4
ARSENIC ACID, SODIUM SALT (SODIUM ARSENATE)	7631-89-2
ARSENIC ACID, SOLUTION	7778-39-4
ARSENIC IODIDE	7784-45-4
ARSENIC PENTASULFIDE	1303-34-0
ARSENIC PENTOXIDE (DOT)	1303-28-2
ARSENIC TRICHLORIDE	7784-34-1
ARSENIC TRIOXIDE	1327-53-3
ARSENIC TRISULFIDE	1303-33-9
ARSENIOUS ACID (ARSENIC TRIOXIDE, SOLID)	1327-53-3
ARSENIOUS OXIDE (ARSENIC TRIOXIDE, SOLID)	1327-53-3
ARSINE	7784-42-1

Table F1 (cont'd)
List of Highly Toxic Compounds

Compound Name	CAS #
AZINPHOS-METHYL	86-50-0
AZIRIDINE	151-56-4
BAY 25141	115-90-2
BENZEDRINE	300-62-9
BENZENETHIOL (PHENYL MERCAPTAN) (DOT)	108-98-5
BIDRIN	141-66-2
BORON TRIFLUORIDE	7637-07-2
BUSULFAN	55-98-1
BUTANEDIOL DIMETHYLSULFONATE, 1,4-	55-98-1
BUTYL-4,6-DINITROPHENOL, 2-SEC-	88-85-7
CALCIUM ARSENATE, SOLID	7778-44-1
CALCIUM CYANIDE	592-01-8
CARBON OXYFLUORIDE	353-50-4
CARBONYL CHLORIDE	75-44-5
CARBONYL FLUORIDE	353-50-4
CARBONYL SULFIDE	463-58-1
CHLORINATED DIPHENYL OXIDE	31242-93-0
CHLORINE (DOT)	7782-50-5
CHLORINE PENTAFLUORIDE	13637-63-3
CHLORINE TRIFLUORIDE	7790-91-2
CISPLATIN	15663-27-1
CYANOGEN	460-19-5
CYANOGEN CHLORIDE	506-77-4
CYCLOHEXIMIDE	66-81-9
CYCLOPHOSPHAMIDE	50-18-0
DASANIT	115-90-2

Table F1 (cont'd)
List of Highly Toxic Compounds

Compound Name	CAS #
DAUNOMYCIN	20830-81-3
DDVP (DICHLORVOS)	62-73-7
DEMETON, MIXED ISOMERS	8065-48-3
DICHLORO-N-METHYLDIETHYLAMINE, 2,2'-	51-75-2
DICHLORVOS	62-73-7
DICROTOPHOS	141-66-2
DIELDRIN (DOT)	60-57-1
DIETHYL S-[2-(ETHYLTHIO)ETHYL]PHOSPHORODITHIOATE, O-	298-04-4
DIETHYLHYDRAZINE, 1,2-	1615-80-1
DIISOPROPLY FLUOROPHOSPHATE	55-91-4
DIMETHYL MERCURY	593-74-8
DINITRO-O-CRESOL, 4,6-	534-52-1
DINITROPHENOL, 2, 4-	51-28-5
DINOSEB	88-85-7
DIOXATHION	78-34-2
DISULFOTON	298-04-4
DNBP	88-85-7
ENDOSULFAN	115-29-7
ENDRIN	72-20-8
EPN	2104-64-5
ETHION	563-12-2
ETHYLENEIMINE (DOT)	151-56-4
FENAMIPHOS	22224-92-6
FENSULFOTHION	115-90-2
FLUOROACETIC ACID, SODIUM SALT	62-74-8
FONOFOS	944-22-9

Table F1 (cont'd)
List of Highly Toxic Compounds

Compound Name	CAS #
GLYCOLONITRILE	107-16-4
GUTHION	86-50-0
HEPTACHLOR	76-44-8
HEPTACHLOR EPOXIDE	1024-57-3
HYDROCYANIC ACID, LIQUIFIED	74-90-8
HYDROGEN CHLORIDE GAS	7647-01-0
HYDROGEN CYANIDE	74-90-8
HYDROGEN FLUORIDE GAS	7664-39-3
HYDROXY-3(3-OXO-1-PHENYLBUTYL)-2H-1-BENZOPYRAN-2-ONE	81-81-2
IRON PENTACARBONYL	13463-40-6
LANNATE	16752-77-5
MELPHALAN	148-82-3
MERCURIC CHLORIDE	7439-97-6
METHYL CYCLOPENTADIENYL MANGANESE TRICARBONYL, 2-	12108-13-3
METHYL HYDRAZINE	60-34-4
METHYL IODIDE	74-88-4
METHYL MERCURY	593-74-8
METHYL PARATHION, LIQUID	298-00-0
METHYL VINYL KETONE, INHIBITED (DOT)	78-94-4
METHYL-BIS(2-CHLOROETHYL) AMINE (NITROGEN MUSTARD), N-	51-75-2
METHYL-N-NITROSO-METHANAMINE,N-	62-75-9
METHYLAZIRIDINE, 2- (PROPYLENEIMINE, INHIBITED)	75-55-8
METHYLHYDRAZINE (DOT)	60-34-4
METHYLPROPYL)-4,6-DINITRO-PHENOL,2-(1-	88-85-7
MEVINPHOS	7786-34-7
MITOMYCIN C	50-07-7

Table F1 (cont'd)
List of Highly Toxic Compounds

Compound Name	CAS #
MONOCROTOPHOS	6923-22-4
MYLERAN	55-98-1
NAPHTHYLTHIOUREA, ALPHA-	86-88-4
NITROGEN MUSTARD	51-75-2
NITROSODIMETHYLAMINE, N-	62-75-9
PARAQUAT, RESPIRABLE FRACTION	2074-50-2
PERFLUOROISOBUTYLENE	382-21-8
PHENYL MERCAPTAN (DOT)	108-98-5
PHENYLPHOSPHINE	638-21-1
PHORATE	298-02-2
PHOSDRIN (MEVINPHOS)	7786-34-7
PHOSGENE	75-44-5
PHOSHONOTHIOIC ACID, O-ETHYL O-(P-NITROPHENYL)ESTER,	2104-64-5
PHOSPHINE	7803-51-2
PHOSPHORUS PENTAFLUORIDE	7641-19-0
POTASSIUM CYANIDE, SOLID (DOT)	151-50-8
PREMERGE	88-85-7
PROPANENITRILE	107-12-0
PROPIONITRILE	107-12-0
PROPYLENEIMINE, INHIBITED (DOT)	75-55-8
SODIUM AZIDE	26628-22-8
SODIUM CYANIDE, SOLID (DOT)	143-33-9
STRYCHNINE, SOLID (DOT)	57-24-9
SULFOTEP	3689-24-5
SYSTOX	8065-48-3
TETRACHLORODIBENZO-P-DIOXIN, 2,3,7,8- (TCDD)	1746-01-6

Table F1 (cont'd)
List of Highly Toxic Compounds

Compound Name	CAS #
TETRAETHYL DITHIOPYROPHOSPHATE (TEDP)	3689-24-5
TETRAETHYL LEAD, LIQUID	78-00-2
TETRAETHYLPYROPHOSPHATE, LIQUID	107-49-3
THIODAN (ENDOSULFAN)	115-29-7
THIOPHENOL (PHENYL MERCAPTAN) (DOT)	108-98-5
TRIETHYLENETHIOPHORAMIDE, N,N',N''-	52-24-4
TRIMETHYLENETRINITRAMINE	121-82-4
URACIL MUSTARD	66-75-1
VANADIUM PENTOXIDE	1314-62-1
VAPATONE (TETRAETHYLPYROPHOSPHATE, LIQUID)	107-49-3
WARFARIN	81-81-2

APPENDIX G:
CHEMICAL STORAGE LIMITS

The University is subject to the International Fire Code (IFC), by virtue of it being adopted by the Murfreesboro Fire and Rescue Department (MFRD), as well as the International Building Code (IBC) since MFRD has adopted the 2017 version of the IFC. MFRD also enforces sections of the National Fire Protection Association (NFPA) standards since these have been adopted by IFC reference.

The tables in this section attempt to portray the limits that are imposed by the codes mentioned above. The entire table can be accessed at the IFC website: https://codes.iccsafe.org/content/IFC2018/chapter-50-hazardous-materials-general-provisions. The Maximum Allowable Quantities (MAQs) listed below are per control area. As discussed in Section 6.1 of this document, a laboratory is not necessarily a control area – it may consist of more than one laboratory. These limits are therefore guidelines since it is beyond the scope of this document to provide information on each campus building. Most laboratories are unlikely to exceed the MAQs. In instances where the MAQs are approached, it is often possible to reduce the inventory on-hand by making minimal changes to procedures. Contact the Chemical Safety Office if you have any questions concerning the limits. Note: Only a few facilities have been specifically constructed to allow quantities in excess of the MAQs.

Table G1 This table provides a list of MAQs based on the class of material. The MAQs are defined below for the ground floor level (floor 1). Higher level floors and below grade floors decrease the MAQ as indicated in Table G2. The table includes storage limits and limits for usage in an open or closed system. IFC defines "open" and "closed" systems as the following:

> *OPEN SYSTEM*. The use of a solid or liquid hazardous material involving a vessel or system that is continuously open to the atmosphere during normal operations and where vapors are liberated, or the product is exposed to the atmosphere during normal operations. Examples of open systems for solids and liquids include dispensing from or into open beakers or containers, dip tank and plating tank operations.
>
> *CLOSED SYSTEM*. The use of a solid or liquid hazardous material involving a closed vessel or system that remains closed during normal operations where vapors emitted by the product are not liberated outside of the vessel or system and the product is not exposed to the atmosphere during normal operations; and all uses of compressed gases. Examples of closed systems for solids and liquids include product conveyed through a piping system into a closed vessel, system, or piece of equipment.

Additional definitions are supplied at the end of this Appendix. When viewing Table G1 note the footnotes below the Tables. These indicate building or containment features that may increase the MAQs or, in some instances, are required. Also, the aggregate quantity in use and storage cannot exceed the quantity listed for storage. Table E1 assumes the laboratory is on the ground floor.

Table G1. International Fie Code (IFC 2017) Maximum Allowable Quantities (MAQ) in Storage per Fire Controlled Areas

Hazardous Material	Class	Storage	Use (Closed System)	Use (Open System)
Flammable Liquid (Gallons)	1A	30[1,2]	30[1]	10[1]
	1B or 1C	120[1,2]	120[1]	30[1]
Combustible Liquids (Gallons)	II	120[1,2]	120[1]	30[1]
	IIIA	330[1,2]	330[1]	80[1]
Flammable gas, gaseous (cubic feet)		1000[1,2]	1000[1,2]	NA
Flammable gas, liquefied (pounds)		150[1,2]	150[1,2]	NA
Flammable solid (pounds)		125[1,2]	125[1]	25[1]
Cryogenics, flammable (pounds)		45[1]	45[1]	10[1]
Cryogenics, oxidizing (pounds)		45[1]	45[1]	10[1]
Organic Peroxide (Pounds)	UD	1[2,4]	0.25[4]	0.25[4]
	I	5[1,2]	1[1]	1[1]
	II	50[1,2]	50[1]	10[1]
	III	125[1,2]	125[1]	25[1]
Highly Toxic gases, gaseous (cubic feet)		20[1]	20[1,3]	NA
Highly Toxic gases, liquefied (pounds)		4[1,3]	4[1,3]	NA
Highly Toxic liquids or solids (pounds)		10[1,2]	10[1]	3[1]
Toxic gases, gaseous (cubic feet)		810[1,2]	810[1,2]	NA
Toxic gases, liquefied (pounds)		150[1,2]	150[1,2]	NA
Toxic liquids or solids (pounds)		500[1,2]	500[1]	125[1]
Oxidizing gas, gaseous (cubic feet)		1500[1,2]	15001,2	
Oxidizing gas, liquefied (pounds)		150[1,2]	150[1,2]	
Pyrophoric solids or liquids (pounds)		4[2,4]	1[4]	0
Pyrophoric gases (cubic feet)		50[2,4]	10[2,4]	0

Table G1. International Fie Code (IFC 2017) Maximum Allowable Quantities (MAQ) in Storage per Fire Controlled Areas

Hazardous Material	Class	Storage	Use (Closed System)	Use (Open System)
Unstable (Reactive) solids or Liquids (Pounds)	4	1[2,4]	0.25[4]	0.25[4]
	3	5[1,2]	1[1]	1[1]
	2	50[1,2]	50[1]	50[1]
Unstable (Reactive) Gases (Cubic Feet)	4	10[2,4]	2[2,4]	
	3	50[1,2]	10[1,2]	
	2	250[1,2]	250[1,2]	
Water Reactive (Pounds)	3	5[1,2]	5[1]	1[1]
	2	50[1,2]	50[1]	10[1]
Corrosive, solids (pounds)		5000[1,2]	5000[1]	1000[1]
Corrosive, liquids (gallons)		500[1,2]	500[1]	100[1]
Corrosive, gases (cubic feet)		810[1]	810[1]	
Corrosive, liquified gas (pounds)		150[1]	150[1]	

NA = Not applicable; a cubic foot = 0.0283 m^3; 1 pound = 0.454 kg.; 1 gallon = 3.785 L.

[1] Maximum quantities shall be increased 100% (Table G1) for buildings equipped throughout with an automatic sprinkler. Where note 2 also applies the increase for both notes are to be applied accumulatively.

[2] Maximum allowable quantities are to be increased up to 100% when stored in approved storage cabinets, gas cabinets, exhausted enclosures, or safety cans as specified in IFC. Where note 1 also applies the increase for both notes are to be applied accumulatively.

[3] Allowed only when stored in approved exhausted gas cabinets or exhausted enclosures as specified in the International Fire Code.

[4] Permitted only in buildings equipped throughout with an automatic sprinkler system.

Additional Notes:

- The combined amounts of all classes (IA, IB, and IC) of flammable liquids cannot exceed the limits for the limits stated for (IB and IC).
- For chemicals that fit into multiple categories, the most restrictive limits apply

Table G2 The MAQs defined in Table D1 are defined for first floor occupancies. Other floors (both above and below grade) have lower MAQs based on a percentage of the 1st floor MAQ. Table G2 provide these percentages as well as the number of allowable control areas per floor.

Table G2: % MAQs and No. of Control Areas by Floor

Floor Level	% of MAQ per Control Area	No. of Control Areas
1	100	4
2	75	3
3	50	2
4 through 6	12.5	2
7 through 9	5	2
10 and above	5	1
Below Grade Level 1	**75**	**1**
Below Grade Level 2	**50**	**1**

Table G3 NFPA 45 *Standard on Fire Protection for Laboratories Using Chemicals* sets limits on the quantities of flammable and combustible liquids that can be stored in any one container based on the construction of the container. Aggregate quantities must still be below the amounts indicated by Tables G1 and G2.

Table G3. Maximum Allowable Size of Containers

Container Type	Flammable Liquids			Combustible Liquids	
	Class IA	Class IB	Class IC	Class II	Class III
Glass or approved plastic	1 pt.	1 qt.	1 gal.	1 gal.	1 gal.
Metal (other than DOT drums)	1 gal.	5 gal.	5 gal.	5 gal.	5 gal.
Safety cans	2 gal.	5 gal.	5 gal.	5 gal.	5 gal.
Metal drums (DOT specifications)	60 gal.	60 gal.	60 gal.	60 gal.	60 gal.
Approved portable tanks	660 gal.	660 gal.	660 gal.	660 gal.	660 gal.

Table G4 The following chart lists the maximum volume of flammables and combustibles that can be stored in a single flammable storage cabinet. Again, quantities in a given control area cannot exceed MAQs listed above.

Table G4. Maximum Storage Quantities for a Flammable Storage Cabinet

MAXIMUM STORAGE QUANTITIES FOR CABINETS	
Liquid Class	**Maximum Storage Capacity**
Flammable/Class I	60 Gal.
Combustible/Class II	60 Gal.
Combustible/Class III	120 Gal.
Combination of classes	120 Gal.

Not more than 60 gallons may be Class I and Class II liquids. No more than 120 gallons of Class III liquids may be stored in a storage cabinet, according to OSHA 29 CFR 1910.106(d)(3) and NFPA 30 Section 4-3.

Table G5 The IFC limits the quantities of flammable liquids that can be stored in a control area. The MAQs are based on the classification of the flammable liquids. The following table provides NFPA classification information for some common solvents. The NFPA fire diamond information is often found on containers or in SDSs. Liquids with a flammability rating of 3 are considered Class IB and IC liquids while those with a flammability rating of 4 are Class IA.

Note that Class IA, IB, and IC are flammable liquids. Class II liquids are combustible.

Table G5. Flammable Liquid Storage, Properties and Classification

Chemical	**Flash Point (℉/ ℃)**	**Boiling Point (℉/ ℃)**	**IFC Classification**
Acetic acid	103/39	245/118	II
Acetone	-4/-20	133/56	1B
Acetaldehyde	-38/-39	70/21	IA
Acetonitrile	42/6	179/82	IB
Acrylonitrile	32/0	171/77	IB
Benzene	12/-11	176/80	IB
t-Butyl Alcohol	52/11	181/83	IB
Cyclohexene	20/-7	181/83	IB
Dioxane	54/12	214/101	IB
Ethyl Acetate	24/-4	171/77	IB

Table G5. Flammable Liquid Storage, Properties and Classification (Cont'd)

Chemical	Flash Point (℉/ ℃)	Boiling Point (℉/ ℃)	IFC Classification
Ethyl Alcohol	55/13	173/78	IB
Ethyl Ether	-49/-45	95/35	IA
Gasoline	-45/-43	100-400/38-204	IB
Hexane	-7/-22	156/69	IB
Isopropanol	53/12	183/83	IB
Methanol	52/11	174/64	IB
Methylene Chloride	none	104/40	-
Methyl Ethyl Ketone	16/-9	176/80	IB
Pentane	-40/	97/36	IA
Petroleum Ether	0/-18	95-140/35-60	IA-IB
Propyl Alcohol	74/23	207/97	IC
n-Propyl Ether	70/21	194/90	IB
Pyridine	68/20	239/115	IB
Tetrahydrofuran	6/-14	151/66	IB
Toluene	40/4	230/111	IB
Triethylamine	16/-7	193/89	IB
m-Xylene	77/25	282/138	IC

Table G6 The following table provides information on the hazards associated with common gases. This will aid risk assessments and also help determine MAQs. Since gases can fall into multiple categories (such as flammable and highly toxic) the most restrictive MAQ applies**.**

Table G6. Hazards of Common Gases

Gas	Asphyxiant	Flammable	Oxidizer	Corrosive	Toxic	Highly Toxic	Pyrophoric	LC_{50}/PEL (ppm)
Ammonia (NH_3)				X	X			4000/50
Arsine (AsH_3)		X				X		20/0.05
Boron Tribromide (BBr_3)				X	X			380/1
Boron Trichloride (BCl_3)				X	X			2541/5
Bromine (Br_2)			X	X		X		113/0.1
Chlorine (Cl_2)			X	X	X			293/1
Chlorine Dioxide (ClO_2)			X		X			250/0.1
Chlorine Trifluoride (ClF_3)			X		X			299/0.1
Diborane (B_2H_6)		X				X	X	80/0.1
Dichlorosilane (SiH_2Cl_2)		X		X	X			314/5
Ethylene Oxide (C_2H_4O)		X			X			4350/1
Fluorine (F_2)			X	X		X		185/0.1
Germane (GeH_4)		X			X			622/0.2
Hydrogen (H_2)	X	X						
Hydrogen Bromide (HBr)				X				2860/3
Hydrogen Chloride (HCl)				X				2810/5
Hydrogen Cyanide (HCN)		X				X		40/10
Hydrogen Fluoride (HF)				X	X			1300/3
Methyl Bromide (CH_3Br)		X			X			1007/20
Nickel Carbonyl [Ni $(CO)_4$]		X				X		18/0.001
Nitrogen Dioxide (NO_2)			X		X			115/5

Table G6. Hazards of Common Gases (Cont'd)

Gas	Asphyxiant	Flammable	Oxidizer	Corrosive	Toxic	Highly Toxic	Pyrophoric	LC_{50}/PEL (ppm)
Oxygen (O_2)			X					
Phosgene ($COCl_2$)						X		5/0.1
Phosphine (PH_3)						X	X	20/0.3
Silane (SiH_4)		X			X		X	9600/5
Sulfur Dioxide (SO_2)				X				2520/5

Note: Argon, carbon dioxide, helium and nitrogen are asphyxiating gases.

PEL: Permissible exposure limit.

LC50: For inhalation experiments, the concentration of the chemical in air that kills 50% of the test animals in a given time (usually four hours) is the LC50 value.

APPENDIX H
EPCRA AND DHS LABORATORY INVENTORY LIST

Middle Tennessee State university is subject to two key regulations which require it to have knowledge of chemical inventories. The Emergency Planning and Community Right-to Know Act (EPCRA) requires the University to report quantities above specified thresholds for listed chemicals to state and local emergency planners. The Department of Homeland Security (DHS) also has created a list of Chemicals of Interest (COI) based on threat criteria such as sabotage, theft, and release. All chemical facilities in the U.S. must report any COIs maintained above the Screening Threshold Quantities (STQs). In order to remain compliant, the University requires that laboratory inventories of the specific chemicals (listed in the tables below) be maintained. Since most laboratories work with low quantities of material the lists have been truncated to include only those chemicals which have a low reporting threshold. Chemical spills involving chemicals on the EPCRA list should be reported to MTSU Chemical Safety Office and EHS since specific reporting requirements may apply.

Laboratory staff should consult the complete https://www.epa.gov/epcra/consolidated-list-lists and the complete https://www.dhs.gov/xlibrary/assets/chemsec_appendixa-chemicalofinterestlist.pdf list when working with unusually large amounts of a hazardous chemical to determine whether the chemical should be included on their inventory. Contact the Chemical Safety Office or EHS for any questions on inventory requirements. The TPQs and STQs have been included for information purposes only.

Below is listed a subset of the EPCRA extremely hazardous substances list which have low threshold planning quantities (TPQs).

Table H1. EPCRA Inventory Requirements:

Chemical	**Cas#**	**Density (lbs/gal)[1]**	**TPQ[2] (lbs)**	**Reportable Volume (gal)**	**Reportable Volume (L)**
Nickel carbonyl	13463-39-3	11.01	1	0.1	0.3
2-Chloro-N-(2-chloroethyl)-N-methylethanamine/ Mechlorethamine / Nitrogen mustard	51-75-2	9.31	10	1.1	4.1
arbonic dichloride / Phosgene	75-44-5	11.43	10	0.9	3.3
Ethylene fluorohydrin	371-62-0	9.20	10	1.1	4.1
Fluoroacetyl chloride	359-06-8	11.27	10	0.9	3.4
Hydrogen selenide	7783-07-5	Gas	10		
Lewisite	541-25-3	15.73	10	0.6	2.4
Methyl vinyl ketone	78-94-4	7.19	10	1.4	5.3
Phorate	298-02-2	9.63	10	1.0	3.9
Propargyl bromide	106-96-7	13.15	10	0.8	2.9

Table H1. EPCRA Inventory Requirements (Cont'd):

Chemical	Cas#	Density (lbs/gal)[1]	TPQ[2] (lbs)	Reportable Volume (gal)	Reportable Volume (L)
Sarin	107-44-8	9.07	10	1.1	4.2
Tabun	77-81-6	8.94	10	1.1	4.2
2-Propenoyl chloride / Acrylyl chloride	814-68-6	9.28	100	10.8	40.8
Arsine	7784-42-1	Gas	100		
Benzene, 1,3-diisocyanato-2-methyl- / Toluene-2,6-diisocyanate	91-08-7	10.16	100	9.8	37.2
Benzoic trichloride / Benzotrichloride	98-07-7	11.46	100	8.7	33.0
Bis(chloromethyl) ether / Chloromethyl ether / Dichloromethyl ether / Methane, oxybis[chloro-	542-88-1	11.02	100	9.1	34.3
Chlorine	7782-50-5	Gas	100		
Chloromethyl methyl ether / Methane, chloromethoxy-	107-30-2	8.83	100	11.3	42.9
Cyanuric fluoride	675-14-9	13.33	100	7.5	28.4
Diborane / Diborane(6)	19287-45-7	Gas	100		
Dicrotophos	141-66-2	10.13	100	9.9	37.4
Diisopropylfluorophosphate / Isofluorphate	55-91-4	8.79	100	11.4	43.1
Diphosphoramide, octamethyl- / Schradan	152-16-9	9.45	100	10.6	40.1
Formothion	2540-82-1	11.34	100	8.8	33.4
Hexachlorocyclopentadiene	77-47-4	14.18	100	7.1	26.7
Hydrocyanic acid / Hydrogen cyanide	74-90-8	5.72 / Gas	100	17	66.2
Hydrofluoric acid / Hydrofluoric acid (conc. 50% or greater)	7664-39-3	8.35	100	12.0	45.4
Hydrogen fluoride / Hydrogen fluoride (anhydrous)	7664-39-3	Gas	100		
Iron carbonyl (Fe(CO)5), (TB-5-11)- / Iron, pentacarbonyl-	13463-40-6	12.41	100	8.1	30.5
Lithium hydride	7580-67-8	Solid	100		
Manganese, tricarbonyl methylcyclopentadienyl	12108-13-3	11.58	100	8.6	32.7
Methacryloyl chloride	920-46-7	9.06	100	11.0	41.8
Methacryloyloxyethyl isocyanate	30674-80-7	9.15	100	10.9	41.4
Methyl phosphonic dichloride	676-97-1	11.58	100	8.6	32.7

Table H1. EPCRA Inventory Requirements (Cont'd):

Chemical	Cas#	Density (lbs/gal)[1]	TPQ[2] (lbs)	Reportable Volume (gal)	Reportable Volume (L)
Nicotine / Pyridine, 3-(1-methyl-2-pyrrolidinyl)-,(S)-	54-11-5	8.41	100	11.9	45.0
Nitric oxide / Nitrogen oxide (NO)	10102-43-9	Gas	100		
Nitrogen dioxide	10102-44-0	12.06 / Gas	100	8.3	31.4
Ozone	10028-15-6	Gas	100		
Parathion / Phosphorothioic acid, O,O-diethyl-O-(4-nitrophenyl) ester	56-38-2	10.50	100	9.5	36.7
Phosphamidon	13171-21-6	10.11	100	9.9	37.5
Phosphonothioic acid, methyl-, S-(2-(bis(1-methylethyl)amino)ethyl) O-ethyl ester	50782-69-9	8.40	100	11.9	45.1
Phosphorus / Phosphorus (yellow or white)	7723-14-0	Solid	100		
Plumbane, tetramethyl- / Tetramethyllead	75-74-1	16.62	100	6.0	22.8
Potassium cyanide	151-50-8	Solid	100		
Sodium cyanide (Na(CN))	143-33-9	Solid	100		
Sulfur fluoride (SF4), (T-4)- / Sulfur tetrafluoride	7783-60-0	Gas	100		
Sulfur trioxide	7446-11-9	Solid	100		
Tellurium hexafluoride	7783-80-4	Gas	100		
TEPP / Tetraethyl pyrophosphate	107-49-3	9.87	100	10.1	38.3
Terbufos	13071-79-9	9.20	100	10.9	41.1
Tetraethyl lead	78-00-2	13.77	100	7.3	27.5
Tetraethyltin	597-64-8	9.99	100	10.0	37.9
Titanium chloride (TiCl4) (T-4)- / Titanium tetrachloride	7550-45-0	14.38	100	7.0	26.3
Trichloro(chloromethyl)silane	1558-25-4	12.30	100	8.1	30.8
Tris(2-chloroethyl)amine	555-77-1	10.29	100	9.7	36.8

Table h1. EPCRA Inventory Requirements (Cont'd):

Chemical	Cas#	Density (lbs/gal)[1]	TPQ[2] (lbs)	Reportable Volume (gal)	Reportable Volume (L)
The Items with two threshold planning quantities listed (e.g., 1/10,000) are those where the lower TPQ number applies if the substance is present as a solid in powder form with particle size less than 100 microns, in solution or in molten form. Inventories must be maintained only when they are in the low TPQ form.					
Chromic chloride	10025-73-7	Solid	1/10,000		
Emetine, dihydrochloride	316-42-7	Solid	1/10,000		
4,6-Dinitro-o-cresol	534-52-1	Solid	10/10,000		
Azinphos-methyl / Guthion	86-50-0	Solid	10/10,000		
Benzenearsonic acid	98-05-5	Solid	10/10,000		
Bis(chloromethyl) ketone	534-07-6	Solid	10/10,000		
Carbofuran	1563-66-2	Solid	10/10,000		
Cobalt carbonyl	10210-68-1	Solid	10/10,000		
Colchicine	64-86-8	Solid	10/10,000		
Digoxin	20830-75-5	Solid	10/10,000		
Dimethyl-p-phenylenediamine	99-98-9	Solid	10/10,000		
Dinitrocresol	534-52-1	Solid	10/10,000		
Diphacinone	82-66-6	Solid	10/10,000		
Endosulfan	115-29-7	Solid	10/10,000		
Fenamiphos	22224-92-6	Solid	10/10,000		
Fluoroacetic acid	144-49-0	Solid	10/10,000		
Fluoroacetic acid, sodium salt	62-74-8	Solid	10/10,000		
Monocrotophos	6923-22-4	Solid	10/10,000		
Organorhodium Complex (PMN-82-147)	0	Solid	10/10,000		
Paraquat dichloride	1910-42-5	Solid	10/10,000		
Paraquat methosulfate	2074-50-2	Solid	10/10,000		
Sodium fluoroacetate	62-74-8	Solid	10/10,000		

[1] Density (lb/gal) = specific gravity *8.33
[2] TPQ = Threshold Planning Quantity

Table H2. DHS Chemical of Interest Inventory Requirements

Chemical	Synonym	CAS Number	Min. Conc. (%)	STQ (in lbs unless otherwise noted
Arsenic trichloride	Arsenous trichloride	7784-34-1	30	2.2
1,4-Bis(2-chloroethylthio)-nbutane		142868-93-7	NA	100g
Bis(2-chloroethylthio)methane		63869-13-6	NA	100g
Bis(2-chloroethylthiomethyl)ether		63918-90-1	NA	100g
1,5-Bis(2-chloroethylthio)-npentane		142868-94-8	NA	100g
1,3-Bis(2-chloroethylthio)-npropane		63905-10-2	NA	100g
2-Chloroethylchloromethylsulfide		2625-76-5	NA	100g
Chlorosarin	o-Isopropyl methylphosphonochloridate	1445-76-7	NA	100g
Chlorosoman	o-Pinacolyl methylphosphonochloridate	7040-57-5	NA	100g
DF	Methyl phosphonyl difluoride	676-99-3	NA	100g
N,N-(2-diethylamino)ethanethiol		100-38-9	30	2.2
o,o-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate		78-53-5	30	2.2
Diethyl methylphosphonite		15715-41-0	30	2.2
N,N-Diethyl phosphoramidic dichloride		1498-54-0	30	2.2
N,N-(2-diisopropylamino)ethanethiol N,N-diisopropyl-(beta)-aminoethane thiol		5842-07-9	30	2.2
N,N-Diisopropyl phosphoramidic dichloride		23306-80-1	30	2.2
N,N-(2-dimethylamino)ethanethiol		108-02-1	30	2.2

Table H2. DHS Chemical of Interest Inventory Requirements (Cont'd)

Chemical	Synonym	CAS Number	Min. Conc. (%)	STQ (in lbs unless otherwise noted
o,o-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate		78-53-5	30	2.2
Diethyl methylphosphonite		15715-41-0	30	2.2
N,N-Diethyl phosphoramidic dichloride		1498-54-0	30	2.2
N,N-(2-diisopropylamino)ethanethiol N,N-diisopropyl-(beta)-aminoethane thiol		5842-07-9	30	2.2
N,N-Diisopropyl phosphoramidic dichloride		23306-80-1	30	2.2
N,N-(2-dimethylamino)ethanethiol		108-02-1	30	2.2
N,N-Dimethyl phosphoramidic dichloride Dimethylphosphoramidodichloridate		677-43-0	30	2.2
Dinitrogen tetroxide		10544-72-6	3.8	15
N,N-(2-dipropylamino)ethanethiol		5842-06-8	30	2.2
N,N-Dipropyl phosphoramidic dichloride		40881-98-9	30	2.2
Fluorine		7782-41-4	6.17	15
Germanium tetrafluoride		7783-58-6	2.11	15
HN1 (nitrogen mustard-1)	Bis(2-chloroethyl)ethylamine	538-07-8	NA	100g
HN2 (nitrogen mustard-2)	Bis(2-chloroethyl)methylamine	51-75-2	NA	100g
HN3 (nitrogen mustard-3)	Tris(2-chloroethyl)amine	555-77-1	NA	CUM 100g
Hydrogen cyanide	Hydrocyanic acid	74-90-8	4.67	15
Hydrogen selenide		7783-07-5	0.07	15

Table H2. DHS Chemical of Interest Inventory Requirements (Cont'd)

Chemical	Synonym	CAS Number	Min. Conc. (%)	STQ (in lbs unless otherwise noted
Isopropylphosphonothioic dichloride		1498-60-8	30	2.2
Isopropylphosphonyl difluoride		677-42-9	NA	100g
Lewisite 1	2-Chlorovinyldichloroarsine	541-25-3	NA	100g
Lewisite 2	Bis(2-chlorovinyl)chloroarsine	40334-69-8	NA	100g
Lewisite 3	Tris(2-chlorovinyl)arsine	40334-70-1	NA	100g
Methylphosphonothioic dichloride		676-98-2	30	2.2
Sulfur mustard (Mustard gas(H))	Bis(2-chloroethyl)sulfide	505-60-2	NA	100g
O-Mustard (T)	Bis(2-chloroethylthioethyl)ether	63918-89-8	NA	100g
Nitric oxide	Nitrogen oxide (NO)	10102-43-9	3.83	15
Nitrogen mustard hydrochloride	Bis(2-chloroethyl)methylamine hydrochloride	55-86-7	30	2.2
Nitrogen trioxide		10544-73-7	3.83	15
Nitrosyl chloride		2696-92-6	1.17	15
Oxygen difluoride		7783-41-7	0.09	15
Phosgene	Carbonic dichloride;carbonyl dichloride	75-44-5	0.17	15
Phosphine		7803-51-2	0.67	15
Propylphosphonothioic dichloride		2524-01-8	30	2.2
Propylphosphonyl difluoride		690-14-2		100g
Selenium hexafluoride		7783-79-1	1.67	15

Table H2. DHS Chemical of Interest Inventory Requirements (Cont'd)

Chemical	Synonym	CAS Number	Min. Conc. (%)	STQ (in lbs unless otherwise noted
Sesquimustard	1,2-Bis(2-chloroethylthio)ethane	3563-36-8	NA	100g
Soman	o-Pinacolyl methylphosphonofluoridate	96-64-0	NA	100g
Stibine		7803-52-3	0.67	15
Sulfur tetrafluoride	Sulfur fluoride (SF4), (T-4)-	7783-60-0	1.33	15
Tabun	o-Ethyl-N,Ndimethylphosphoramido-cyanidate	77-81-6	NA	100g
Tellurium hexafluoride		7783-80-4	0.83	15
Thiodiglycol	Bis(2-hydroxyethyl)sulfide	111-48-8	30	2.2
VX	o-Ethyl-S-2-diisopropylaminoethyl methyl phosphonothiolate	50782-69-9	NA	100g

APPENDIX I
CHEMISTRY GUIDELINES FOR CHEMICAL DISPOSAL

Wastes forbidden from sink/sewer disposal

The following wastes must **NEVER** be discharged to the sanitary sewer in ANY concentration. These wastes must be collected and managed as hazardous waste.

1. **Raw Chemical Waste.**
   Unused, pure, or concentrated chemicals.

2. **Chlorinated Hydrocarbon Waste.**
   Chlorinated hydrocarbons are compounds that contain chlorine, hydrogen, and carbon. Examples of chlorinated hydrocarbons include but are not limited to:
   a. Chloromethanes:
      Specific examples:
      - Methylene chloride
      - Trichloromethane (chloroform)
      - Trichlorofluoromethane
   b. Chloroethanes:
      Specific examples:
      - 1,1-Dichloroethane
      - 1,1,l-Trichloroethane
      - 1,1,2-Trichloroethane
      - Hexachloroethane
   c. Chloroethylenes:
      Specific examples:
      - Vinyl chloride
      - Trichloroethylene
      - Tetrachloroethylene
   d. Chloropropanes, chlorobutanes, chlorobutenes:
      Specific examples:
      - Dichlorobutadiene
      - Hexachlorobutadiene
   e. Chlorinated paraffins;
   f. Chlorinated pesticides
      Specific examples:
      - Aldrin
      - Heptachlor epoxide
      - Chlordane
      - Hexachloride
      - DDT
      - Hexachlorobenzene
      - 2,4-D
      - Lindane
      - Dieldrin
      - Methoxychlor
      - Endrin
      - Mirex
      - Heptachlor
      - Toxaphene
   g. Nucleus-chlorinated aromatic hydrocarbons
      Specific examples:
      - Dichlorobenzene

- Dichlorotoluene
- Chlorobenzene
- 1,2-Dichlorobenzene
- 1,4-Dichlorobenzene
- Chlorinated biphenyls (including PCBs)
- Chlorinated naphthalenes
- Pentachlorophenol
- 2,4,5-Trichlorophenol
- 2,4,6-Trichlorophenol

h. Side-chain chlorinated aromatic hydrocarbons
Specific examples:
- Chloromethyl benzene (benzyl chloride)
- Dichloromethyl benzene (benzal chloride)
- Trichloromethyl benzene (benzotrichloride).

3. **Chlorofluorcarbon Waste**

4. **Brominated Hydrocarbon Waste**
Specific examples:
   a. Bromoform
   b. Bromomethane

5. **Cyanide Waste.**
Includes cyanide, cyanate (OCN-), and thiocyanate (SCN-) compounds.
Specific examples:
   a. Potassium cyanide
   b. Sodium cyanide
   c. Hydrogen cyanide
   d. Zinc cyanide
   e. Copper cyanide
   f. Nickel cyanide.

6. **Heavy Metal Waste.**
Specific examples:
   a. Antimony
   b. Mercury
   c. Arsenic
   d. Nickel
   e. Barium
   f. Selenium
   g. Cadmium
   h. Silver
   i. Chromium
   j. Thallium
   k. Copper
   l. Zinc
   m. Lead

7. **Corrosive Waste.**
Corrosive wastes are wastes that could cause corrosive structural damage to the sink/sewer piping. All wastes with a **pH** lower than 5.0 Standard Units (S.U.) or higher than 9.0 S.U. are considered corrosive wastes. Laboratories must not neutralize corrosive wastes to comply with this requirement unless it is part of a written protocol for the laboratory process generating the waste and the neutralization process is carried out by trained, qualified personnel.

8. **Solvent Waste.**
   Wastes containing any of the following solvents in any concentration:
   a. Acetone
   b. *Please note that acetone used to wash glassware falls into this category.*
   c. Ethyl Ether
   d. Benzene
   e. Isobutanol
   f. n-Butyl Alcohol
   g. Methanol
   h. Carbon Disulfide
   i. Methyl Ethyl Ketone (MEK)
   j. Carbon Tetrachloride
   k. Methyl Isobutyl Ketone
   l. Cresols
   m. Nitrobenzene
   n. Cyclohexanone
   o. 2-Nitropropane
   p. Cresylic Acid
   q. Pyridine
   r. 2-Ethoxyethanol
   s. Toluene
   t. Ethyl Acetate
   u. Xylene
   v. Ethyl Benzene

9. **Oil and Grease Wastes.**
   Waste oils and grease, including vacuum pump oil, must be collected and managed as hazardouswastes. Wastes that are contaminated with oil or grease in concentrations greater than 50 mg/L must also be collected and managed as hazardous waste.

10. **Ignitable Wastes.**
    Ignitable wastes are: 1) Liquid wastes with a flashpoint less than 60 degrees C (140 degrees F); 2) Non-liquid wastes that are capable of causing fire through friction, reaction with moisture, or spontaneous chemical changes; 3) Ignitable compressed gases; or 4) Oxidizers. Ignitable wastes include most waste solvents found in laboratories, ignitable compressed gases such as hydrogen, and oxidizers such as nitrates/nitrites (sodium nitrate, potassium nitrite, etc.) and chlorates and perchlorates (magnesium perchlorate, etc.). Ignitable wastes include mixtures of ignitable chemicals with other materials if the mixture still exhibits the ignitability characteristic (i.e., flashpoint less than 60 degrees C).

11. **Reactive Wastes.**
    Reactive wastes: 1) Are normally unstable and readily undergo violent change; 2) React violentlyor form explosive mixtures with water; 3) Can generate toxic gases, vapors or fumes when mixedwith water or exposed to extreme pH conditions; or 4) Are capable of detonation or explosive reaction under certain conditions. Common reactive wastes found in laboratories include certain cyanides, sulfides, and silanes or any mixtures of multiple wastes that exhibit reactivity characteristics.

12. **Solid or Viscous Wastes.**
    Solid or viscous wastes that may coat, clog, or otherwise cause obstruction to the flow of sewer pipes must never be discharged to the sewer. Examples of prohibited solid or viscous waste include sand, animal tissues, bones, plastics, rubber, glass, wood chips, wood shavings, plaster, paint, etc. in such quantity, concentration, or form that may cause interference with proper sewer flow. Depending on the nature of the waste, it may be discharged to the normal trash or collected and managed as hazardous waste.

13. **Nuisance Waste.**
Wastes that may cause a discoloration or that may cause interference in the Metro wastewater treatment plant must not be discharged to the sewer. Wastes that are noxious or malodorous to the extent that a nuisance may be created at the Metro wastewater treatment plant or in other laboratories must not be discharged to the sewer.

14. **Untreatable Waste.**
Wastes that contain any element or compound that cannot be adequately treated or removed by theMetro wastewater treatment plant (biological activated sludge treatment) and that is known to be an environmental hazard must not be discharged to the sewer.

15. **Hot Liquid or Vapor Wastes.**
Liquid or vapor wastes with a temperature above 65.5 oC (150 oF) must not be discharged to the sewer.

16. **Ethidium Bromide and Acrylamide Waste.**
Buffer solutions and other solutions containing ethidium bromide or acrylamide in anyconcentration and ethidium bromide and acrylamide gels.

17. **Priority Pollutant Wastes.**
All wastes containing any of the following priority pollutant compounds in any concentration mustbe collected and managed as hazardous waste:

a. **Volatiles**

Acrylonitrile	Benzene	Bromoform
Carbon tetrachloride	Chlorobenzene	Chlorodibromomethane
Chloroethane	2-Chloroethylvinyl ether	Chloroform
Dichlorobromomethane	Dichlorodifluoromethane	1,1-Dichloroethane
1,2-Dichloroethane	1,1-DichloroethyJene	Dichloromethane
1,2-Dichloropropane	1,2-Dichloropropylene	1,3-Dichloropropylene
2,4-Dichloropropylene	Ethylbenzene	Methyl bromide
Methyl chloride	Methylene chloride	1,1,2,1-Tetrachloroethane
1,1,2,2-Tetrachloroethane	Tetrachloroethylene	Tetrachloromethane
Toluene	Trans-dichloroethylene	1,2-Trans-dichloroethylene
1,1, I-Trichloroethane	**1,**1,2-Trichloroethane	Trichloroethylene
Trichlorofluoromethane	Trichloromethane	Vinyl chloride

b. Base/Neutral

Acenaphthene	Acenaphthylene	Anthracene
Benzidine	Benzo(a)anthracene	Benzo(a)pyrene
3,4-Benzofluoranthene	Benzo(ghi)perylene	Benzo(b)fluoranthene
Benzo(k)fluoranthene	Bis(2-chloroethoxy)methane	Bis(2-chloroethyl)ether
Bis(2-chloroisopropyl)ether	Bis(2-chloromethyl)ether	Bis (2-ethylhexyl)phthalate
4-Bromophenyl phenyl ether	Butylbenzyl phthalate	2-Chloronaphthalene
4-Chlorophenyl phenyl ether	Chrysene	Dibenzo(a,h)anthracene
1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene
3,3'-Dichlorobenzidine	Di-n-ethyl phthalate	Diethyl phthalate
Di-c-methyl phthalate	Dimethyl phthalate	Di-n-butyl phthalate
2,4-Dinitrotoluene	2,6-Dinitrotoluene	Di-n-octyl phthalate
1,2-Diphenylhydrazine	Fluroranthene	Fluorene
Hexachlorobenzene	Hexachlorobutadiene	Hexachlorocyclopentadiene
Hexachloroethane	Indeno(1,2,3-cd)pyrene	Naphthalene
Nitrobenzene	N-nitrosodimethylarnine	N-nitrosodi-n-propylarnine
N-nitrosodiphenylarnine	Phenanthrene	Pyrene
1,2,4-Trichlorobenzene		

c. **Pesticides**

Acrolein	Aldrin	BHC, alpha
BHC, beta	BHC, delta	BHC,gamma
Chlordane	4,4'-DDT	4,4'-DDE
4,4'-DDD	Dieldrin	Endosulfan, alpha
Endosulfan, beta	Endosulfan sulfate	Endrin
Endrin aldehyde	Heptachlor	Heptachlor epoxide
Isophorone	PCB-1016	PCB-1221
PCB-1232	PCB-1242	PCB-1248
PCB-1254	PCB-1260	TCDD (Dioxin)
Toxaphene		

d. **Inorganics, Metals, Phenols, and Cresols**

Antimony	Arsenic	Asbestos
Beryllium	Cadmium	Chromium
Copper	Lead	Mercury
Nickel	Selenium	Silver
Thallium	Zinc	Cyanide
2-Chlorophenol	Cresols	2,4-Dichlorophenol
2,4-Dimethylphenol	4,6-Dinitro-o-cresol	2,4-Dinitrophenol
2-Nitrophenol	4-Nitrophenol	P-chloro-m-cresol
Pentachlorophenol	Phenols	2,4,6-Trichlorophenol

18. **Rinseate**
Empty containers that are being rinsed should be triple rinsed with a minimal amount of liquid and the rinseate collected and managed as hazardous waste, if the container held any of the wastes described above in Sections 1, 2, 3, 4, 5, 6, or 8. Subsequent rinses may be discharged to the sewer. Depending on the waste, fewer rinses may be required to be collected. Contact EHS for evaluation of specific waste containers . Rinseate from empty containers that held other types of waste may be discharged to the sewer if the rinseate does not exhibit the hazardous characteristic of the waste (for example, rinseate from a container that held ignitable waste may be sewer disposed if the rinseate is not ignitable).

Wastes with limited sink/sewer disposal

1. **Radioactive Wastes.**
A radioactive waste that is water soluble or readily dispersible in water and not prohibited from sewer disposal based on the criteria described in the previous section may be disposed via the sanitary sewer system. The disposal limit is 200 µCi per laboratory per day. Records of sewer disposal must be maintained on the Radioactive Material Usage Log.

2. **Biological Materials.**
Biological waste must not be discharged to the sewer unless it has been properly treated. Please refer to Proper Disposal of Biological Waste in the Guide to Biosafety at Vanderbilt for biological waste disposal policies and procedures (EHS website). Biological waste intended for sewer disposal must not be prohibited from sewer disposal based on the criteria described in the previous section.

3. **Specific Organic Chemicals in Concentrations of One Percent or Less.**
Organic chemicals suitable for sink/sewer disposal are described below. Only those organic compounds that are reasonably soluble in water are suitable for sink/sewer disposal. A compound is considered water soluble if it dissolves to the extent of at least three percent. Chemicals listed below must be in concentrations of approximately one percent or less to be suitable for sink/sewer disposal. If the total volume of waste to be disposed is greater than four liters per day, approval by EHS is required. Sewer discharges of these chemicals must not be prohibited in the previous section. Any chemicals that fall into categories described below but are specifically prohibited from sink/sewer disposal in the previous section must NOT be discharged to the sewer.
    a. Alkanols with 4 or fewer carbon atoms.
    Specific examples:
        - 2-Butanol
        - 2-Propanol
        - Tert-butanol
        - Ethanol 1-Propanol
    b. Alkanediols with 7 or fewer carbon atoms.
    Specific examples:
        - Butanediol and isomers
        - Butylene glycol
        - Ethylene glycol
        - Heptamethylene glycol
        - Heptanediol and isomers
        - Hexanediol and isomers
        - Hexylene glycol
        - Pentanediol and isomers
        - Pentylene glycol
        - Propylene glycol
    c. Sugars and sugar alcohols (polyols).
    Specific examples:
        - Dithioerythritol
        - Dithiothreitol
        - Erythritol
        - Glycerol
        - Lactitol
        - Maltitol
        - Mannitol
        - Molasses
        - Sorbitol
        - Xylitol
    d. Alkoxyalkanols with 6 or fewer carbon atoms.
    Specific examples:
        - Butoxyethanol
        - Ethoxyethanol
        - Methoxyethanol
    e. Aliphatic aldehydes with 4 or fewer carbon atoms.
    Specific examples:
        - Acetaldehyde
        - Butyraldehyde (butanal)
        - Formaldehyde
        - Glutaraldehyde
        - Isobutyraldehyde

- Propionaldehyde (propanal)

f. RCONH2 and RCONHR with 4 or fewer carbon atoms and RCONR2 with 10 or fewer carbon atoms.
Specific examples:
  - Acetamide
  - Butanamide
  - Butyramide
  - Formamide
  - Isobutyramide
  - N,N-Diethyl formamide
  - N,N-Dimethyl acetamide
  - N,N-Dimethyl propionamide
  - N-Ethyl acetamide
  - N-Ethyl formamide
  - N-Methyl acetamide
  - N-Methyl formamide
  - N-Methyl propionamide
  - Propionamide

g. Aliphatic amines with 6 or fewer carbon atoms.
Specific examples:
  - Amylamine
  - Isobutylamine
  - Butylamine
  - Dimethylpropylamine
  - Ethylamine
  - 1-Ethylpropylamine
  - Hexylamine
  - Isobutylamine
  - Isopropylamine
  - Methylamine
  - Methylbutylamine
  - N-Ethylbutylamine
  - N-Ethylmethylamine
  - N-Methylpropylamine
  - Trimethylamine
  - Iso-amylamine
  - Diethylamine

h. Aliphatic diamines with 6 or fewer carbon atoms.
Specific examples:
  - Ethylene diamine
  - Hexamethylene diamine and isomers
  - Pentamethylenediamine and isomers
  - Piperazine
  - 1,2-Propanediamine
  - 1,3-Propanediamine
  - Triethylenediamine

i. Alkanoic acids with 5 or fewer carbon atoms and the ammonium, sodium, and potassium salts of these acids with 20 or fewer carbon atoms.
Specific examples:
  - Acetic acid
  - Butyric acid
  - Forrnic acid
  - Isobutyric acid
  - Isovaleric acid
  - Propionic acid
  - Valerie acid

j. Alkanedioic acids with 5 or fewer carbon atoms and the ammonium, sodium, and potassium salts of these acids with 20 or fewer carbon atoms.
Specific examples:
- Fumaric acid
- Glutaric acid (1,5-pentanedioic acid)
- Malic acid
- Malanie acid (1,3-propanedioic acid)
- Oxalic acid (1,2-ethanedioic acid)
- Succinic acid (1,4-butanedioic acid)
- Tartaric acid

k. Hydroxyalkanoic acids with 5 or fewer carbon atoms and the ammonium, sodium, and potassium salts of these acids with 20 or fewer carbon atoms.
Specific examples:
- Glycolic acid
- 3-Hydroxybutyric acid
- 2-Hydroxyisobutyric acid
- Lactic acid (2-hydroxypropanoic acid)

l. Aminoalkanoic acids with 6 or fewer carbon atoms and the ammonium, sodium, and potassium salts of these acids with 20 or fewer carbon atoms.
Specific examples:
- 3-Amino butyric acid
- 4-Amino butyric acid
- Amino isobutyric acid
- 5-Amino pentanoic acid and isomers
- 3-Amino propanoic acid

m. Esters with 4 or fewer carbon atoms.
Specific examples:
- Ethyl formate
- Isopropyl acetate
- Isopropyl formate
- Methyl acetate
- Methyl formate
- Methyl propionate
- Propyl formate

n. Nitriles.
Specific examples:
- Acetonitrile
- Butyronitrile
- Isobutylnitrile
- Propionitrile

o. Sulfonic acids and sodium and potassium salts of the acids.
Specific examples:
- Methane sulfonic acid
- Ethane sulfonic acid
- 1-Propane sulfonic acid
- 1-Butane sulfonic acid
- 1-Pentane sulfonic acid
- 1-Hexane sulfonic acid
- 1-Heptane sulfonic acid
- 1-Octane sulfonic acid
- 1-Decane sulfonic acid
- 1-Dodecane sulfonic acid
- 1-Tetradecane sulfonic acid
- 1-Hexadecane sulfonic acid

4. **Specific Inorganic Chemicals in Concentrations of One Percent or Less.**
Inorganic chemicals suitable for sink/sewer disposal are described below. Only those inorganic compounds that are reasonably soluble in water are suitable for sink/sewer disposal. A compound is considered water soluble if it dissolves to the extent of at least three percent. Chemicals listed below must be in concentrations of approximately one percent or less to be suitable for sink/sewer disposal. If the total volume of waste to be disposed is greater than four liters per day, approval by EHS is required. Sewer discharges of these chemicals must not be prohibited in the previous section. Any chemicals that fall into categories described below but are specifically prohibited from sink/sewer disposal in the previous section must NOT be discharged to the sewer.

a. **Inorganic salts cations and anions:**

Cations	**Anions**
Aluminum, Al3+	Borate, BO33-, B4O72-
Ammonium, NH4+	Bromide, Br-
Calcium, Ca2+	Carbonate, CO32-
Cesium, Cs+	Chloride, Cl-
Hydrogen, H+	Bisulfite, HSO3-
Lithium, Li+	Hydroxide, OH-
Magnesium, Mg2+	Oxide, 02-
Potassium, K+	Iodide, I-
Sodium, Na+	Nitrate, NO3-
Strontium, Sr2+	Phosphate, PO43-
Tin, Sn2+	Sulfate, SO42-
Titanium, Ti3+, Ti4+	
Zirconium, Zr2+	

References

1. Tennessee Department of Environment and Conservation (TDEC) Rule 1200-1-11.
2. Metropolitan Government of Nashville and Davidson County Code of Laws Title 15.60.
3. P111dent Practices for Handling Hazardous Chemic als in Laboratories, National Academy Press, Washington, D.C., 1981.
4. Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington, D.C., 1983.
5. Prudent Practices in the Laboratory: Handling and Disposal. of hemicals, National Academy Press, Washington, D.C., 1995.

Summary of specific chemicals forbidden from sewer disposal

The following chemicals must not be discharged to the sanitary sewer in any concentration. This list contains examples of specific chemicals and does NOT include all chemicals that are forbidden from sewer disposal. For more information on whether a chemical not listed below can be discharged to the sewer, refer to the detailed sections in this guide or contact EHS.

Acenaphthene	Acenaphthylene
Acetone	Acrolein
Acrylamide	Acrylonitrile
Aldrin	Anthracene
Antimony	Arsenic
Asbestos	Barium
Benzene	Benzidine
Benzo(a)anthracene	Benzo(a)pyrene
Benzo(b)fluoranthene	Benzo(ghi)perylene
3,4-Benzofluoranthene	Benzo(k)fluoranthene
Beryllium	BHC, alpha
BHC, beta	BHC, delta
BHC, gamma	Bis (2-ethylhexyl)phthalate
Bis(2-chloroethoxy)methane	Bis(2-chloroethyl)ether
Bis(2-chloroisopropyl)ether	Bis(2-chloromethyl)ether
Bromoform	Bromoform
Bromomethane	4-Bromophenyl phenyl ether
Butylbenzyl phthalate	Cadmium
Carbon Disulfide	Carbon Tetrachloride
Chlordane	2-Chloroethylvinyl ether
Chlorinated biphenyls (including PCBs)	Chlorinated naphthalenes
Chlorobenzene	Chlorodibromomethane
Chloroethane	Chloroform
Chloromethyl benzene (benzyl chloride)	2-Chloronaphthalene
2-Chlorophenol	4-Chlorophenyl phenyl ether
Chromium	Chrysene
Copper	Copper cyanide
Cresols	Cresylic Acid
Cyanide	Cyclohexanone
2,4-D	DDT
4,4'-DDD	4,4'-DDE
4,4'-DDT	Dibenzo(a,h)anthracene
Dichlorobenzene	1,2-Dichlorobenzene

1,3-Dichlorobenzene	1,4-Dichlorobenzene
3,3'-Dichlorobenzidine	Dichlorobromomethane
Dichlorobutadiene	Dichlorodifluoromethane
1,1-Dichloroethane	1,2-Dichloroethane
1,1-Dichloroethylene	1,2-Trans-dichloroethylene
Dichloromethane	Dichloromethyl benzene (benzal chloride)
2,4-Dichlorophenol	1,2-Dichloropropane
1,2-Dichloropropylene	1,3-Dichloropropylene
2,4-Dichloropropylene	Dichlorotoluene
Di-c-methyl phthalate	Dieldrin
Diethyl phthalate	2,4-Dimethylphenol
Dimethyl phthalate	2,4-Dinitrophenol
Di-n-butyl phthalate	Di-n-ethyl phthalate
Di-n-octyl phthalate	4,6-Dinitro-o-cresol
2,6-Dinitrotoluene	1,2-Diphenylhydrazine
Endosulfan sulfate	Endosulfan, alpha
Endosulfan, beta	Endrin
Endrin aldehyde	Ethidium Bromide
2-Ethoxyethanol	Ethyl Acetate
Ethyl Benzene	Ethyl Ether
Ethylbenzene	Fluorene
Fluroranthene	Heptachlor
Heptachlor epoxide	Hexachloride
Hexachlorobenzene	Hexachlorobutadiene
Hexachlorocyclopentadiene	Hexachloroethane
Hydrogen cyanide	Indeno(1,2,3-cd)pyrene
Isobutanol	Isophorone
Lead	Lindane
Mercury	Methanol
Methoxychlor	Methyl bromide
Methyl chloride	Methyl Ethyl Ketone (MEK)
Methyl Isobutyl Ketone	Methylene chloride
Mirex	Naphthalene
n-Butyl Alcohol	Nickel
Nickel cyanide	Nitrobenzene
2-Nitrophenol	4-Nitrophenol
2-Nitropropane	N-nitrosodimethylamine

N-nitrosodi-n-propylamine	N-nitrosodiphenylamine
PCB-1016	PCB-1221
PCB-1232	PCB-1242
PCB-1248	PCB-1254
PCB-1260	P-chloro-m-cresol
Pentachlorophenol	Phenanthrene
Phenols	Potassium cyanide
Pyrene	Pyridine
Selenium	Silver
Sodium cyanide	TCDD (Dioxin)
1,1,2,1-Tetrachloroethane	**1,**1,2,2-Tetrachloroethane
Tetrachloroethylene	Tetrachloromethane
Thallium	Toluene
Toxaphene	Trans-dichloroethylene
1,2,4-Trichlorobenzene	1,1,l-Trichloroethane
1,1,2-Trichloroethane	Trichloroethylene
Trichlorofluoromethane	Trichloromethane (chloroform)
Trichloromethyl benzene (benzotrichloride)	2,4,5-Trichlorophenol
2,4,6-Trichlorophenol	Vinyl chloride
Xylene	Zinc
Zinc cyanide	

Summary of specific chemicals with limited sewer disposal

The following chemicals may be discharged to the sewer in concentrations of approximately one percent or less. If the percentage is greater than one percent, approval by EHS is required. If the total volume of waste to be disposed is greater than four liters per day, approval by EHS is required. Sewer discharges of these chemicals must not be prohibited for any other reason. Specifically, solutions containing these chemicals must not also contain chemicals specifically forbidden from sewer disposal. This list contains examples of specific chemicals and does NOT include all chemicals with limited discharge to the sewer.

For more information on whether a chemical not listed below can be discharged to the sewer, refer to the detailed sections in this guide or contact EHS.

Acetaldehyde	Acetamide
Acetic acid	Acetonitrile
3-Amino butyric acid	4-Amino butyric acid
Amino isobutyric acid	5-Amino pentanoic acid and isomers
3-Amino propanoic acid	Amylarnine
Butanamide	Butanediol and isomers
I-Butane sulfonic acid	2-Butanol
Butoxyethanol	Butylamine

Butylene glycol	Butyraldehyde (butanal)
Butyramide	Butyric acid
Butyronitrile	1-Decane sulfonic acid
Diethylamine	Dimethylpropylamine
Dimethyl sulfoxide (DMSO)	Dithioerythritol
Dithiothreitol	1-Dodecane sulfonic acid
Erythritol	Ethane sulfonic acid
Ethanol	Ethoxyethanol
Ethyl formate	Ethylamine
Ethylene diamine	Ethylene glycol
1-Ethylpropylamine	Formaldehyde
Formamide	Formic acid
Fumaric acid	Glutaraldehyde
Glutaric acid (1,5-pentanedioic acid)	Glycerol
Glycolic acid	Heptamethylene glycol
Heptanediol and isomers	I-Heptane sulfonic acid
1-Hexadecane sulfonic acid	Hexamethylene diamine and isomers
I-Hexane sulfonic acid	Hexanediol and isomers
Hexylamine	Hexylene glycol
3-Hydroxybutyric acid	2-Hydroxyisobutyric acid
Iso-amylamine	Isobutylamine
Isobutylamine	Isobutylnitrile
Isobutyraldehyde	Isobutyramide
Isobutyric acid	Isopropyl acetate
Isopropyl formate	Isopropylamine
Isovaleric acid	Lactic acid (2-hydroxypropanoic acid)
Lactitol	Malic acid
Malanie acid (1,3-propanedioic acid)	Maltitol
Mannitol	Methane sulfonic acid
Methoxyethanol	Methyl acetate
Methyl formate	Methyl propionate
Methylamine	Methylbutylamine
Molasses	N,N-Diethyl formamide
N,N-Dimethyl acetamide	N,N-Dimethyl propionamide
N-Ethyl acetamide	N-Ethyl formamide
N-Ethylbutylamine	N-Ethylmethylamine
N-Methyl acetamide	N-Methyl formamide
N-Methyl propionamide	N-Methylpropylamine

l-Octane sulfonic acid	Oxalic acid (1,2-ethanedioic acid)
Pentamethylenediamine and isomers	Pentanediol and isomers
1-Pentane sulfonic acid	Pentylene glycol
Piperazine	1,2-Propanediamine
1,3-Propanediamine	l-Propane sulfonic acid
1-Propanol	2-Propanol
Propionaldehyde (propanal)	Propionamide
Propionic acid	Propionitrile
Propyl formate	Propylene glycol
Sorbitol	Succinic acid (1,4-butanedioic acid)
Tartaric acid	Tert-butanol
1-Tetradecane sulfonic acid	Triethylenediamine
Trimethylamine	Valeric acid
Xylitol	

Appendix J
Disposal of Non-hazardous Laboratory Waste Chemicals as Trash

The following table, adapted from *Prudent Practices*, lists solid chemicals which are not considered hazardous and are therefore suitable for disposal with regular trash. However, neither custodians nor trash collectors can readily distinguish between hazardous and non-hazardous wastes. Therefore, the packaging of suchwaste for disposal must be secure, and its transfer to the dumpster carried out by laboratory personnel.

A. *Organic Chemicals*

Enzymes
Sugars and sugar alcohols
Starch
Naturally occurring amino acids and salts
Citric acid and its Na,K,Mg,Ca,NH_4 salts
Lactic acid and its Na,K,Mg,Ca,NH_4 salts

B. *Inorganic Chemicals*

Silica	
Sulfates:	Na,K,Mg,Ca,Sr,NH_4
Phosphates:	Na,K,Mg,Ca,Sr,NH_4
Carbonates:	Na,K,Mg,Ca,Sr,NH_4
Oxides:	B,Mg,Ca,Sr,Al,Si,Ti,Mn,Fe,Co,Cu
Chlorides:	Ca,Na,K,Mg,NH_4
Borates:	Na,K,Mg,Ca

C. *Laboratory Materials Not Contaminated with Hazardous Chemicals*

Chromatographic adsorbent
Glassware
Filter papers
Filter aids
Rubber and plastic
protective clothing

Other examples of non-hazardous bio-chemicals include polysaccharides, nucleicacids and naturally occurring precursors, and dry biological media

APPENDIX K
MTSU CHEMICAL WASTE DISPOSAL POLICY

Waste Management Policy

Waste Management

A waste management plan should be in place before work begins on any laboratory activity. The plan should utilizethe following hierarchy of practices:

- Reduce waste sources. The best approach to minimize waste generation is by reducing the scale ofoperations, reducing its formation during operations, and, if possible, substituting less hazardous chemicals for a particular operation.

- Reuse surplus materials. Only the amount of material necessary for an experiment should be purchased,and, if possible, materials should be reused.

- Recycle waste. If waste cannot be prevented or minimized, consider recycling chemicals that can be safelyrecovered or used as fuel.

- Dispose of waste. Sink disposal is **NEVER** appropriate. Proper waste disposal methods should be implemented. Environmental health and safety (EH&S) office should be consulted in determining whichmethods are appropriate for different types of waste.

According to the EPA: "***Hazardous waste is waste that is dangerous or potentially harmful to our health or theenvironment. Hazardous wastes can be liquids, solids, gases, or sludge***. EPA-Hazardous Waste Definition

Types of hazardous waste:
1. Listed Wastes
2. Characteristic Wastes
3. Universal Waste
4. Mixed Waste

Listed Wastes

By definition, EPA determined that some specific wastes are hazardous. These wastes are incorporated into listspublished by the Agency. These lists are organized into three categories:

1. **The F-list** (non-specific source wastes). This list identifies wastes from common manufacturing and industrial processes, such as solvents that have been used in cleaning or degreasing operations. Because the processesproducing these wastes can occur in different sectors of industry, the F-listed wastes are known as wastes from non-specific sources. Wastes included on the F-list can be found in the regulations at 40 CFR §261.31

2. **The K-list** (source-specific wastes). This list includes certain wastes from specific industries, such as petroleumrefining or pesticide manufacturing. Certain sludges and wastewaters from treatment and production processes in these industries are examples of source-specific wastes. Wastes included on the K-list can be found in the regulations at 40 CFR §261.32

3. **The P-list and the U-list** (discarded commercial chemical products). These lists include specific commercial chemical products in an unused form. Some pesticides and some pharmaceutical products become hazardouswaste when discarded. Wastes included on the P- and U-lists can be found in the regulations at 40 CFR §261.33

Characteristic Wastes: 40 CFR Part 261 Subpart C

Characteristic wastes are not listed specifically by their chemical name but they are regulated as hazardous wastesbecause they exhibit one or more hazardous characteristics; Ignitability, Corrosivity, Reactivity, and Toxicity.

Ignitability characteristic applies to wastes that are: 40 CFR §261.21

- Liquids with a flash point less than 140°F
- Solids capable of spontaneous combustion under normal temperature and pressure
- Oxidizing materials
- Ignitable compressed gases
- Examples include ethanol, sodium nitrate, hydrogen gas, xylene and acetone

Corrosivity characteristic applies to wastes that are: 40 CFR §261.22

- Aqueous solutions with a pH less than or equal to 2 or greater than or equal to 12.5
- This does not apply to solid or non-aqueous materials
- Examples include hydrochloric acid, nitric acid, and sodium hydroxide

Reactivity characteristic applies to the following: 40 CFR §261.23

- Materials that react violently or generate toxic fumes when mixed with water
- Cyanide or sulfide bearing wastes which evolve toxic fumes when mixed with acids or bases
- Materials that are normally unstable or explosive
- Examples include sodium metal, reactive sulfides, potassium cyanide and picric acid

Toxicity characteristics applies to the following: 40 CFR §261.24

- Waste that have potential to contaminate groundwater if improperly disposed.
- Waste that have the potential to leach out specific toxic substances in a landfill.

Universal Waste: 40 CFR part 273

Waste that are federally designated as “universal wastes," include:

- batteries
- pesticides
- mercury-containing equipment (e.g., thermostats)
- lamps (e.g., fluorescent bulbs)

Mixed Waste: Mixed Waste Rule

Mixed waste contains both radioactive and hazardous waste components. As a result, both treatment and regulation arecomplex. Contact EH&S before generating mixed waste.

Collection and Storage of Waste:

- Chemical waste should be accumulated at or near the point of generation, under the control of laboratoryworkers.
- Each waste type should be stored in a compatible container pending transfer or disposal.
- Incompatible waste types should be kept separate to ensure that heat generation, gas evolution, or anotherreaction does not occur.
- Waste containers should be segregated by how they will be managed. Waste containers should be stored in adesignated location that does not interfere with normal laboratory operations. Ventilated storage and secondary containment may be appropriate for certain waste types.
- Waste containers should be clearly labeled and kept sealed when not in use. Labels should include the content,accumulation start date and hazard warnings as appropriate.

Labeling:

In order to comply with state and federal regulations and University policy, the following information must appear oneach container of hazardous waste.

a) "Hazardous Waste": State and federal regulations require that each container must be clearly marked with thewords, "Hazardous Waste".

b) Chemical Constituents: Write all constituents, whether hazardous or non-hazardous, on the waste label. Formulas, trade names, abbreviations, and general names and nomenclature are not acceptable. The proper chemical name must be written out in its entirety. Provide percentage of constituents, if known. Estimates areacceptable.

c) An accumulation start date.

Hazardous waste label

Unlabeled hazardous waste container

Properly labeled hazardous waste container

Hazardous Waste Pickup Information

Hazardous waste disposal is done on a semi-annual bases. Contact EHS Services for all hazardous waste disposal.Information required:

- **A written inventory of all hazardous waste containing;**
  - **Waste type**
  - **Quantity**
  - **Container size**
  - **Location(s) and Contact person**
- **Email inventory to EHS @ ehs@mtsu.edu**

For additional information on hazardous waste disposal visit:
http://www.mtsu.edu/chemistry/docs/Disposal%20of%20Hazardous%20Waste.pdf

APPENDIX L
CHEMICAL SPILL RESPONSE GUIDELINES

The range of types and quantities of hazardous substances used in MTSU teaching and research laboratories make it impractical to provide a comprehensive plan for dealing with chemical spill incidents. Each lab group is expected to deal with minor spills (see definitions, below) occurring in their area. This requires pre-planning, training and rehearsal.

This document provides a template for the development of an individualized spill response plan. Download andmodify the document to suit your needs.

1. **Types of Spills**
    1. Minor spills are those which can be handled by the lab group, typically low volumes of materials that are not volatile, highly toxic or highly reactive.
    2. Major spills are those which require notification of or assistance from EHS and/or other external agencies. A spill should be considered major in the following instances:
        - There is a fire or the threat of fire.
        - There is personal injury or exposure likely to require medical assistance.
        - The spill involves unknown, volatile, highly toxic, or highly reactive material. There is a releaseof a toxic or flammable gas outside of a controlled space.

2. **Personnel to Be Notified**

Position	Name	Work Phone	Home/Cell Phone
Lab Manager			
Primary Investigator			
DSO/Building Mgr.			
University Police		615-898-2424	
MTSU EHS			

3. **Spill Control/Containment Material/Supplies**

Spill control/containment materials for this laboratory are located:______________________

____

(See the Material tables in this document for recommended list of materials/supplies).

4. Minor Chemical Spill Procedures

Note: Long pants and non-absorbent shoes must be worn when cleaning up chemical spills.

- Alert People in the immediate area of spill
- Put on protective equipment, including safety goggles, suitable gloves, and long-sleeved lab coat.
- Confine spill to small area.
- Use appropriate materials to neutralize and absorb inorganic acids and bases.
- For other liquids, absorb spill with vermiculite, dry sand, or absorbent pads.
- For solid spills, cover the spill with a slight damp paper towel to avoid creating a cloud of dust, Push the material into a dustpan or other instrument using the towel. Do not use a broom or dust brush.
- Collect material, used absorbent/neutralizing agents, etc. in a polyethylene bucket or bag.
- Place collected small spill material in the designated waste area in the lab until scheduled waste pickup.

5. Major Chemical Spill Procedures

- Secure the area.
- Attend to injured or contaminated persons and remove them from exposure.
- Alert people in the area to evacuate. If danger is believed sufficient – pull the fire alarm and evacuate the building.
- If spill material is flammable, turn off ignition and heat sources if that can be done safely.
- Close doors to affected area.
- Call University Police at 615-898-2424. Proved as much information as possible such as:
    - Spill Location, chemicals involved, and approximate amount spilled
    - Nature of any injuries
    - What control measures have been taken
    - Your Name, Phone, and your current location.
    - Meet Responders at a designated location

6. Type of Material/Clean-Up Procedure

Table 1 below provides a synopsis of types of chemicals that may be spilled and recommended cleanup materials. This list should be amended to add any chemicals requiring special procedures. As always, the SDS on the particular chemical is preferable reference. If you chose to purchase pre-packaged, commercially available spill kits, the cleanup procedures should be modified to reflect the kit's instructions.

Table 1: Quick Reference for Spill Cleanup

Chemical Spill	Cleanup Procedures
Acids, organic	Apply sodium bicarbonate. Adsorb with spill pillow or vermiculite.
Acids, inorganic	Apply sodium bicarbonate/calcium oxide or sodium carbonate/calcium oxide. Adsorb with spill pillow or vermiculite. NOTE: Hydrofluoric acid is an exception to the general practice, see below.
Acid chlorides	Do not use water. Absorb with sand or sodium bicarbonate.
Aldehydes	Absorb with spill pillow or vermiculite.
Aliphatic amines	Apply sodium bisulfite. Adsorb with spill pillow or vermiculite.
Aromatic amines	Absorb with spill pillow or vermiculite. Avoid skin contact or inhalation.
Aromatic halogenated amines	Absorb with spill pillow or vermiculite. Avoid skin contact or inhalation.
Azides	Absorb with spill pillow or vermiculite. Neutralize with 10% ceric ammonium nitrate solution.
Bases (caustic alkalis)	Neutralize with acid, citric acid, or commercial chemical neutralizers. Absorb with spill pillow or vermiculite.
Carbon disulfide	Adsorb with spill pillow or vermiculite.
Chlorohydrins	Absorb with spill pillow or vermiculite. Avoid skin contact or inhalation.
Cyanides	Cover solids with damp paper towel and push onto dustpan or use a HEPA filter vacuum to collect the solids. Absorb with spill pillow or vermiculite.
Halides, organic or inorganic	Apply sodium bicarbonate.
Halogenated hydrocarbons	Absorb with spill pillows or vermiculite.
Hydrazine	Avoid organic matter. Apply "slaked lime". Adsorb with spill pillow or vermiculite.

Table 1: Quick Reference for Spill Cleanup (cont'd)	
Chemical Spill	**Cleanup Procedures**
Hydrofluoric acid CAUTION!	Adsorb with calcium carbonate (limestone) or lime (calcium oxide). The use of sodium bicarbonate will lead to the formation of sodium fluoride, which is considerably more toxic than calcium fluoride. **CAUTION:** Some spill pillows contain silicates that are incompatible with hydrofluoric acid.
Inorganic salt solutions	Apply soda ash.
Mercaptans/organic sulfides	Neutralize with calcium hypochlorite solution. Absorb with spill pillow or vermiculite.
Nitriles	Sweep up solids. Absorb liquids with spill pillows or vermiculite.
Nanoparticles	Pick up particles with a HEPA or ULPA filtered vacuum.
Nitro compounds/organic nitriles	Absorb with spill pillow or vermiculite. Avoid skin contact or inhalation.
Oxidizing agents	Apply sodium bisulfite.
Perchloric acid	Neutralize with sodium bicarbonate or other inorganic acid neutralizer. Sweep up neutralized spill with a non-flammable material and then cleanthe spill area thoroughly with water. **DO NOT** use rags, paper towels, sawdust, or other organic materials to soak up perchloric acid spills.
Peroxides	Absorb with spill pillow or vermiculite.
Phosphates, organic and related	Absorb with spill pillow or vermiculite.
Reducing substances	Apply soda ash or sodium bicarbonate.

7. Spill Clean Up Materials

Each laboratory/or lab group should have enough material to handle a spill that represent that worst-case scenario. Ensure the appropriate PP# (e.g., chemical-resistant gloves, splash goggles, shoe covers, chemical-resistant lab coats/Tyvek, etc.) is available. Additionally, each laboratory, especially those with floor drains should have spill socks, pillows, pads or bulk absorbent to prevent hazardous materials form being released into the environment. Table 2 below represent contents of a spill kit for a ”typical “ laboratory. If your lab contains special hazards not addressed in this guidance, consult the relevant literature or contact EHS.

Table 2. Spill Kits and Usages

Material	Spill Type	What it does.
Mercury adsorb powder	Elemental mercury	Converts elemental mercury on work surfaces, incracks, and hard to reach places into metal/mercury amalgam.
Dry acid neutralizer	All acids except hydrofluoric acid (HF)	Neutralizes acids
Dry Hydrofluoric acid neutralizer	Hydrofluoric acid	Neutralizes hydrofluoric acid
Formaldehyde polymerizer	Formaldehyde/formalin	Reacts with water-based formaldehyde solutions to form a nontoxic, polynoxylin polymer whichyields a plastic like solid
Activated carbon	Flammable solvents	Cleans up flammable solvent spills and suppresses hazardous vapors
Solid-A-Sorb	All spills except HF	Mixes well with water and oil-based substances
Sorbent pads	Liquids	Quickly contains small spills
Sorbent socks or booms	Liquids	Quickly contains larger spills
Hydrophobic (oil-only) absorbent spill socks	Oil/pump oil spills	Absorbs oil spill and forms a barrier around floor drains to prevent oil from entering waterway
Oil spill pads	Oil/pump oil	For placement under pumps and work tops to absorb oil used in procedures

APPENDIX M
USE AND STORAGE OF
INERT CRYOGENIC LIQUIDS

Scope

This policy applies to all Middle Tennessee State University faculty, staff, students, and part time employees who use inert cryogenic liquids (including argon, nitrogen, and helium) in university facilities, including research and teaching laboratories. The Environment, Health & Safety Department (EHS) has established this policy to provide a safe and healthy working environment for all faculty, staff, and students. This policy is intended to ensure that facilities where inert cryogenic liquids are used and stored have the proper engineering controls and postings and that university staff are provided with the knowledge and training necessary to work safely when using inert cryogenic liquids.

Policy Background

Cryogenic liquids are liquefied gases that are kept in their liquid state at very low temperatures. Cryogenic liquids have boiling points below -150°C (- 238°F). Inert cryogenic liquids do not undergo chemical reactions under normal conditions and are considered to be non- toxic. The gases they give off are colorless, odorless, and tasteless which can make a leak or exposure difficult to detect. Their low temperatures can cause cryogenic burns on contact with skin and embrittle materials leading to structural damage. More significantly, the high expansion ratio of these liquids increases the potential to create dangerous oxygen deficient atmospheres leading to the possibility of asphyxiation of individuals working in or entering facilities. *See Tables 2 and 3 for information on the asphyxiation hazards of inert cryogenics*. Without a proper hazard analysis followed by implementation of the necessary controls, university students and staff may be at risk for an adverse event.

Note: While certain materials such as cryogenic liquid carbon dioxide do not technically fit in the definition of inert cryogenic liquids, many of the required elements outlined in the policy will be enforced as determined by EHS.

Policy

MTSU EHS has defined four risk levels of hazard for facilities that use or store inert cryogenic liquids. These levels are outlined in Table 1. Each defined level imposes requirements on engineering controls, administrative controls, postings, and training. All facilities where inert cryogenic liquids are used shall be evaluated and assigned a risk level by EHS. Once a level is assigned by EHS staff all required actions shall be taken to minimize the risk.

In order to enact this policy, the following **responsibilities** are assigned:

EH&S: The Environment Health & Safety Department has the responsibility to:

- Establish reasonable risk-based levels for inert cryogenic liquid usage;
- Assess facilities housing inert cryogenic liquids to define the hazard level and recommend necessary controls;
- Provide training on general hazards associated with use of inert cryogenic liquids;

- Provide technical assistance to Principal Investigators and Facility Managers when necessary;
- Periodically review operations of all identified Level 2, 3, and 4 spaces to ensure that all required elements of the safety plan are enacted.

Principal Investigators (PIs) or Facility Managers: Principal Investigators, facility managers, or other personnel in charge of laboratories or other facilities have the responsibility to:

- Contact EHS prior to initial use of inert cryogenic gases;
- Implement and maintain the controls and practices determined by policy and the hazard level set forth by EHS;
- Ensure appropriate personnel have general and facility-specific training of hazards and appropriate procedures for working with cryogens;
- Maintain documentation of required activities (such as training, monitoring, calibrating detectors, etc.);
- Ensure that all oxygen monitors and other engineering controls are operating properly and that they are calibrated as required.

Note: Some of these duties can be delegated to the Lab Manager/Safety Officer or other facility personnel.

Staff and Students: Individuals working in facilities that use cryogenic liquids have the responsibility to:

- Understand the hazards associated with the use of cryogens;
- Follow the policies and lab rules set forth by the PI or facility manager;
- Only operate systems for which they are trained and authorized;
- Notify supervisor and/or PI of any apparent safety hazard.

MTSU Environmental Health and Safety Committee (EHSC): EHSC reviews and approves policies related to the safety of University staff and students.

Information on Policy Requirements and Implementation

This section provides details on additional requirements and information on policy implementation. Table 1 provides a summary of the levels referred to in this section.

Hazard Evaluation Process

In order to evaluate the hazard of a particular room containing inert cryogenic liquids several parameters will be considered, including:

- The amount of cryogen present and how it is used;
- The size of the laboratory (See Table 3);
- Room ventilation;

- Failure modes (including worst-case scenarios) necessary to bring about a hazardous situation.

Using these criteria, the likelihood of a failure leading to an Oxygen Deficiency Hazard (ODH) will be assessed and a hazard level assigned. If the laboratory/facility operations change or the quantity of cryogenic liquid in the space is in either increased or decreased the space shall be reassessed.

Engineering Controls

Ventilation

The space where inert cryogenic liquids are stored or used must be properly ventilated according to National and State standards while also considering any additional ventilation needs due to the amount of material in that space. Under no circumstances shall inert cryogenic liquids be stored in an unventilated room.

For Level 4 facilities emergency ventilation is typically required where oxygen depletion can occur rapidly. The ventilation system will immediately increase the air exchange within the facility.

Oxygen Monitors

Room oxygen monitors must be in place in Level 3 and 4 facilities. Normally, these monitors will be set to alarm when the concentration of oxygen drops below 19.5%. The number of monitors needed, and their placement will depend on the room dimensions, size of the cylinders, the quantity of the cylinders, the types of cryogenic gas being used, whether the gas is being piped into a room, and height of the ceiling. Liquid nitrogen is heavier than air, so it is recommended that the monitors are mounted closer to the ground as opposed to higher up in the air.

The oxygen monitors must give both audible and visual alarm when oxygen levels drop below the alarm point. The alarm must be noticeable before entering the room. In some instances, the hazard evaluation will indicate the need for personal monitors to be carried by each individual entering the facility. Training and postings must include the necessary response to an alarm.

Each department/purchaser is responsible for ensuring that the oxygen monitors are operating properly and are calibrated as required. The EHS will keep a record of facilities containing oxygen monitors and will ensure that maintenance is being performed by the perspective labs.

You can contact EHS for recommendations or examples of appropriate oxygen monitors.

Administrative Control

Administrative controls and workplace-specific rules should be in place to address any hazards in the lab. Common administrative controls that may be necessary include, but are not limited to:

- Maximum quantity limits for room space;
- Written safe working procedures;
- A 2-person rule requirement;
- Limited access to hazardous areas;
- Emergency response procedures.

The appropriate administrative controls will be determined during the hazard assessment.

Personal Protective Equipment

Appropriate PPE must be worn when handling or dispensing cryogenic liquids. When handling inert cryogenic liquids, it is typically necessary to wear safety goggles, closed-toed shoes, long sleeved shirts, and long pants always. Face shields and thermal gloves should be worn whenever filling a Dewar or transferring large amounts of cryogenic liquid. These items must be provided by the employer and available to anyone working with cryogens.

Storage

Cryogens should be stored in containers specifically designed to house them. The containers should be insulated and double walled. Store all cryogenic liquid containers upright in well-ventilated areas. Handle them carefully, and avoid dropping, rolling, or tipping them on their sides. Cryogen tanks and containers should not be stored near elevators, walkways, and unprotected platform edges or in locations where heavy moving objects may strike or fall on them.

Transporting Cryogenic Liquids

Cryogenic liquid containers should be moved on a hand truck, cart, or other appropriate transportation method. Containers need to be secured while being transported and kept upright at all times. If inert cryogenic liquids must be transported by elevator, routes and procedures should be evaluated to ensure that the cryogens can be moved safely. In the event of a power failure a passenger would be trapped in the confined space of an elevator with the container containing the cryogenic liquid. Evaporation of the liquids could lead to displacement of oxygen.

Evaluation of the routes should consider the amount of material being transported, the vessel used, typical evaluation rates, and ventilation in all locations, including elevators. Mitigating procedures such as sending containers alone on elevators or keeping others informed as to when cryogenic liquids are being transported may be required based on a hazard assessment.

Training

Students and staff working with or around cryogenic liquids must be trained on the procedures for its use and be made aware of the hazards involved. Training must be documented with trainee signatures and training dates. General training can be received through EHS. Facility specific training must also be provided by the PI/Facility Manager or designee. The training received shall provide information on the following topics:

- Properties and hazards of the cryogen being used;
- Personal Protective Equipment (PPE) requirements;
- Facility-specific procedures, including appropriate handling and filling methods;
- Proper use and function of engineering controls, including oxygen monitors, instrument interlocks, fume hoods, and other room ventilation;
- Review of all administrative controls;
- Incident/Exposure response and emergency contact;
- Transporting cryogenic liquids.

Signage/Postings

Any facility categorized as level 2 or higher shall have signage and/or warning information posted at the room's entrance.

Level 2 Signage:
All rooms assigned as risk level 2 must be posted with a sign indicating the presence of an inert cryogenic liquid. The posting will be chosen at the discretion of the Office of Chemical Safety. The signage will be either:

Warning Sign informing the public of the presence of a cryogenic liquid. This sign indicates the potential for low oxygen environments.

Danger Sign with information on who to contact in case of emergency or other concerns. This indicates the potential for an oxygen deficiency hazard of %15 or less.

Figure 1: Example sign posting for Level 2 Facility

Level 3 and 4 Signage:

All rooms assigned as risk level 3 and 4 must be posted with a sign indicating the following:

- Presence of liquid nitrogen
- Do not enter if alarm is sounding
- Instructions for what to do in case of emergency

Level 4 facilities must also post entry requirements and may require additional signage or restrictions.

Figure 2: Example sign posting for Level 3 and 4.

Table 1 – Risk Level for Facilities using Inert Cryogenic Liquids * Oxygen Deficiency Hazard (ODH)

Level	Risk	General Requirements	Definition/Typical Application
Level 1	Cold burn risk Insignificant ODH	Inert Cryogenic Safety Training (This includes PPE usage)	Minimal use where a worst-case scenario (such as Dewar spill) will not bring O_2 level below 18%
Level 2	Cold Burn Risk Low ODH Impaired coordination	Inert Cryogenic Training Cryogenic Signage and Posting: Warning/Danger (if level can drop below 15%) Ventilation Site specific training	Typical in locations where liquid nitrogen is stored or its use does not require extensive transfer. Worst-case scenario calculations may show that O_2 level may drop as low as 15%. Lower levels are possible if 2 independent modes of low probability are required to reach the level.
Level 3	Medium ODH Impaired coordination, perception, and judgement	Inert Cryogenic Training Cryogen Signage and Posting Ventilation Oxygen Monitors	Typical in locations where large amounts of inert cryogenics are transferred or where a single failure mode can lead to oxygen levels below 15%.
Level 4	High ODH Mental Failure, Unconsciousness or death	Inert Cryogenic Training Cryogen Signage and Posting Ventilation Oxygen Monitors Plus some or all of the following: • Personal Monitors • 2-person rule • Secured Facility • Rescue Oxygen • Emergency Ventilation	Highest hazard level. O_2 level may drop below 12% quickly in the event of a release or failure. **The EHS office must be notified and a hazard assessment must be performed.**

Table 2 – Effects of Oxygen Deficiency

Oxygen Levels (%)	Symptoms of Exposure
19.5	Minimum oxygen level without adverse effect.
15 to 19	Decreased ability to work strenuously. Impaired coordination. Early symptoms.
12 to 14	Breathing rate increases, increase in heart rate. Impaired coordination, perception, and judgment.
10 to 12	Breathing further increases in rate and depth, lips turn blue. Poor judgment.
8 to 10	Mental failure. Fainting. Nausea. Unconsciousness. Vomiting.
6 to 8	8 minutes – fatal, 6 minutes – 50% fatal, 4 – 5 minutes – possible recovery.
4 to 6	Coma in 40 seconds, Convulsions, Breathing stops, Death.

Table 3 – Oxygen Concentration and Laboratory Size

	Oxygen Concentration			
Laboratory Size	**17.5% O_2**	**15% O_2**	**12%O_2**	**8% O_2**
20 ft^2	1L	2L	3L	4L
40 ft^2	2L	4L	5L	8L
60 ft^2	3L	6L	8L	12L
80 ft^2	4L	7L	11L	16L
100 ft^2	5L	9L	14L	20L
150 ft^2	8L	14L	21L	30L
200 ft^2	11L	18L	25L	40L
250 ft^2	13L	23L	35L	50L
300 ft^2	16L	30L	40L	55L
350 ft^2	18L	30L	50L	70L
400 ft^2	21L	35L	55L	80L

** Amounts of Liquid Nitrogen are approximate and have been rounded to the nearest whole liter*

The percentages are calculated under the following assumptions: No ventilation, standard temperature and pressure, 8 ft. ceiling height, and an expansion ratio of 694

APPENDIX N
PURCHASE AND INITIAL USE OF
HIGH-HAZARD GAS CYLINDERS

Scope

This policy applies to all Middle Tennessee State University faculty, staff, students, and part-time employees that use compressed gas cylinders containing high-hazard gases in University facilities, <u>including research and teaching laboratories</u>.

Policy Background

The Middle Tennessee State University is dedicated to providing a safe and healthy working environment for all faculty, staff, students, and visitors. Cylinders containing compressed or liquefied gases pose a significant safety hazard if proper care is not taken in the storage, set-up, and use of the gases.

Policy

The MTSU requires approval by the Environment, Health & Safety Department (EH&S) prior to both the initial purchase and initial use of the high-hazard gases falling into the categories listed below. Approval is not required for re-orders of gas cylinders if their use has not changed. This policy is designed to ensure that the users have performed a hazard assessment, enacted appropriate engineering controls, and have received the necessary training prior to using the gases. It is the responsibility of the individual who intends to use a high-hazard gas to contact the EHS prior to ordering. The EHS can be contacted via phone at 615-898-5689
.
The gases in the following hazard classes are subject to this policy:

I. All gases that are designated by Global Harmonization System (GHS) classification as Category 1 or 2 for acute toxicity;

II. All corrosive gases as designated by GHS, including both gases that are corrosive to the skin and/or corrosive to metal;

III. All pyrophoric gases.

Appendix 1 of this document lists some of the most common hazardous gases, by class, which fit the above criteria. This policy applies to the properties of the contents of cylinders taken as a whole, not the individual components. For example, a pure gas may have acute toxicity and be subject to this policy while a gas mixture containing a high percentage of an inert gas along with the same toxic gas may not be subject to this policy. Contact the Chemical Safety Office for additional information on which gases or gas mixtures may meet the above criteria.

NOTES: Certain vendors require formal risk assessments prior to selling specific gases – some which are outside the above criteria. In these instances, EH&S will work with the vendors and MTSU staff to ensure that the assessments are performed. Use of gas cylinders is also subject to various restrictions and regulations as outlined in the MTSU Safety Handbook and the MTSU Chemical Hygiene Plan.

Additional Information

Information on the classes of gases subject to this policy is given below.

Gases with Acute Toxicity

Gases designated as Category 1 for acute toxicity have a median lethal concentration (LC50) in air of 100 parts per million (ppm) or less by volume based on a 4-hour animal exposure. Category 2 gases have a LC50 greater than 100 ppm and equal to/or greater than 500 ppm. When experimental values are taken from tests using a 1-hour exposure, they can be converted to a 4-hour equivalent by dividing the 1-hour value by a factor of 2 for gases and vapors. Safety Data Sheets for gases meeting these criteria (in addition to the Health Hazard GHS pictogram) will have the following hazard statement: **"Fatal if Inhaled"**

Pyrophoric Gases

A pyrophoric substance is a chemical that will ignite spontaneously in air at a temperature of 130 degrees Fahrenheit (54.4 degrees C) or below. Pyrophoric gases (in addition to the Flame GHS pictogram) will have the following hazard statement: **"Catches fire spontaneously if exposed to air"**

Corrosive Gases

Gases designated as a skin corrosive cause visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact, typically based on 4-hour (or less) animal exposure studies. Gases designated as corrosive to metal have a corrosion rate on either steel or aluminum surfaces exceeding 6.25 mm per year at a test temperature of 55°C (131°F) when tested on both materials. Corrosive gases (in addition to the Corrosion GHS pictogram) will have the following hazard statements: **"Causes severe skin burns and eye damage"** or **"May be corrosive to metals"**

More in-depth information on the Global Harmonization System can be found on the Occupational Safety and Health Administration's website.

- A guide to "*A Guide to the Globally Harmonized System of Classification and Labeling of Chemicals*"
- The Appendices to 29 CRF 1910.1200 (*Hazard Communication*) provide detailed information on the classifications. See Appendix A of the above reference regulation for information on acute toxicity and corrosion classes and Appendix B on pyrophoric materials.

Table 1 - List of Pure Gases Subject to this Policy
Below is a list of common gases that fall into the three defined hazard classes which are subject to this policy. The list should not be construed as a complete list. Note that some gases fall into more than one class.

Table 1 – Lists of Pure Gases subject to this Policy

Corrosive Gases	**Toxic Gases**	**Pyrophoric Gases**
Ammonia (NH_3)	Arsine (AsH_3)	Arsine (AsH_3)
Boron Trifluoride (BF_3)	Boron Trifluoride (BF_3)	Diborane (B_2H_6)
Boron Trichloride (BCl_3)	Chlorine (Cl_2)	Phosphine (PH_3)
Chlorine (Cl_2)	Chlorine Dioxide (ClO_2)	Silane (SiH_4)
Chlorine Dioxide (ClO_2)	Chlorine Trifluoride (ClF_3)	Stibine (SbH_3)
Chlorine Trifluoride (ClF_3)	Diborane (B_2H_6)	
Dichlorosilane (SiH_2Cl_2)	Dichlorosilane (SiH_2Cl_2)	
Fluorine (F_2)	Formaldehyde (CH_2O)	
Hydrogen Bromide (HBr)	Fluorine (F_2)	
Hydrogen Chloride (HCl)	Germane (GeH_4)	
Hydrogen Fluoride (HF)	Hydrogen Cyanide (HCN)	
Methylamine (CH_3NH_2)	Hydrogen Selenide (H_2Se)	
Nitric Oxide (NO)	Hydrogen Sulfide (H_2S)	
Sulfur Dioxide (SO_2)	Nickel Carbonyl [Ni $(CO)_4$]	
Sulfur Tetrafluoride (SF_4)	Nitrogen Dioxide (NO_2)	
Trimethylamine ($N(CH_3)_3$)	Phosgene ($COCl_2$)	
	Phosphine (PH_3)	
	Stibine (SbH_3)	
	Sulfur Tetrafluoride (SF_4)	

APPENDIX O

PROPER AUTOCLAVE USAGE FOR USABLE GOODS

Below are the guidelines and procedures for Autoclave Usage in the Laboratories:

1. Always assume the autoclave is hot.
2. Make sure that liquids to be autoclaved do not exceed 60% of the vessel capacity.
3. Make sure that all vessels are loosely covered with either aluminum foil or with a lid and that all other items are wrapped in aluminum foil.
4. Place items that need to be sterilized in the autoclave.
5. Fill the bottom of the autoclave with deionized water to just below the ledge at the bottom of the door opening. This water can be obtained from either of the two large carboys residing next to the autoclaves or the deionized water faucet located at the sink opposite the autoclaves.
6. Close the door by pulling down on the handle until the bottom of the door seal rests in the bottom of the door opening.
7. Rotate the handle forward, engaging the lower curved portion under the horizontal rod at the bottom of the door opening.
8. With little pressure, push down on the handle until the door is locked securely in position. (NOTE: This should require very little effort. If the door is difficult to close, then open and begin the process again).
9. Set the exhaust selector to either fast or slow exhaust. <u>Any vessel containing liquids should always be set to the liquid cycle.</u> All other items can be set to fast or slow exhaust.
10. Push the reset button for low water indication.
11. Set the timer for no less than 15 minutes.
12. While wearing the appropriate gloves and standing off to the side, the autoclave my be opened after the timed cycle is complete and **when the pressure has reached zero**. The temperature gauge does not need to be at zero. (NOTE: **<u>DO NOT</u>** ATTEMPT TO OPEN THE AUTCLAVE UNDER ANY CIRCUMSTANCES IF THE PRESSURE IS NOT AT ZERO. **<u>SEVERE BURNS MAY OCCUR</u>**).
13. While still wearing the appropriate gloves, remove all items and set aside in an appropriate area to cool. If necessary, mark the area with a caution: **HOT!!** sign.

APPENDIX P

Guidelines for Laboratory Equipment

Laboratory Equipment – Aerosol Production
The term “aerosol” refers to liquid or solid particles suspended in air. These can pose a serious risk because small aerosols readily penetrate and remain deep in the respiratory tract, they can remain suspended in the air for long period of time, and they easily contaminate equipment and ventilation systems. The following equipment may produce aerosols:

- Centrifuge
- Blender
- Shaker
- Magnetic stirrer
- Sonicator
- Pipet
- Vortex mixer
- Syringe and needle
- Grinder, mortar and pestle
- Separatory funnel

Follow these guidelines to eliminate or reduce the hazards associated with aerosols:

- Conduct procedures that may produce aerosols in a biological safety cabinet or a chemical fume hood, as appropriate.
- Keep tubes stoppered when vortexing or centrifuging.
- Allow aerosols to settle for one to five minutes before opening a centrifuge, blender or tube.
- When combining liquids, discharge the secondary material down the side of the container or as close to the surface so the primary liquid as possible.
- Use a mechanical pipetting device.

Laboratory Equipment – Centrifuges
Centrifuging presents the possibility of two serious hazards: mechanical failure and aerosols. The most common hazard associated with centrifuging is a broken tube. To ensure safety when operating a centrifuge, take precautions to ensure the following:

- Proper loading (accurate balancing)
- Safe operating speeds (do not exceed manufacturing recommendations)
- Safe stopping
- Complete removal of materials
- Proper cleanup
- Follow these guidelines when working with a centrifuge:
- When loading the rotor, examine the tubes for signs of stress and discard any tubes that are damaged.
- Inspect the inside of each tube cavity or bucket. Remove any glass or other debris from the rubber cushion.
- Ensure that the centrifuge has adequate shielding to guard against accidental 'fly-aways'.
- Use a centrifuge only if it has a disconnect switch that deactivates the rotor

when the lid is open.
- Always keep the lid closed during operations and shut down. Do not open the lid until the rotor is completely stopped.
- Do not break the head rotation by hand.
- Do not use aluminum foil to cap a centrifuge tube. Foil may rupture or detach.
- When balancing the rotors, consider the tubes, buckets, adapters, inserts and any added solution.
- Stop the rotor and discontinue operation if you notice anything abnormal such as a noise or vibration.
- Rotor heads, buckets, adapters, tubes and plastic inserts must match.

High-speed centrifuges pose additional hazards due to the higher stress and force applied to their rotors and tubes. In addition to the safety guidelines outlined above, follow these guidelines for high-speed centrifuges:
- Filter the air exhausted from the vacuum lines.
- Keep a record of rotor usage in order to avoid the hazard of metal fatigue.
- Frequently inspect, clean and dry rotors to prevent corrosion or other damage.
- Follow the manufacturers operating instructions exactly.

Laboratory Equipment – Electrophoresis

Electrophoresis equipment may be a major source of electrical hazard in the laboratory. The presence of high voltage and conductive fluid in this apparatus presents a potentially lethal combination. Many people are unaware of the hazards associated with this apparatus; even a standard electrophoresis operating at 100 volts can deliver a lethal shock at 25 milliamps. In addition, even a slight leak in the device tank can result in a serious shock. Protect yourself from the hazards of electrophoresis and electrical shock by taking these precautions:

- Use physical barriers to prevent inadvertent contact with the apparatus.
- Use electrical interlocks.
- Frequently check the physical integrity of the electrophoresis equipment.
- Use warning signs to alert others of the potential electrical hazard.
- Use only insulated lead connectors.
- Turn the power off before connecting the electrical leads.
- Connect one lead at a time using one hand only.
- Ensure that your hands are dry when connecting the leads.
- Keep the apparatus away from water and water sources.
- Turn the power off before opening the lid or reaching into the chamber.
- Do not disable safety devices.
- Follow the equipment operating instructions.

Laboratory Equipment – UV Light Tables

UV or ultraviolet lamps are used in biological safety cabinets, light boxes, and cross linkers in many university laboratories. One of the problems in working with UV radiation is that the symptoms of overexposure are not immediately felt so that persons exposed do not realize the hazard until after the damage is done.

UV radiation is that radiation just outside the visible range, or under 400 nanometers (nm). A University lab employee received skin and eye burns while using an acrylic plastic shield for protection against UV. The lab did not realize that the shield had not been manufactured for this use and was not rated for protection against UV light. Please check your safety equipment to ensure that it is rated for the wavelength in use. The health effects of exposure to UV light are familiar to anyone who has had sunburn. However, the UV light levels around some UV equipment greatly exceed the levels found in nature. Acute (short-term) effects include redness or ulceration of the skin. At high levels of exposure, these burns can be serious.

For chronic exposures, there is also a cumulative risk of harm. This risk depends upon the amount of exposure during your lifetime. The long-term risk for large cumulative exposure includes premature aging of the skin and even skin cancer. UV exposure is not immediately felt, so the user may not realize a hazard until after the damage is done. The eyes are also susceptible to UV damage. Like the skin, the covering of the eye or the cornea, is epithelial tissue, too.

The danger to the eye is enhanced by the fact that light can enter from all angles around the eye and not only the direction you are looking in. The lens can also be damaged, but since the cornea acts as a filter, the chances are reduced. This should not lessen the concern over lens damage however, because cataracts are the direct result of lens damage. Burns to the eyes are usually more painful and serious than a burn to the skin. Make sure your eye protection is appropriate for this work. There are specially-made safety glasses for the different UV ranges.

NORMAL EYEGLASSES OR CONTACTS OFFER VERY LIMITED PROTECTION!!
Do not forget to protect the rest of the face. Severe skin burns can happen in a very short time, especially under your chin (where most people forget to cover). Full-face shields are really the only appropriate protection when working with UV light boxes for more than a few seconds.
Be sure to protect your arms and hands by wearing a long-sleeve lab coat and gloves.

Laboratory Equipment – Glassware
Accidents involving glassware are the leading cause of laboratory injuries. To reduce the chance of cuts or punctures, use common sense when working with glassware. In addition, follow special safety precautions for tasks that involve unusual risks. Follow these practices for using laboratory glassware safely:

- Prevent damage to glassware during handling and storage.
- Inspect glassware before and after each use. Discard or repair any cracked, broken or damaged glassware in a sturdy container.
- Thoroughly clean and decontaminate glassware after each use.
- Use special care when working with evacuated glass apparatus. Remember to wrap or shield equipment to contain chemicals or fragments in case of implosion.
- When inserting glass tubing into rubber stoppers or corks, follow these guidelines:
  - a) use adequate hand protection
  - b) lubricate the tubing
  - c) hold hands close together to minimize movement if the glass breaks
- When possible, substitute plastic or metal connectors for glass connectors.
- Large glass containers are highly susceptible to thermal shock. Heat and cool large glass containers slowly.
- Be careful when handling hot glassware and apparatus while in the laboratory. “Hot glass looks just like cool glass”. Use Pyrex or heat-treated glass for heating operations.
- Leave at least 10 percent air space in containers with positive closure.
- Never use laboratory glassware for vacuum operation.
- Use round-bottomed glassware for vacuum operations. Flat-bottomed glassware is not

as strong as round-bottomed glassware.

NOTE: Use a standard laboratory detergent to clean glassware when permitted. Seek advice for laboratory PI for further instructions on other cleaning methods.

Follow these safety guidelines for handling glassware:

- When handling cool flasks, grasp the neck with one hand and support the bottom with the other hand.
- Lift cool beakers by grasping the sides just below the rim. For large beakers, use two hands: one on the side and one supporting the bottom.
- Never carry bottles by their necks.
- Use a cart to transport large bottles of dense liquid (e.g., a 4 liter bottle of Chloroform).

Follow these guidelines for handling and disposing of broken glass:

- Do not pick up broken glass with bare or unprotected hands. Immediately use a brush and dust pan to clean up broken glass. Remove broken glass in sinks by using tongs for large pieces and cotton held by tongs for small pieces and slivers.
- Glass contaminated with biological, chemical, or radioactive materials must be decontaminated before disposal or be disposed of as hazardous waste.
- Dispose of broken glass in the cardboard receptacles located in accessible areas within each laboratory but out of high traffic areas.
- When broken glass container is full, close the box off with the extra flap and alert the proper laboratory contacts or EH&S for disposal and replacement of the broken glass receptacle.

Laboratory Equipment – Sharps Containers

OSHA defines a contaminated sharp as any item that can penetrate the skin, including but not limited to needles, scalpels, broken glass, glass slides, broken capillary tubes, and exposed ends of dental wires. The Standard prohibits the bending, recapping (except in certain circumstances), removal, shearing, or breaking of contaminated needles. Contaminated sharps must be discarded immediately or as soon as possible in sharps containers that are:

- Closable (containers are not required to be closed while in use, only between use and upon removal from use)
- Puncture resistant
- Leakproof on sides and bottom
- Biohazard labeled (including symbol), or container may be red/red-orange color-coded

The Standard requires that sharps containers be easily accessible to personnel and located as close as possible to the immediate area of patient care or other regions where sharps may be encountered but not in an area of high traffic. Sharps containers must be kept upright throughout use, replaced routinely, and never overfilled.

When Sharps Container is full, close the container and alert the proper laboratory contacts or EH&S for disposal and replacement of the Sharps container. Before removal from use, sharps containers must be immediately closed to prevent spillage or protrusion of contents during handling, storage, transport, or shipping. The sharps container must then be carefully placed in a secondary container if leakage is possible. The secondary container must be:

- Closable
- Constructed to contain all contents and prevent leakage during handling, storage, transport, or shipping
- Biohazard labeled (including symbol), or container may be red/red-orange color-coded

Laboratory Equipment – Heating Systems

Common hazards associated with laboratory heating devices include electrical hazards, fire hazards and hot surfaces. Some laboratory heating procedures involve an open flame. Devices that supply heat for reactions or separations include the following:

- Open flame burners
- Hot plates
- Heating mantles
- Oil and air baths
- Hot air guns
- Ovens
- Furnaces
- Ashing systems

IMPORTANT: Never leave an open flame unattended.

Follow these guidelines when using heating devices:

- Ensure that heating units have an automatic shutoff to protect against overheating.
- Ensure that heating devices and all connecting components are in good working condition.
- Heating baths should be equipped with timers to ensure that they turn on and off at appropriate times.
- Use a chemical fume hood when heating flammable or combustible solvents. Arrange the equipment so that escaping vapors do not contact heated or sparking surfaces.
- Use non-asbestos thermal-heat resistant gloves to handle heated materials and equipment.
- Perchloric acid digestions must be conducted in a functioning perchloric fume hood with an EH&S approved wash-down system.
- Minimize the use of open flames.
- Heated chemicals can cause more damage and more quickly than would the same chemicals at a lower temperature. RULE OF THUMB: Reaction rates double for each 10°C increase in temperature.

Laboratory Equipment – Pressurized Systems

Do not conduct a reaction in, or apply heat to, a closed system apparatus unless the equipment is designed and tested to withstand pressure. Pressurized systems should have an appropriate relief valve. Pressurized systems must be fully shielded and should not be conducted in an occupied space until safe operation has been assured. Until safe operation is assured, remote operation is mandatory.

Safety Points to Remember:

- Minimize risk and exposure
- Identify and assess all hazards and consequences
- Use remote manipulations whenever possible
- Minimize pressure, volume and temperature
- Use material with a predictably safe failure mode
- Ensure that the components of the pressurized system will maintain structural integrity at the maximum allowable working pressure; avoid material that may become brittle.
- Operate within the original design parameters
- Provide backup protection (e.g., pressure relief valves, fail-safe devices)
- Use quality hardware
- Use protective shield or enclosures
- Use tie-downs to secure tubing and other equipment
- Do not leave a pressurized system unattended

IMPORTANT: Normally pressurized systems should not include glass components unless they are specially designed and intended for that purpose

Laboratory Equipment – Refrigerators/Freezers

Household refrigerators must not be used to store flammable liquids, unless the flammable liquid container can be secondarily enclosed in a sealed container. Many flammable solvents are still volatile at refrigerator temperatures. The storage compartment of a household refrigerator contains ignition sources such as the thermostat and light. Additionally, the compressor and electrical circuits located at the bottom of the unit where chemical vapors are likely to accumulate are not sealed. This combination of flammable vapor and ignition source has created explosions in many university laboratories.

Laboratory-safe or explosion-proof refrigerators are required if large containers or volumes of flammable liquids must be refrigerated. In laboratory-safe refrigerators the sparking components are located on the exterior of the refrigerator. Explosion-proof refrigerators are required in areas that may contain high levels of flammable vapors (e.g., chemical storage rooms with large quantities of flammable chemicals).

Laboratory Equipment – Cold Traps

A cold trap is a condensing device used to prevent moisture contamination in a vacuum line. Guidelines for using a cold trap include:

- Locate the cold trap between the system and vacuum pump.
- Ensure that the cold trap is of sufficient size and cold enough to condense vapors present in the system.
- Check frequently for blockages in the cold trap.
- Use isopropanol/dry ice or ethanol/dry ice instead of acetone/dry ice to create a cold trap.
- Isopropanol and ethanol are cheaper, less toxic and less prone to foam.
- Do not use dry ice or liquefied gas refrigerant bath in a closed system. These can create uncontrolled and dangerously high pressures.

Laboratory Equipment – Mercury Containing Devices and Thermometers
Mercury thermometers and mercury-containing devices are a major source of contamination from spills, leaks and breaks. Contamination is easily spread and often expensive to clean up.
This is in addition to the usual high cost of disposal. Therefore, the use of mercury containing devices must be phased out as much as practicable. Here are a few ways to better manage mercury containing devices:

- Collect and submit to hazardous waste collection any unwanted mercury thermometers.
- Dispose of any mercury spill cleanup debris as hazardous waste.
- Replace mercury thermometers with alcohol thermometers (blue and red types are alcohol thermometers) whenever possible.
- Dispose of mercury containing items through EHS (these include manometers, some blood pressure cuffs, mercury switches, and thermometers). Always double-bag mercury containing items.
- Do not take mercury containing devices to surplus/salvage unless the mercury has first been removed.
- Do not accumulate more mercury thermometers than you need.

If precision work is being done that necessitates a mercury thermometer, buy a Teflon coated thermometer. The added cost is easily offset compared against the inconvenience and money spent cleaning up broken thermometers