Marywood
UNIVERSITY

Chemical Hygiene Plan

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Marywood University: Chemical Hygiene Plan

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Section 1: Introduction

1.1 Purpose

Marywood University (Marywood) has developed this Chemical Hygiene Plan to designate safety procedures required for working with hazardous chemicals in laboratory settings. This Plan was developed in accordance with the Occupational Safety and Health Administration's Occupational Exposure to Hazardous Chemicals in Laboratories Standard, in addition to various industry Best Practices and recommendations to minimize laboratory accidents and personnel injuries/exposures to hazardous chemicals during covered activities. Mechanisms developed by this Plan include:

1. Ensuring personnel are aware of hazards associated with laboratory activities they perform.
2. Assignment of roles and responsibilities for all levels of personnel that may affect safety procedures and Plan implementation.
3. Hazard assessments in accordance with the American Chemical Society guidelines.
4. Facility and laboratory design to ensure optimal environments for handling and storage of chemicals, as well as provision of contingency equipment.
5. Implementation of general and specific Standard Operating Procedures (SOP) that incorporate safe work practices, such as labeling, storage, prohibited activities, protective equipment, etc.
6. Quality assurance indicators, such as procurement procedures, laboratory inspections and periodic Plan review.

1.2 Scope and Applicability

The requirements and procedures set forth in this plan are to be followed by all Marywood laboratory personnel who work with hazardous chemicals in laboratory settings as defined by this plan. This Plan does not apply to:

1. Uses of hazardous chemicals which do not meet the definition of laboratory activities.
2. Laboratory uses of chemicals which provide no potential for employee exposure.

Laboratory activities are defined as handling or manipulation of hazardous chemicals in reactions, transfers, etc. in small quantities on a non-production basis.

Hazardous chemicals are defined as any chemical or mixture of chemicals which is classified as a physical hazard or health hazard, simple asphyxiant, combustible dust, pyrophoric gas, or hazard not otherwise specified in Appendix A & B of the OSHA Hazard Communication Standard.

Laboratory personnel include faculty, staff, research and lab assistants, laboratory instructional assistants, graduate and undergraduate students.

Laboratory settings under the scope of this plan include any Marywood building where the above laboratory operations occur. This includes laboratories within the Center for Natural and Health Science and the Human Performance Lab.

1.3 Regulations, Standards and Industry Guidelines

The below regulations, standards and industry guidelines are referenced in this Plan:

U.S. Department of Labor, Occupational Safety and Health Administration (OSHA)

- Occupational Exposure to Hazardous Chemicals in Laboratories [29 CFR 1910.1450]
- Hazard Communications [HCS-2012- 29 CFR 1910.1200]*
- Personal and Respiratory Protection [29 CFR Subpart I]
- Medical and First Aid [29 CFR 1910 Subpart K]
- Fire Protection [29 CFR 1910 Subpart L]

American Chemical Society

- Identifying and Evaluating Hazards in Research Laboratories [2013]
- Guide for Chemical Spill Response Planning in Laboratories [1995]

National Fire Protection Association

- Life Safety Code [NFPA 101]

American National Standards Institute (ANSI), American Industrial Hygiene Association (AIHA), and American Society of Safety Engineers (ASSE)

- Laboratory Ventilation and Decommissioning [ANSI/AIHA/ASSE Z9.5-2012; Z9.11-2008]

***NOTE:** In 2012, OSHA revised the Hazard Communication Standard to incorporate provisions adopted from the United Nation's Globally Harmonized System and Labeling of Chemicals (GHS). Under this revision (HCS-2012), Marywood has until December 2015 to comply with the GHS elements. However, this program has been revised to reflect Marywood compliance with the GHS elements as of the effective date listed above.

A copy of 29 CFR 1910.1450 is found in Appendix A of this Plan.

1.4 Referenced Marywood Plans and Programs

This Chemical Hygiene Plan will work in concert with other Plans and Programs implemented by Marywood, including:

- Hazardous and Universal Waste Management Plan
- Personal/Respiratory Protective Equipment Program
- Exposure Control Plan (Bloodborne Pathogens)
- Emergency Response/Evacuation Plans
- Hazard Communication Program

1.5 Definitions

Action Level: A concentration designated in 29 CFR Part 1910 for a specific substance calculated as an eight hour time weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Chemical Hygiene Officer: An employee who is designated by the employer, and who is qualified by training or experience to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

Chemical Hygiene Plan: A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment, and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of the OSHA Occupational Exposure to Hazardous Chemicals in Lab Standard (29 CFR 1910.1450).

Combustible Liquid: Any liquid having a flashpoint at or above 100°F (37.8°C), but below 200°F (93.3°C), except any mixture having components with flashpoints of 200°F (93.3°C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

(i) A gas or mixture of gases having a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C); or
(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C); or
(iii) A liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM D-323-72.

Common Name: Any designation or identification such as code name, code number, trade name, brand name or generic name used to identify a chemical other than by its chemical name

Designated Area: An area which may be used for work with "select carcinogens", reproductive toxins, or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory, or a device such as a laboratory hood.

Emergency: Any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in all uncontrolled release of a hazardous chemical into the workplace.

Employee: An individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Employer: A person engaged in a business where chemicals are either used, distributed, or are produced for use or distribution, including a contractor or subcontractor.

Explosive: A chemical that causes a sudden, almost instantaneous release of pressure, gas and heat when subjected to sudden shock, pressure or high temperature.

Flammable: A chemical that falls into one of the following categories:

(i) *Aerosol Flammable*- An aerosol that, when tested by the method described in 18 CFR 1500.45, yields a flame protection exceeding 18" at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening.

(ii) *Gas Flammable*- (A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or (B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) *Liquid Flammable*- Any liquid having a flashpoint below 100°F (37.8°C), except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) *Solid Flammable*- A solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint: The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite.

Hazardous Explosive: A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Hazard Category: The division of criteria within each hazard class, e.g., oral acute toxicity and flammable liquids include four hazard categories.

Hazard Class: The nature of the physical or health hazards, e.g., flammable solid, carcinogen, oral acute toxicity.

Hazard Statement: A statement assigned to a hazard class and category that describes the nature of the hazard(s) of a chemical, including, where appropriate, the degree of hazard.

Health Hazard: A chemical which is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard.

Immediate Use: The hazardous chemical will be under the control of and used only by the person who transfers it from a labeled container and only within the work shift in which it is transferred.

Label: An appropriate group of written, printed or graphic information elements concerning a hazardous chemical that is affixed to, printed on, or attached to the immediate container of a hazardous chemical, or to the outside packaging.

Laboratory: A facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory Personnel: Faculty, staff, research associates and assistants, technicians, teaching assistants, graduate and undergraduate students that may perform a laboratory activity.

Laboratory Scale: Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type Hood: A device located in a laboratory, enclosure on five sides with a moveable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms. Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not comprised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory Use of Hazardous Chemicals: Handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale".
(ii) Multiple chemical procedures or chemicals are used.
(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and
(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Laboratory Visitor: An individual that may or may not be affiliated with Marywood that enters a laboratory facility. This may include Facilities employees, contractors or guest groups.

Medical Consultation: A consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

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

Oxidizer: A chemi al other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Physical Hazard: A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

Pictogram: A composition that may include a symbol plus other graphic elements, such as a border, background pattern, or color, that is intended to convey specific information about the hazards of a chemical. Eight pictograms are designated under this standard for application to a hazard category.

Precautionary Statement: A phrase that describes recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to a hazardous chemical, or improper storage or handling.

Product Identifier: The name or number used for a hazardous chemical on a label or in the SDS. It provides a unique means by which the user can identify the chemical. The product identifier used shall permit cross-references to be made among the list of hazardous chemicals required in the written hazard communication program, the label and the SDS.

Protective Laboratory Practices and Equipment: Those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive To xins: Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Safety Data Sheet (SDS): Written or printed material concerning a hazardous chemical that is prepared in accordance with 29 CFR 1910.1200(g).

Select Carcinogen: Any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen
(ii) It is listed under the category, "known to be carcinogens", in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition)
(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions)
(iv) It is listed in either Group 2A or 2B by IARC or under the Category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: (A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3; (B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or (C) After oral dosages of less than 50 mg/kg of body weight per day.

Signal Word: A word used to indicate the relative level of severity of hazard and alert the reader to a potential hazard on the label. The signal words used in this section are "danger" and "warning." "Danger" is used for the more severe hazards, while "warning" is used for the less severe.

Unstable (Reactive): A chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Use: To package, handle, react, emit, extract, generate as a byproduct, or transfer.

Water-reactive: A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

1.6 Toxicology

Individuals performing laboratory activities shall be aware of the toxicological characteristics of each chemical they are working with. Factors to consider include:

- Type of Hazard (Physical and Health Hazards)
- Routes of Entry
- Signs and Symptoms of Exposure
- Occupational Exposure Values

Type of Hazard: Chemical hazards may be one or both of the following types: Physical Hazard, and/or Health Hazard. Physical hazards act outside of the body to cause harm and may include flammables, explosives, oxidizers/reactives. Health hazards are defined by OSHA as a chemical which is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard. HCS-2012 compliant labels shall contain pictograms for each hazard associated with the chemical. The pictogram on the label is determined by the chemical hazard classification. Pictograms for various hazard classes are provided in Figure 1, below.

Figure 1: HCS-2012 Compliant Pictograms

Oxidizer	Flammable	Explosive
 Oxidizers	 Flammables, Pyrophorics, Self-Heating, Emits Flammable Gas Self-Reactives, Organic Peroxides	 Explosives Self-Reactives Organic Peroxides
Toxin/Poison	**Corrosive**	**Compressed Gas**
 Acute Toxicity (fatal or toxic)	 Skin Corrosion/Burns Eye Damage Corrosive to Metals	 Gases Under Pressure
Health Hazard	**Environmental Hazard**	**Irritant/Acute Toxicity/Other**
 Carcinogen, Mutagenicity Reproductive Toxicity, Respiratory Sensitizer ,Target Organ Toxicity	 Aquatic Toxicity	 Irritant (skin and eye), Skin Sensitizer, Acute Toxicity, Narcotic Effects Respiratory Tract , Irritant, Hazardous to Ozone Layer

Routes of Entry: Knowing the route of entry(ies) for a chemical is an important step in identifying proper controls and protective equipment necessary for the activity. Routes of entry will be designated by the M/SDS and/or the specific laboratory procedure (if developed). Possible routes of entry include one or more of the following: Ingestion; Inhalation; Absorption; Injection.

Toxic effects can be immediate or delayed, reversible or irreversible, local or systemic. The toxic effects of chemicals can vary from mild and reversible, such as a headache from a single episode of inhaling the vapors of petroleum naphtha that disappears when the injured person gets fresh air, to serious and irreversible, such as birth defects from excessive exposure to certain materials during pregnancy or perhaps cancer from extended chemical exposure. The toxic effects from exposure to a chemical depend on the severity of the exposure.

Signs and Symptoms of Exposure: All laboratory personnel shall be aware of signs or symptoms of exposure to the chemicals or mixtures they are using. Knowing the signs or symptoms will provide an indicator that an exposure is occurring and allow the individual to stop the exposure and seek medical attention. Signs and symptoms of exposure are found in the M/SDS and/or the specific laboratory procedure (if developed). Common examples include:

- Headaches
- Fatigue
- Confusion
- Dizziness, lightheadedness
- Nausea, vomiting, abdominal pain
- Burns or irritation of the eyes, nose, throat
- Skin irritation or dermatitis
- Respiratory distress (cough, tightness, pain or difficulty breathing

Occupational Exposure Values: There are the concepts known as Occupational Exposure Values that shall be adhered to for laboratory activities. These include:

- ACGIH's Threshold Limit Value (TLV)
- OSHA's Permissible Exposure Limit (PEL) or Action Levels
- NIOSH's Recommended Exposure Level (REL)
- Ceiling Values
- Immediately Dangerous to Life and Health (IDLH) atmospheres

Exposure limits for select chemicals are provided in Appendix B of this Plan. Additionally, M/SDSs for hazardous chemicals and mixtures of hazardous chemicals cite applicable exposure limits.

Section 2: Plan Administration

2.1 Roles and Responsibilities

Roles and Responsibilities designated by this Chemical Hygiene Plan for various Marywood employees or employee groups are outlined below.

2.1.1	**Department Administration (Department Chair, Dean/Provost)**	Plan implementation and enforcement via: ➢ Act as a liaison to the University ➢ Ensure Resources are available for the identification, evaluation and control of all laboratory hazards and employee training ➢ Ensure the working environment is acceptable for all personnel to report suggestions regarding potential improvements for employee safety ➢ Ensure protocols have been developed for the authorization and reauthorization of research activities

2.1.2	**Chemical Hygiene Officer**	➢ Review Lab Activity Templates and assist in the development of SOPs ➢ Facilitate General and Specific Training ➢ Review and approve procurement of new chemicals ➢ Facilitate the review of accident forms

2.1.3	**Faculty/Principal Investigator**	➢ Ensure students/research personnel are aware and understand hazards and associated controls ➢ Identify all Lab activities via completing the Lab Activity Template and forward to CHO ➢ Assist in the hazard evaluation and control process ➢ Promote culture of laboratory safety ➢ Ensure the expectation that participation is contingent on adherence to safety protocols ➢ Meet with research staff and ensure safety is discussed ➢ Ensure accident forms are completed ➢ Routinely review SOP and provide recommendations to CHO

2.1.4	**Health and Safety Office**	➢ Assist with General Training Sessions ➢ Assist with scheduled inspections ➢ Assist with SOP development and review ➢ Assist with the periodic review and plan update ➢ Present new information (standards, Best Management Practices) as they become available ➢ Facilitate periodic compliance reviews ➢ Recordkeeping ➢ Review accident forms to identify direct and root causes and provide recommendations to minimize re-occurrence

2.1.5	**Lab Manager**	➢ Assist with inventory management ➢ Ensure chemical receipt protocols are followed ➢ Facilitate contracted services ➢ Facilitate equipment inspections ➢ Facilitate work order submittals and ensure completion

2.1.6	**Research/Laboratory Personnel**	➢ Participate in the development of safety procedures and comply ➢ Act within one's training and comfort level ➢ Request information, report concerns ➢ Provide recommendations based on anticipated changes or unexpected activity

2.2 Training and Information

Marywood will provide safety information and facilitate training for all personnel covered by this Plan to ensure awareness of all hazards and control measures associated with their activities. Information and training sessions shall be provided for all personnel who may be exposed to potential hazards in connection with laboratory operations. This group includes faculty, students, laboratory supervisors, laboratory workers, custodial, and maintenance personnel, and others who work adjacent to laboratories. Training will be provided in two (2) formats:

1. General Laboratory Training that will be conducted on an annual basis* by Marywood's EHS Consultant. This training will be lecture-based and include: applicable OSHA standards and exposure criteria; the existence and elements of this Plan; overview of typical laboratory hazards, including signs and symptoms of exposure; general safety procedures and control measures; and, methods for detecting chemicals.

2. Specific Laboratory Training provided as needed for each laboratory activity that may be performed by an individual. This training is provided by the Faculty member, the Chemical Hygiene Officer or the Principal Investigator and may include various methodologies, such as lecture, discussion, online or hands-on within the actual laboratory setting.

*or upon hire, prior to first performing an activity covered by this Plan.

Additional student training requirements include Prelab sessions, written safety elements built into lab descriptions, and requirements to include safety discussions in reports.

Records from employee training will be maintained indefinitely with this Plan (example in Appendix C) and will be maintained by the Laboratory Manager.

To ensure individuals are aware of potential hazardous chemicals in an area, Marywood will utilize signs that delineate certain work areas. All chemicals are labeled in accordance with OSHA requirements. Examples of signage that may be utilized in appropriate areas are depicted in Figure 1.

- Emergency telephone numbers.
- Identity labels showing contents of containers (including waste receptacles). The label should clearly state the full name of the chemical, the date it was placed in the container, the initials of the worker who placed the material in the container, and associated hazards of the chemical (flammable, carcinogenic, pyrophoric, etc.).
- Location signs for eyewash stations, first aid kits, fire extinguishers and exits.
- No smoking signs.
- Food and beverages prohibition.
- Warnings at areas or equipment where special hazards exist (high voltages, bodily fluid work, flammable gases in use, strong magnetic fields present, laser operation, etc.).

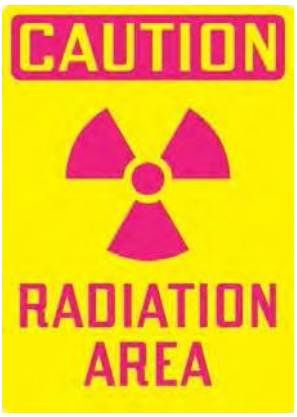


Figure : Work Area Signage

2.3 Medical Monitoring Program

Marywood will provide all personnel who work with hazardous chemicals an opportunity to receive medical attention, including follow-up examinations which the examining physician determines to be necessary, under the below circumstances. All required medical examinations and consultations will be provided to laboratory personnel at no cost, without loss of pay, and at a reasonable time and place.

1. Whenever an employee, visitor or student develops signs or symptoms associated with a hazardous chemical to which these personnel may have been exposed in the laboratory, the personnel shall be provided an opportunity to receive an appropriate medical examination.

2. Where exposure monitoring reveals an exposure level routinely above the action level (or the PEL, in the absence of an action level) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected personnel as prescribed by the particular standard.

3. Whenever an event takes place in a work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected personnel shall be provided the opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

4. Whenever significant work with chemicals of high chronic toxicity or select carcinogens occurs.

Marywood shall provide the following information to the physician:

- The identity of the hazardous chemical(s) to which the personnel may have been exposed.

- A description of the conditions under which the exposure occurred including quantitative exposure data, if available.

- A description of the signs and symptoms of exposure that the affected person is experiencing, if any.

For examinations and consultations required under this plan, Marywood will obtain a written opinion from the examining physician which shall include the following:

- Any recommendation for further medical follow-up.

- The result of the medical examination and associated tests.

- Any medical condition which may be revealed in the course of the examination which may place the person at increased risk of exposure to a hazardous chemical in the workplace.

- A statement that the person has been informed by the physician of the results of the consultation or medical examination and of any medical condition that may require further examination or treatment. The written opinion shall not reveal specific findings or diagnoses unrelated to occupational exposure.

In addition to the provisions stated above, personnel trained in first aid will be available during normal working hours.

All medical recordkeeping shall be in compliance with the requirements of the OSHA Medical Recordkeeping Standard codified at 29 CFR 1910.1020.

2.4 Chemical Procurement and Inventory

2.4.1 Chemical Purchase Requests

All chemicals will be ordered by the each Department's purchasing representative. Requests for chemical procurement will fall into one of two categories: (1) Chemicals on the approved list; and (2) Chemicals not on the approved list.

(1) Chemicals on the Approved List: For procurement of chemicals already on the approved list, the purchasing representative must verify that information regarding the proper handling, storage, and disposal (e.g. the product's Safety Data Sheet/SDS) is on file and current.

The current stock of the chemical shall be reviewed prior to order placement to minimize the total quantities of chemicals stored on campus.

(2) Chemicals Not on the Approved List: For procurement of chemicals not on the approved list, the requesting individual must submit the chemical purchasing request form (Appendix D) to the Chemical Hygiene Officer for review. The purchasing representative may not proceed with the process until the above form is approved by the Chemical Hygiene Officer. Purchase orders requisition forms must be completed for requested items. They may be obtained on the Marywood University website at: http://www.marywood.edu/dotAsset/76960.pdf

This review will ensure the provision of a pre-use hazard assessment, which is required to identify necessary improvements to facility engineering controls and work practices. Chemical use will not occur until the M/SDS is received by Marywood and is subsequently approved for use.

In addition to the types of chemicals ordered, personnel shall reference the current stock of the chemical at Marywood to ensure excess quantities are not purchased and stored.

2.4.2 Chemical Receipt and Distribution

All chemical deliveries are to be directed to the central receiving location, identified by this Plan as Mailing Center. Regarding acceptance of a chemical delivery and subsequent distribution of chemicals, the following provisions are in place:

- **Manufacturer Labeling:** Chemicals, including compressed gases, will not be accepted/distributed for use if a compliant identifying label is not provided from the manufacturer/supplier. For chemicals shipped after June 1, 2015, it is necessary that this label meet the OSHA Hazard Communication Standard (HCS-2012). A comparison of manufacturer's labeling systems with the OSHA GHS-Compliant labeling system is provided in Table 1. An example label is provided in Figure 2.

Table 1: Container Labeling Systems	
Non-GHS (until June 2015)	**GHS-Compliant (after June 1, 2015)**
➢ Identity of the chemical ➢ Appropriate hazard warnings ➢ Name and address of the manufacturer	➢ Identity of the chemical ➢ Signal Word ➢ Hazard Statement ➢ Pictogram ➢ Precautionary Statement ➢ Manufacturer name, address and phone

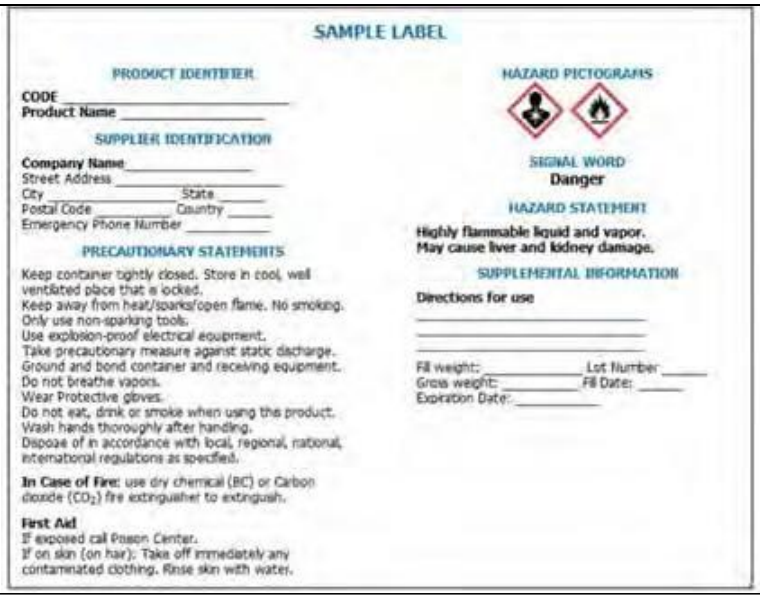


Figure 2: Sample OSHA Compliant Label (HCS-2012)

- **Containers:** Prior to accepting a chemical shipment, the packages and containers for all chemicals will be inspected to ensure sufficient condition, integrity and compatibility. Chemical containers are not to have any obvious signs of cracks, leakage, spills, or corrosion. For compressed gases, the receiver will check that the contents are clearly marked on the cylinder, and that the hydrostatic test date stamped on the cylinder is no more than 10 years old. The cylinder should not be corroded nor should it have any visible dents.

- **Discrepancies:** Any discrepancies with orders, such as quantities, conditions, products, etc. are to be immediately reported to the purchasing representative or the Chemical Hygiene Officer prior to acceptance of the shipment.

2.4.3 Inventory/SDS Management

An accurate online database will be maintained at all times for each area. Access to the database will be provided through the Vertere Inventory Manager utilizing the following methods:

All individuals will have access to Safety Data Sheets (SDS) for each hazardous chemical in their respective area utilizing the above database. The database will be managed by the Lab Manager

SDS shall be readily available via paper copies or electronic access for all affected employees, including transient Marywood employees that may perform work in the building (e.g. custodial, maintenance, IT staff).

2.5 Hazard Analysis and SOP Development

Prior to first ordering or working with a chemical, the Chemical Hygiene Officer will facilitate a review of the chemical and anticipated use (research, experiment). The intent of this review, identified by this Plan as the Hazard Analysis, will be to identify potential hazards and designate protocols (engineering controls, work practices, protective equipment) necessary for minimizing personnel exposures and managing risk presented by those hazards. The three (3) elements to a Hazard Analysis, as defined by the American Chemical Society[1], include:

1. **Hazard Identification-** The identification of the type and nature of adverse effects for an agent, operation or equipment.
2. **Hazard Evaluation-** The qualitative, and where applicable, quantitative description of the inherent properties of an agent or situation having the potential to cause adverse effects.
3. **Control Designation-** A barrier, such as a device, measure, or limit, used to minimize the potential consequences associated with a hazard.

Hazard Analysis shall be conducted in accordance with guidelines established by the American Chemical Society[1].

The Hazard Analysis will be conducted utilizing the Laboratory Standard Operating Procedures (SOP) development mechanism. The SOP process is initiated by the responsible individual (such as Faculty, PI) through completion of the Laboratory Standard Operating Procedure Template, found in Appendix E of this Plan, with the Chemical Hygiene Officer. The Health and Safety Office may assist in the process. If the general safety procedures found in Section 3 of this Plan are not adequate in addressing/controlling identified hazards, an SOP will be generated.

The SOP must be written to clearly identify any hazard control (facility design/equipment, work practices, protective equipment) and emergency procedures that are required, as well as the nature of the hazards the procedure is intended to minimize. Upon completion, the SOP will be assigned a sequential number and incorporated into Section 4 of this Plan. The responsible individual shall review all assigned SOPs each year and update them if necessary with the Chemical Hygiene Officer.

2.6 Plan Review and Updates

The Chemical Hygiene Officer shall review the entire Chemical Hygiene Plan at least annually and shall make any revisions as deemed necessary to maintain compliance. The review will include any accident reports, modifications of facility equipment of operations, all chemical inventories, internal or third party safety inspections, and input from users of the Chemical Hygiene Plan, where applicable.

[1] American Chemical Society: Identifying and Evaluating Hazards in Research Laboratories, Washington D.C., 2013.

2.7 Recordkeeping

Marywood will maintain accurate and complete records relative to: Plan reviews and updates; Medical examination and consultation records; Exposure monitoring reports; Personnel Training; Laboratory inspections; Fume hood testing reports; and, Accident reports.

Table 2			
Type	**Examples**	**Maintained By**	**Length**
Medical Examination and Consultation*	Includes medical test results and physician's written opinions	Human Resources	30 years after employment
Exposure Records*	Reports, laboratory analytical data, sample collection information	Human Resources	30 years after employment
Accident reports*	Completed accident report forms	Lab Manager	30 years after employment
Training Records	Sign-in forms and instructor reports	Lab Manager	30 years after employment
Inspections	Laboratory safety inspection checklists and reports	Lab Manager	5 years after the inspection
Fume Hood Evaluations	Testing reports provided by vendor	Lab Manager	1 year after the evaluation

*Records shall be maintained in accordance with 29 CFR 1910.1020(h) "Access to Employee Exposure and Medical Records".

2.8 Laboratory Safety Inspections

Inspections of laboratory equipment and practices will be performed in accordance with the below schedule by designated personnel or vendors to ensure all elements of this Plan are implemented.

Table 3			
Type	**Examples**	**Performed by**	**Frequency**
Fume Hood Evaluations	Testing and operational inspections in accordance with ANSI protocols	Vendor	Annually
Safety Equipment Inspection	Visual inspections of fire extinguishers, eye washes, showers	Buildings and Grounds	Monthly
Safety Equipment Inspection	Visual inspections of first aid kits and spill kits	Lab Manager	Monthly
Laboratory Inspections	Review of chemical storage, use, work practices, labels, etc.	Health and Safety Office	1/semester

Records for each of the above will be maintained in accordance with the provisions designated in Section 2.7 of this Plan.

Section 3: General Safety Procedures

3.1 Facilities and Engineering Controls

3.1.1 Emergency Equipment

Each Laboratory Setting is equipped with emergency equipment contingent on the nature of activities conducted in the area. Examples of emergency equipment that may be present in a Laboratory include:

Fire Safety:	Extinguishers (based on class of fire present, including Class A, B, C or D); Blankets; Alarms and Pull Stations; evacuation maps.
Exposure Response:	First Aid Kits; Eye Washes; Drench Showers.
Chemical Release:	Chemical Spill Kits.
Communication:	Phones; Emergency Contact Postings; Alarms and Pull Stations.

All emergency equipment is inspected and maintained in accordance with applicable guidelines (NFPA) and manufacturer recommendations. Further descriptions on the above equipment are provided in Section 5 of this Plan.

3.1.2 Chemical Storage

Chemical Prep Rooms (107, 302) and areas within research labs shall be conveniently located and open during normal working hours so that laboratory workers need not store excessive quantities of chemicals in their laboratories or working areas. All storage areas are designed and maintained with the following provisions:

Design:

- Adequate storage space to allow aisle clearance and permit container inspection
- Signage to identify designated areas for each hazard group (acids, bases, oxidizers, etc.)
- Adequate ventilation for active storage areas
- Areas for hazard-specific storage (flammable storage cabinets, acid cabinets, chemical refrigerators)
- Surfaces that allow for efficient cleanup in the event of a spill or leak and minimize spread of liquids after a leak
- Control or elimination of environmental situations (temperature, sunlight, water, moisture) that may lead to a reaction with certain chemicals
- Security measures to prohibit unauthorized access

Stock Protocols:

- Purchasing controls shall be implemented to avoid excessive chemical storage.
- A first-in, first-out system of stock keeping shall be used.
- Fume hoods in laboratories are not permitted to be used as storage areas.

Chemical Storage:

- Avoid storing hazardous liquid chemicals on hard-to-reach shelves
- Shelves shall be made of a chemically resistant material.
- Chemical storage will be based on a hazard class storage system. Incompatible chemicals must not be stored together. Refer to Figure 4.

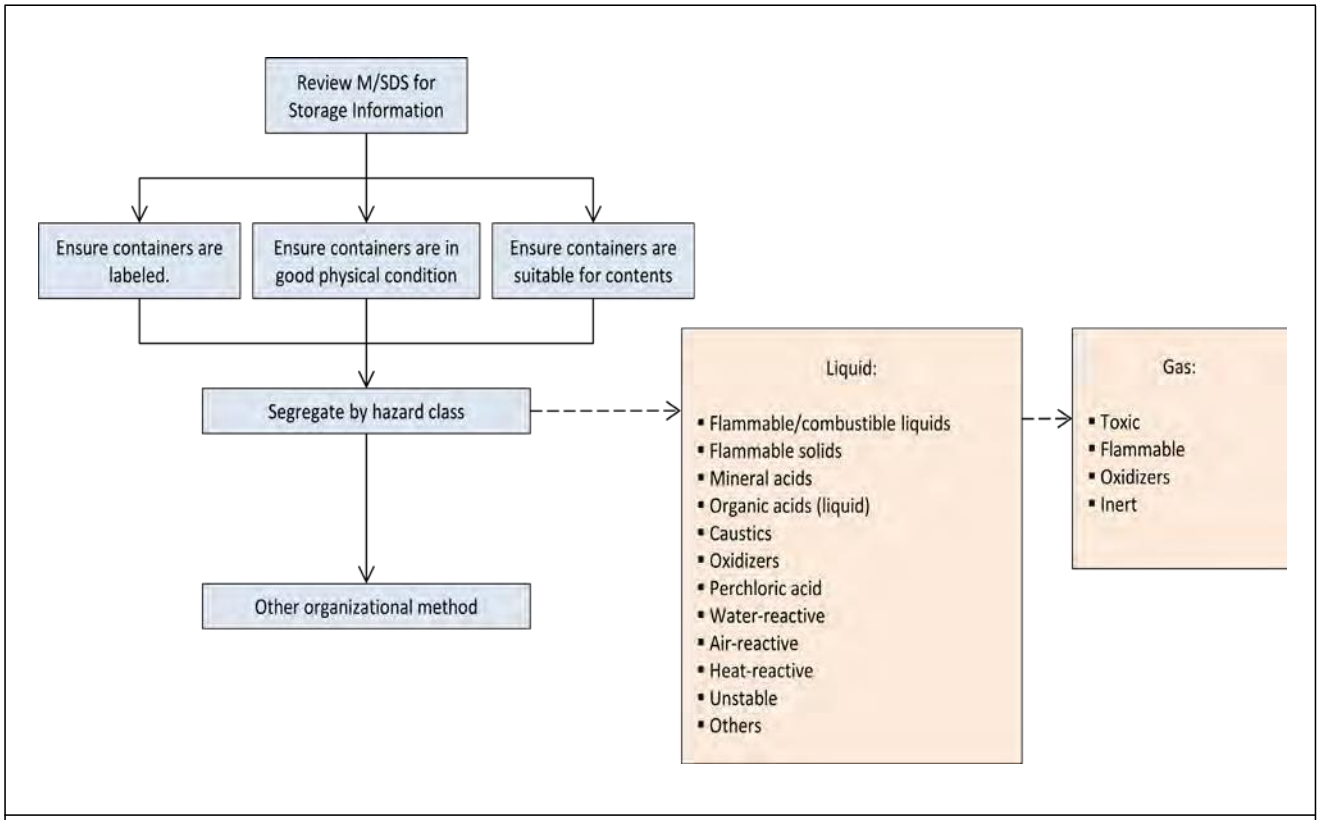


Figure 4: Chemical Storage Hierarchy

Chemicals stored in prep rooms shall be examined at least every semester, with the inventory filed with the Chemical Hygiene Officer. At this time, those chemicals that have been kept beyond their appropriate shelf life or have deteriorated, have questionable labels, are leaking, have corroded caps, or have developed any other problem should be disposed of in a safe manner.

Storage of chemicals within laboratories shall be kept at a minimum (e.g. only those chemicals that will be used) and shall follow the basic provisions designated above. Additionally, storage areas within these laboratories shall be located away from emergency egress areas and high traffic walkways.

3.1.3 Designated Work Areas

All laboratory rooms are delineated as designated work areas by appropriate signage. Eating, drinking, application of cosmetics (including lip balm) and use of tobacco products are prohibited in these designated work areas.

Additionally, activities involving certain classes of chemicals will require more stringent controls and restrictions for the associated laboratory. These chemical classes include: select Carcinogens; Allergens and Embryotoxins; chemicals designated as Moderate Chronic or High Acute Toxicity; and, chemicals designated as High Chronic Toxicity. Specific details for these chemicals are provided in Section 3.3 of this Plan.

3.1.4 Ventilation and Fume Hoods

Chemical exposures should always be below any established Occupational Exposure Value that is referenced in the applicable M/SDS. If you smell a chemical, you are inhaling it. Also, remember that the vapors of many chemicals can be at hazardous concentrations without any noticeable odor. The same applies to dusts, mists, and smokes. A chemical that has an odor may not be hazardous, aside from the nuisance of the odor

In all cases, the movement of air in the general ventilation system is designed to be from corridors into the laboratories. All air from laboratories should be exhausted outdoors and not be recycled, providing a negative pressure within the laboratories with respect to the rest of the building. Laboratory doors shall be maintained in a closed position whenever possible. The air intakes for a building with laboratories are in a location that reduces the possibility that the input air will be contaminated by the exhaust air from the same building or nearby laboratory buildings.

The use of fume hoods offers two additional pieces of protection: the window sash can serve as a protective barrier between workers and chemicals; and, it can provide an effective containment device in the event of accidental spills. The following factors should be implemented for the daily use of hoods:

Annual Evaluation: Fume hoods shall be evaluated at least annually by a qualified vendor to ensure adequate face velocities, and reevaluated whenever a change is made in local ventilation devices. Fume hoods passing the evaluation are labeled with a fume hood inspection sticker indicating the date of evaluation. Fume hoods failing the evaluation are posted with a failure notification form and reported to Department Administration.

Work Practices: The following work practices are recommended for fume hood use:

1. Conduct all operations that may generate irritating and/or hazardous air contaminants inside a fume hood.
2. Ensure that the hood is operating by looking at the flow indicator. If the hood is not operating, report this information to facilities immediately.
3. Keep all apparatus and chemicals at least six inches (6") back from the face of the hood.
4. Minimize any obstruction of rear baffles by apparatus or containers.
5. Use equipment with legs, or raise it off the work surface with blocks to allow even airflow under equipment.
6. Minimize sources of turbulence at the hood face including foot traffic, ventilation supply diffusers, fans, or abrupt moving of arms in and out of the hood.
7. Do not lean into the hood or put your head in the hood when in use.
8. Do not permanently store chemicals or apparatus in the hood. Do not vent waste chemicals in the hood.
9. Keep the hood sash closed as much as possible. During use, position sash at or below the height indicated.
10. Do not place electrical receptacles or other ignition sources inside the hood when flammable liquids or gases are present. Permanent electrical receptacles are not permitted in the hood.

11. Face velocities should typically range from 30-120 linear feet per minute as measured by a standard airflow meter.

3.1.5 Flammable Storage Cabinets

Flammable storage cabinets are provided in all storage rooms and most stock rooms for storage of small quantities of flammable liquids. Flammable storage cabinets are labeled, made of double-walled steel, and equipped with flame arresters. All flammable storage cabinets at Marywood are designed to meet performance requirements established by OSHA, NFPA and Uniform Fire Codes. Storage within these cabinets shall be limited to flammable materials. Storage capacity limits for flammable liquids shall not be exceeded.

Additional requirements regarding storage of flammable materials are provided in Section 3.3.1 of this Plan.

3.2 Work Practices

Administrative controls are work procedures such as safety policies, rules, supervision, and training in order to reduce the duration, frequency, and severity of exposure to hazardous chemicals. Work practices are described in Sections 3.2 and 3.3 of this Plan.

3.2.1 Basic Precautions and Chemical Handling

The following general safe work practices have been implemented for all Laboratory Personnel. These represent general requirements for all chemicals. Refer to Section 3.3 of this Plan for additional requirements for various hazard groups and Section 4 for activity-specific protocols.

Awareness: Prior to use, review the safety and health hazard data of all chemicals:

- Know the signs and symptoms of overexposure and the physical and sensory characteristics (odor, appearance) of these chemicals.
- Know appropriate procedures for emergencies, including the location and operation of all emergency equipment.
- Do not use unlabeled chemicals.
- Identify and follow the Personal Protective Equipment (PPE) requirements for the activity.

Avoidance of "routine" exposure: Safe chemical working habits at the personnel level are implemented to avoid unnecessary exposure to chemicals by any route. These include:

- Do not smell or taste chemicals.
- Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices.
- Inspect any equipment prior to use.

Chemical handling: Use bottle carriers and carts equipped with spill containment (tubs, absorbent pads, lips) to transport chemicals. Close caps securely. Pour all chemicals carefully.

Food and Beverages: Eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present is prohibited; wash hands before conducting these activities.

Break Areas: Storage, handling, or consumption of food or beverages in chemical storage areas, refrigerators, glassware or utensils which are also used for laboratory operations is prohibited.

Equipment: Use equipment only for its designed purpose.

Glassware: Handle and store laboratory glassware with care to avoid damage; do not use damaged glassware. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur.

Horseplay: Avoid actions or behavior which might confuse, startle or distract another worker.

Mouth suction: Do not use mouth suction for pipeting or starting a siphon.

Unattended operations: Reactions that are left to run unattended, overnight, or at other times have an increased potential for fire, release or explosion. Approval from the Chemical Hygiene Officer must be obtained (written, electronic) prior to the activity. When planning for the activity, account for the following:

- Do not let equipment such as power stirrers, hot plates, heating mantles, and water condensers run overnight without fail-safe provisions.
- Check unattended reactions periodically.
- Always leave a note plainly posted with a phone number where you can be reached in case of an emergency. Remember that in the middle of the night, emergency personnel are entirely dependent on accurate instructions and information

Working alone: Avoid working alone in a laboratory.

Chemical/Waste Use and Storage: Store and handle chemicals in accordance with the guidelines contained in this Chemical Hygiene Plan or in accordance with the chemical manufacturer's guidelines. Chemicals shall be stored in a closed, labeled container in the designated area.

Reporting: Report all accidents, even if they do not result in injury, to the Faculty/PI, Chemical Hygiene Officer, Laboratory Manager and/or Health and Safety Office immediately.

3.2.2 Laboratory Techniques

There are a number of generally accepted laboratory techniques that will make working with chemicals safer. Some of these are discussed below.

- When opening bottles, hold the bottle with its label toward your palm to protect the label (and also the hand of the next user) in case some reagent drains down the side of the container. Stoppers that cannot stand upside down on the bench top should be held at the base and pointed outward between two fingers of the pouring hand. Do not pour toward yourself when adding liquids or powders. Use a funnel if you are pouring into a small opening. If a stopper or lid is stuck, use extreme caution in opening the bottle.

- Always add a reagent slowly; never dump it in. Observe when the first small amount is added, and wait a few moments before adding more; some reactions take time to start.

- Before pouring a liquid into a funnel, make sure the stop cock is closed, firmly seated, and freshly lubricated (if glass). Use a stirring rod to direct the flow of the liquid being poured. Keep a beaker under the funnel in the event the stopcock opens unexpectedly.

- To avoid a violent reaction and spattering while diluting solutions, always pour concentrated solutions slowly into water or into less concentrated solutions while stirring. The more concentrated solution is usually denser, and any heat evolved is better distributed. This applies especially when preparing dilute acids and bases. Always wear goggles and use the laboratory chemical hood when diluting concentrated solutions.

- Support a small beaker by holding it around the side with one hand. If the beaker is 500 mL or larger, support it from the bottom with the other hand, and consider using heavy-duty beakers. When setting the beaker down, first remove your hand from the base, and then place the beaker slowly on the clean surface of the bench. A small piece of grit can make a "star" crack in the thin, flat bottom of a beaker or flask. If the beaker is hot, use beaker forceps or heavy gloves and place the beaker on a ceramic-centered gauze pad.

- Grasp multi-necked flasks by the center neck, never by one of the side-necks. If the flask is round bottomed, it should rest on a proper-sized cork ring when it is not assembled for a reaction. Large flasks must always be supported at the base during use.

- Never look down the opening of a vessel.

- Never use mouth suction to fill a pipette. Use an aspirator bulb or a loose-fitting hose attached to an aspirator. Constantly watch the tip of the pipet, and do not allow it to draw air.

- Flasks and beakers containing hot or boiling liquids should always be cooled before any additional chemical is added.

- When carrying large bottles of corrosive, toxic, or flammable liquids, use impact-resistant transport containers.

3.2.3 Labels

All chemicals shall contain a legible label attached to the container that meets designated labeling specifications. Labeling under the scope of this Plan will be in one of two formats: Primary (Manufacturer) Labels and Secondary Labels. A discussion of each is provided below.

Primary/Manufacturer Labels: As described in Section 2.4.2 of this Plan, Manufacturers are required to provide a label meeting OSHA (HCS-2012) requirements.

Secondary Labels: In the event chemicals are transferred into other containers without the original manufacturer label, a secondary label must be applied. At a minimum, this label must be attached to the container, be legible and identify the following:

- Chemical Name (chemical formulas are not permitted)
- Designated hazards

Also, for certain chemicals that may become unstable, peroxidable or expire over time, a date of use is to be provided. Labeling systems, such as the NFPA 704 Labeling System, may be used to meet this requirement.

3.2.4 Housekeeping

In the laboratory and elsewhere, keeping things clean and neat generally leads to a safer environment. Avoid unnecessary hazards by keeping drawers and cabinets closed while you are working. Never store materials, especially chemicals, on the floor-even temporarily. Workspaces and storage areas should be kept clear of broken glassware, leftover chemicals, and even scraps of paper. Do not store chemicals in the laboratory chemical hoods. Keep aisles and paths of egress free of obstructions such as chairs, boxes, and waste receptacles. Do not block access to emergency equipment or utilities. Do not use hallways and stairs as storage spaces. Avoid slipping hazards by keeping the floor clear of ice, stoppers, glass beads, glass rods, other small items, and spilled liquids. Use the required procedures for the proper disposal of chemical and other wastes.

The following general rules will apply:

- Work areas will be kept clean and free from obstructions. Cleanup should take place at the end of each work session (class) or before the end of each working day.
- Wastes should be disposed of in appropriate receptacles.
- Minor spills of chemicals should be cleaned up immediately and disposed of properly.
- All chemicals should be labeled at the time of use or transfer to other containers.
- Floors will be cleaned regularly. Trip hazards will not be permitted.
- Stairways, hallways and areas of egress will not be used as storage areas.
- Access to exits, safety showers, eyewashes, fire extinguishers, and other safety devices will never be blocked.
- Chemicals should be stored properly, with clutter kept to a minimum, especially in fume hoods. Storage will be in a manner that facilitates routine visual inspections.
- Eyewash stations and safety showers will be inspected and tested weekly. Other safety equipment will be inspected monthly, including First Aid kits. Fume hoods will be inspected and tested on an annual basis, face velocities will be checked periodically.
- Flammable/combustible liquids should be closed/stored at the completion of each day.

3.2.5 Occupational Hygiene

All laboratory areas are designed to include areas for personnel to perform hygiene activities. Occupational hygiene requirements include:

- Washing hands and areas of exposed skin before leaving the laboratory.
- Utilizing break areas for any food/drink consumption.
- Avoiding contact with items that may have become contaminated during laboratory activities. These items, such as cell phones, calculators, laboratory instruments, etc. are to be cleaned prior to handling without protective equipment.

3.2.6 Transporting Chemicals

For transporting chemicals between laboratories, prep rooms, or within laboratories, the following requirements shall apply:

- Carts, bottle carriers, pails and/or secondary containers shall be used to move chemicals from one area to another. These devices shall be in good condition and be able to hold the contents safely without contributing to a release.
- When moving in the laboratory, ensure a clear walkway and anticipate sudden movement or changes in direction by others.
- The individual transporting the chemical should be knowledgeable about the hazards of the chemical and should know how to handle a spill of the material.
- When transporting compressed gas cylinders, the cylinder should always be strapped in a cylinder cart and the valve protected with a cover cap. Do not attempt to carry or roll cylinders from one area to another.
- Keep chemicals in their original packing with required labels when transporting.
- Chemicals shall not be left unattended during transport. Routes shall be planned to avoid unnecessary stops between transport.

Note that transporting of chemicals from the building is prohibited.

3.3 General Procedures for Certain Hazard Groups

3.3.1 Flammable/Combustible Materials

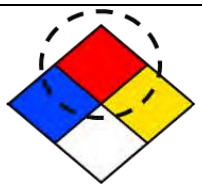
Classes of flammable and combustible materials are designated based on Flash Point and/or Boiling Point by the NFPA.

Table 2: Flammable and Combustible Classifications

Type	Class	Flash Point	Boiling Point
Flammable	**IA**	<73°F	<100°F
	IB	<73°F	≥100°F
	IC	≥73°F	-
Combustible	**II**	≥100°F	-
	IIA	≥140°F	-
	IIIB	≥200°F	-

Table Notes:

°F: Degrees Fahrenheit

Identifiers:			
	OSHA Pictogram	**NFPA 704 Diamond** 1- Will not burn 2- Flash point >200°F 3- Flash point 100-200°F 3- Flash point <100°F 4- Flash point <73°F	**DOT Labels**

This Plan designates the following requirements for working with flammable and combustible materials.

1. Eliminate or Control Ignition Sources: **Caution- Open flames are not the only source of ignition for flammable liquids.** All sources of ignition should be eliminated when using flammable materials.

   - **Open Flames:**
     - Alternatives to open flames should be used whenever possible in chemical storage and laboratory areas.
     - Open flames are not to be left unattended.
   - **Sparks:**
     - Electric motors, controls and connections must meet NFPA 70 specifications for use in areas where flammable gases or liquids are present in concentrations sufficient for ignition and flame propagation to occur.
   - **Hot Surfaces:**
     - The use of ovens and hot plates in areas where materials with low autoignition temperatures are being used shall be minimized; when necessary, these activities shall be continuously monitored by laboratory personnel.

2. Storage:
   - Flammable materials are to be stored in an approved container and placed inside a flammable storage cabinet when not in use. At a minimum, return the container to the cabinet after each activity, or at the end of the day.
   - Refrigerators and freezers are allowed for chemical storage only (no food for human consumption) if the units are certified as "explosion-proof". Such refrigerators must be hard-wired into the electrical supply system and used according to the manufacturer's instructions. Never use household refrigerators for chemical storage.
   - Incompatible Materials include: oxidizers, compressed gases, highly toxic materials, corrosives, and water-reactive chemicals
   - Flammable gases should be stored in ventilated areas in a secure manner. All gas cylinders must be individually secured to a sturdy object to prevent tipping. Whenever a gas cylinder is moved from one location to another, the valve guard cap must be in place.
   - Maximum Container Sizes for glass or approved plastic containers:
     - Class IA: one pint (1 pt)
     - Class IB: one quart (1 qt)*

- Class IC: one gallon (1 gal)
- Class II: one gallon (1 gal)

**Up to one gallon (1-gal) is permitted if stored in an approved metal container.*

3. Handling of Flammable Liquids
   - Sparks from static electricity can cause fires and explosions of flammable gases, vapors and dusts. Operations such as pouring and agitation of flammable liquids may generate a static charge, particularly on days of low humidity. Accordingly, the transfer of liquids between metal containers shall be performed after direct metal-to-metal contact or coupling of the containers has been accomplished with ground cables. Grounding cables shall be provided and used in any area where transfer of flammable liquids takes place. Grounding is not required when one container is made of glass or other non-conducting material.
   - Transfer and storage of flammable materials should not be in an area where a spill of the liquid could block an exit from the room, hallway, or building in the event of a fire, and where there is a source of ignition.

4. Handling of Flammable Solids
   - General:
     - The M/SDS for each flammable metal is located on the chemical cart.
     - All secondary containers of solid flammables should contain hazard warnings signifying that the substance is Water Reactive Flammable.
     - A solid flammable is stored as indicated on the specific M/SDS.
     - Solid Flammable Metal fires cannot be put out with water. A Class D fire extinguisher is required where the flammable solids are stored.
     - All flammable solids are stored in flammable solid storage cabinet when not in use.
     - Only a minimal amount of flammable solids required for the experiment should be placed in the lab.
   - Magnesium Metal:
     - Avoid the use of magnesium powder. Experiments involving magnesium should use magnesium ribbon.
     - Magnesium is kept in its original container with the lid taped and is stored in a flammable cabinet.
   - Calcium Metal:
     - Calcium is a flammable solid which reacts with atmospheric moisture.
     - Avoid the use of calcium powder. When possible use small calcium turnings in its place.
     - Calcium should be stored in a flammable cabinet.
     - Large pieces of calcium metal should not be placed in the lab area.

5. Emergency Events
   - In case of spill, please consult the individual chemical's M/SDS for specific accidental release measures and disposal instructions since each chemical have specific required actions.
   - If a flammable material is spilled, advise everyone in the area to immediately turn off all electrical equipment and evacuate the area until the cleanup is complete.
   - Small spills are diluted with water and may be neutralized with the appropriate spill kit by trained personnel. An absorbent such as carbon is then used. The waste is collected in an appropriate container and disposed of as a hazardous

waste.

- Large spills require immediate evacuation and activation of emergency procedures.

3.3.2 Oxidizers

Oxidizers are materials which readily yield oxygen or another oxidizing gas, or that readily react to promote or initiate combustion of flammable/combustible materials. Oxidation reactions are a frequent cause of chemical accidents. Observe these precautions to reduce risk when storing or handling oxidizers.

Examples	Bromine, Chromic acid, Fluorine, Hydrogen peroxide, Perchloric acid
Identifiers	  
Handling	➢ Know the reactivity of the materials involved in experiment or process. Ensure there are no extraneous materials in the area which could become involved in a reaction. ➢ If the reaction can be violent or explosive, use shields or other methods for isolating the materials or the process. ➢ Use the minimum amounts necessary for the procedure. Do not keep excessive amounts of the material in the vicinity of the process.
PPE	➢ Eye protection (goggles) ➢ Chemical resistant gloves ➢ Lab coats
Storage	➢ Fire resistant shelving in a well-ventilated area.
Incompatibles	➢ Organic materials, flammable materials and other reducing agents.

3.3.3 Unstable Materials

Pyrophoric materials ignite spontaneously upon contact with air. The flame may or may not be visible.

Examples	Butyllithium, Silane, and Yellow Phosphorous
Identifiers	
Handling and PPE	Refer to specific handling protocols and M/SDS for the laboratory activity that requires use of any pyrophoric material. Do not attempt to clean up any release involving a pyrophoric material.
Storage	➢ Storage must be in an inert atmosphere
Incompatibles	➢ Air

Water reactive materials react with water to produce a flammable or toxic gas, or other hazardous condition. Special precautions for safe handling of water-reactive materials will depend on the specific material, and the conditions of use and storage.

Examples	Alkali and alkaline earth metals (Lithium, Sodium, Potassium, Magnesium)
Identifiers	
Handling and PPE	➢ Refer to specific handling protocols and M/SDS for the laboratory activity that requires use of any water reactive material. Do not attempt to clean up any release involving a water reactive material.
Storage	➢ Storage must be in an inert atmosphere away from water sources
Incompatibles	➢ Aqueous solutions and oxidizers

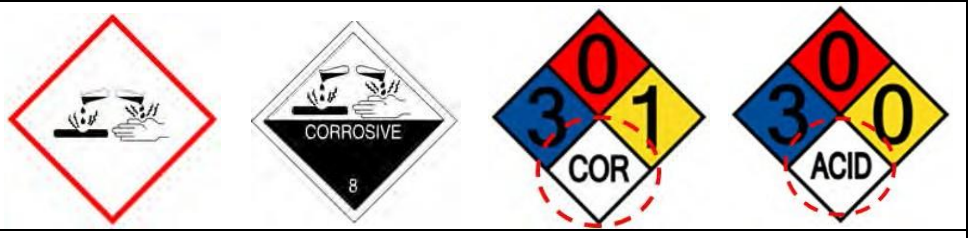
Peroxidizables are substances or mixtures which react with oxygen to form peroxides. Some peroxides can explode with impact, heat, or friction such as that caused by removing a lid. Peroxides form inside the containers of some materials even if they have not been opened. Peroxide formation may be detected by visual inspection for crystalline solids, or by using specialized kits. If you suspect that peroxides have formed, do not open the container to test since peroxides deposited on the threads of the cap could detonate.

Examples	Ethyl ether, Tetrahydrofuran, Liquid paraffins (alkanes), Olefins (alkenes)
Identifiers	

Examples	Ethyl ether, Tetrahydrofuran, Liquid paraffins (alkanes), Olefins (alkenes)
Handling	➢ Do no open or handle any container having obvious crystal formation. Notify the Chemical Hygiene Officer upon identification of crystals. ➢ Handle under precautions similar to that listed for flammables. ➢ Maintain accurate inventory, labeling and location of all Peroxidizable materials. ➢ Minimize peroxide formation in ethers by storing in tightly sealed containers placed in a cool place in the absence of light. Do not store at or below the temperature at which the peroxide freezes or the solution precipitates. ➢ Inspect for peroxides of any opened containers before use ➢ Do not use solutions of peroxides in volatile solvents under conditions in which the solvent might be vaporized. This could increase the concentration of peroxide in the solution. ➢ Do not use metal spatulas or magnetic stirring bars with peroxide forming compounds, since contamination with metals can lead to explosive decomposition. Ceramic, Teflon or wooden spatulas and stirring blades are usually safe to use. ➢ Do not use glass containers with screw-top lids or glass stoppers. Polyethylene bottles with screw-top lids may be used.
PPE	➢ Eye protection (goggles) ➢ Face shields ➢ Chemical resistant gloves ➢ Lab coats
Storage	➢ Date all peroxidizable materials upon receipt and opening. ➢ Dispose of after 12 months from the date of receipt or 6 months from date of opening. ➢ Avoid friction
Incompatibles	➢ Organic and Inorganic Acids

3.3.4 Corrosive Materials

Corrosives are materials which can react with the skin causing burns similar to thermal burns, and/or which can react with metal causing deterioration of the metal surface. Acids and bases are corrosives. Observe the following special precautions.

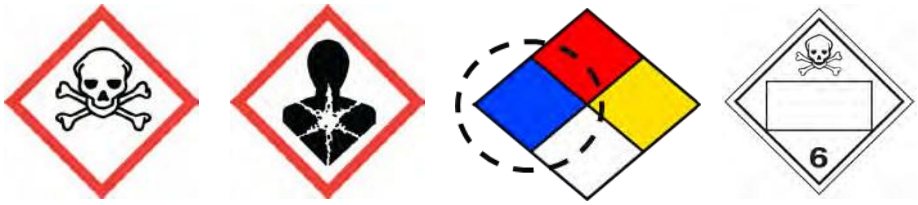
Examples	**Acids:** Sulfuric acid, Phosphoric acid, Hydrochloric acid **Bases:** Sodium hydroxide, Sodium amide, Sodium bicarbonate
Identifiers	
Handling	➢ When mixing concentrated corrosives with water, add the corrosive slowly to water. **Never** add water to acids or bases

Examples	**Acids:** Sulfuric acid, Phosphoric acid, Hydrochloric acid **Bases:** Sodium hydroxide, Sodium amide, Sodium bicarbonate
PPE	➢ Eye protection (goggles) ➢ Chemical resistant gloves ➢ Face shields, resistant aprons (worn over lab coats) and other additional protection may also be warranted.
Storage	➢ Containers and equipment used for storage and processing of corrosive materials should be corrosion resistant. Dilute bases can be stored in a plastic container. ➢ Acids and bases should be stored separately from each other.
Incompatibles	➢ Store liquid corrosives below eye level ➢ **Inorganic Acids**, Flammable liquids/solids bases, oxidizers, organic acids ➢ **Organic Acids:** Flammable liquids/solids, bases, oxidizers, inorganic acids ➢ **Bases:** Flammable liquids, oxidizers, poisons, and acids

3.3.5 Toxic Materials

Prior to any laboratory activity, laboratory personnel shall consult the specific M/SDS that lists toxic properties of the substance being worked with. The procedures listed below should be followed if any substance is known to be moderately or highly toxic. These procedures shall also be followed if the material has unknown toxicological properties. The overall objective of these procedures is to minimize exposure to these toxic substances by any route using all reasonable precautions. The procedures listed below are general in design and are to be supplemented by specific procedures designated by the Hazard Evaluation.

Toxic materials are categorized into the following: (1) Allergens and Embryotoxins; (2) Chemicals of Moderate, Chronic or High Acute Toxicity; (3) Chemicals of High Chronic Toxicity; (4) Animal Work with Chemicals of High Chronic Toxicity. Additionally, more stringent requirements are specified chemicals specified by OSHA as a Particularly Hazardous Substance.

Identifiers	

Particularly Hazardous Substances Toxic materials include those materials classified by OSHA as a "Particularly Hazardous Substance", such as Carcinogens, Reproductive Toxins and Substances with High Acute Toxicity. Work with Particularly Hazardous Substances requires approval from the Chemical Hygiene Officer, in addition to very specific inventory, recordkeeping, handling and disposal practices as designated by the Hazard Evaluation. The approval form found in Appendix F must be provided to the Chemical Hygiene Officer for review.

Carcinogen: Regulated by OSHA as a carcinogen; listed under the category "known carcinogen" (or "reasonably anticipated to be carcinogens"*) by the National Toxicology Program; listed in Group I (or 2A, 2B*) by the International Agency for Research on Cancer.

Reproductive Toxins: Substances that have adverse effects on various aspects of reproduction, including fertility, gestation, lactation, and general reproductive performance.

High Acute Toxicity : High acute toxicity includes any chemical that falls within any of the following OSHA-defined categories: (1) chemical with a median lethal dose (LD50) of 50 mg or less per kg of body weight; (2) chemical with an LD50 of 200 mg less per kg of body weight when administered by continuous contact for 24 hours to certain test populations; (3) chemical with a median lethal concentration (LC50) in air of 200 parts per million (ppm) by volume or less of gas or vapor, or 2 mg per liter or less of mist, fume, or dust, when administered to certain test populations by continuous inhalation for one hour, provided such concentration and/or condition are likely to be encountered by humans when the chemical is used in any reasonably foreseeable manner.

**Under certain situations.*

Allergens and Embryotoxins Toxic materials may also include classification as an Allergen or Embryotoxin. Examples of these materials include:

Allergens: Allergens are agents that produce an immunologic reaction, such as asthma or dermatitis. Diazomethane, Isocyanages, Formaldehyde, Chromium, Nickel, Bichromates

Embroyotoxics: Organomercurials, Lead compounds, Formamide

Work with these materials shall occur only in a fume hood or other enclosed containment device, whose performance has been confirmed prior to the start of work. The fume hood must be labeled "Hazardous Material – Do Not Turn Off" and designate chemical names. Minimal PPE requirements include suitable gloves, lab coats and laboratory goggles to prevent skin contact.

Chemicals of Moderate, Chronic, or High Acute Toxicity Examples include Hydrogen Cyanide, Hydrofluoric Acid, Diisopropylfluorophosphate. The following general requirements are designated by this plan:

- At least two people must be in the immediate area when highly toxic chemicals are in use.
- All work will be done in a hood (or glove box), whose adequate performance has been established immediately prior to the start of the work (the hood must have a face velocity of at least 90 linear feet per minute). This hood must be within the designated area of the laboratory for use with select carcinogens. The hood switch must be labeled "Hazardous Chemicals in Use - Do Not Turn Off".
- The designated area within the laboratory must be delineated with special warning signs which state that highly toxic or moderately chronic chemicals are being used in the area. These signs must also bear the specific names of the chemicals being used, and the names of the workers using the chemicals.
- Work which generates aerosols must trap all vapors to prevent their discharge with hood exhaust.
- Workers shall double-glove when working. As always, the hands and arms should be washed immediately after working with these materials.

- All waste material generated should be stored in closed, suitably labeled (Cancer-Suspect Agent, etc.), impervious containers to await disposal. If possible, any generated waste should be chemically converted to a non or less toxic form. All contaminated clothing should be sealed in plastic and properly labeled to await incineration.

Chemicals of High Chronic Toxicity Examples include Dimethylmercury, Nickel Carbonyl, benzo[a]pyrene, N-nitrosamines, bis(chloromethyl)ether, aflatoxin B_1 . While not currently approved for use under the scope of this plan, in the event special approval is given by the CHO, the following general requirements are designated:

- All work and transfers with these substances will be done in a "controlled area", within the regular designated area of the laboratory. This work will take place in a restricted access hood or glove box. All personnel who have access to this area should be aware of the substances being used and the precautions necessary. The M/SDS for this material will be posted on the restricted access device.

- The controlled area will be posted with warning signs stating "Toxic Substances in Use: Authorized Personnel Only" to indicate the specific hazards associated with the materials involved. The signs must also include the names of the chemicals being used, as well as the names of the workers using the materials.

- A plan of action must be prepared before any highly chronic chemicals are used. This plan must include the details of experimental manipulation of the chemicals and the means of disposal of the substances. The plan will be approved by the CHO before work begins. (e.g. Hazard Evaluation)

- A disposable impervious laboratory coat shall be worn when handling materials of high chronic toxicity. Workers will double-glove when using any chemical in this area. Surfaces and equipment should be protected from contamination by the use of chemically resistant trays and absorbent paper as stated above.

- Upon exiting the controlled area, workers should remove protective apparel, place it in plastic bags, seal the bag, and thoroughly wash hands, forearms, face, and neck. The bag should be labeled "Caution Contents Contaminated with Substances of High Chronic Toxicity" and await proper disposal in the appropriate waste storage area (See "Waste Disposal").

- An accurate record of the amounts of each substance being used and stored, dates of use, and names of users must be maintained. Medical monitoring may be required by the CHO if toxicologically significant quantities of highly chronic toxic substances are being used on a regular basis (three times per week).

- Storage areas for these substances should also have limited access, with special signs posted. Any area used for storage of substances of high chronic toxicity should be maintained under negative pressure with respect to the surroundings when not in use.

- Negative pressure glove boxes used with these substances must have ventilation rates of at least four volumes/hour and a pressure of at least 0.5 inches of water. Positive pressure glove boxes should be thoroughly checked for leaks immediately before each use. When using either type of glove box, exit gases must be trapped, or filtered through a HEPA filter and then released in the controlled area hood.

- Vacuum pumps should be protected with scrubbers or HEPA filters and vented into the controlled area hood.

- Pumps, along with all other equipment should be decontaminated before leaving the controlled area. Importantly, the controlled area should be decontaminated before normal work is resumed there.

- In the event of spills, the area should be evacuated immediately.

- Waste materials should be chemically converted to non or less toxic substances whenever feasible. Containers of wastes (including washings from contaminated flasks) should be transferred from the controlled area in a secondary container under the supervision of the research mentor. Storage should take place in a specially designated zone of the waste area.

3.3.6 Compressed Gases

The publications of the Compressed Gas Association and of major suppliers should be consulted before using compressed gases. The rules for proper use of compressed gases are summarized in the Marywood University Compressed Gas Safety Policy and include the following:

Examples	Oxygen, Nitrogen, Helium, Nitric oxide, Acetylene
Identifiers	
Handling	➢ Handle cylinders of compressed gases as high-energy sources and therefore as potential explosives. ➢ When storing or moving cylinders, secure the protective caps in place over the valves in order to protect the valve stems. ➢ When moving cylinders, use only properly designed wheeled carts, and before moving, strap the cylinders securely in place on the cart. ➢ Never use cylinders if their contents cannot be identified positively. ➢ Never lubricate, modify, force, or tamper with cylinder valves. ➢ Use toxic, flammable, or reactive gases only in laboratory hoods that are known to be operating properly. ➢ Never direct compressed air or high-pressure gases at a person. ➢ Do not use compressed gas or compressed air to blow away dust or dirt. ➢ Rapid release of a compressed gas builds up a static charge that could ignite the gas if it is flammable or combustible. ➢ Close main cylinder valves tightly when they are not in use. ➢ Promptly remove the regulators from empty cylinders, and replace the protective caps at once. Label the cylinder to show that it is empty. ➢ Never bleed cylinders completely. Leave a slight pressure to keep out contaminants. ➢ Use the appropriate regulator on each gas cylinder. The threads on the regulators are designed to prevent improper use.
PPE	➢ Eye protection (goggles) ➢ Chemical resistant gloves ➢ Lab coats
Storage	➢ Restrain cylinders of all sizes, empty or full, individually by straps, chains, or a suitable stand to prevent them from falling. ➢ Store cylinders in appropriately ventilated cabinets or in an open storage area. ➢ Do not expose cylinders to temperatures higher than about 50°C. The rupture devices on some cylinders will release at about 65 °C. Some small cylinders, such as lecture bottles, are not fitted with rupture devices and may explode if exposed to high temperatures.
Incompatibles	➢ **Flammable Gases:** Oxidizing and toxic compressed gases, oxidizing solids ➢ **Oxidizers:** Flammable gases ➢ **Toxics:** Flammable and toxic compressed gases,

3.4 Laboratory Equipment

3.4.1 Glassware

The following requirements are designated for handling and use of glassware:

- Glassware shall be of borosilicate specification (e.g. Pyrex) where possible
- Glassware shall be handled with care and inspected for damage (cracks, chips) prior to use.
- Damaged items shall be discarded immediately in designated glass receptacles.
- Use precaution when handling hot glassware.
- Utilize adequate hand protection while inserting glass tubing into rubber stoppers.

For cleaning glassware:

- Appropriate PPE (gloves, goggles) shall be utilized while handling glassware that contained chemicals.
- Clean used glassware at the laboratory sink or in laboratory dishwashers using environmentally acceptable cleaning agents.
- Use scouring powder if necessary.
- Do not allow glassware to accumulate in cleaning areas.
- The following cleaning agents are not permitted: acids, strong oxidizers, flammable solvents.

3.4.2 Centrifuges

The following requirements are designated for use of centrifuges:

- Benchtop centrifuges shall be anchored securely.
- The centrifuge lid must be closed prior to starting the unit, and throughout operation.
- If vibration occurs, stop the centrifuge immediately and inspect the counterbalance load.
- Do not leave the centrifuge until full operating speed is attained and the unit is operating safely without vibration.
- Allow the centrifuge to coast to a complete stop on its own or via installed brake if present.
- Ensure mechanical components of the centrifuges are inspected and maintained regularly.

3.4.3 Vacuums

While performing work in an evacuated system, hazards include release of chemical vapors, or implosion that may release glass, particles, fire or chemicals. The following requirements are designated for use of vacuums when working with reduced pressure:

- Ensure the proper units are selected for use.
- Always use the apparatus in accordance with manufacturer guidelines.
- Protect mechanical vacuum pumps by using cold traps, with vented exhausts.
- Use shielding when working with glass vessels at reduced pressure. Only glassware made specifically for operations at reduced pressure shall be utilized.

- Glass vacuum desiccators shall be protected with friction tape applied in a grid pattern. Where practical, replace glass desiccators with applicable plastic ones.
- Ensure the apparatus is assembled appropriately.

3.4.4 Temperature-Based Devices

When working with temperature-controlling devices, the following is required:

- The actual heating element in any laboratory heating device should be enclosed in such a fashion as to prevent a laboratory worker or any metallic conductor from accidentally touching the wire carrying the electric current.
- If the heating element is exposed, the device should be either discarded or repaired before it is used again.
- Heating devices should not be exposed to flammable liquids or vapors.

3.5 Personal and Respiratory Protective Equipment

The use of Personal and Respiratory Protective Equipment (PPE/RPE) within Marywood laboratories includes the general requirements and any additional specific requirements designated by the Hazard Analysis. All laboratory personnel shall be trained in the proper use and care of P/RPE in addition to assigned requirements for each activity they perform.

Equipment that can provide protection against hazardous chemicals includes, but is not limited to: safety glasses, goggles, face shields, gloves, footwear, respirators and protective clothing. This equipment is designed to provide an immediate barrier between personnel and the hazardous material, thereby minimizing the spread of contaminants.

All P/RPE shall be certified by the appropriate organization, such as ANSI, ASTM, NIOSH, etc., and utilized in accordance with OSHA requirements codified in Subpart I of 29 CFR 1910.

3.5.1 Attire Requirements and Body Protection

All laboratory personnel and any visitors are required to abide by the following attire requirements for any entry into a Marywood laboratory setting:

- All loose hair and clothing must be confined
- Closed-toe shoes are required
- Entry into a laboratory where active work is performed requires the use of a flame-resistant lab coat and goggles, at a minimum.
- Footwear that is appropriate (minimizing slip/trip potential) for the laboratory setting shall be worn.

Additional PPE may be required as designated by the Hazard Analysis. This may include: hand and face protection, respiratory protection, or the use of chemical-resistant aprons or coats.

3.5.2 Eye and Face Protection

Eye and face protection shall include the use of safety goggles or glasses at a minimum. Goggles are required for most activities and entry into active laboratories. Glasses shall be assigned for work with solid materials. For laboratory activities that involve increased chemical splash potential (such as pouring chemicals), vacuum work or flying particles, goggles/glasses shall be used in concert with face shields. The level of eye/face protection shall be assigned by the Hazard Analysis.

- Entry into a laboratory setting requires the use of safety goggles, at a minimum.
- All safety glasses/goggles shall comply with the ANSI Occupational and Educational Eye and Face Protection Standard (Z87.1). Standard eyeglasses are not sufficient.
- Goggles equipped with vents to prevent fogging are recommended, and they may be worn over regular eyeglasses.
- The user shall inspect the equipment prior to each use, and clean after each use. The equipment shall fit comfortably, while maintaining adequate protection.

3.5.3 Hand Protection

Chemical-resistant gloves are required for any active laboratory activity. A supply of standard nitrile gloves is provided in each laboratory. Further protection (such as double gloving, increased chemical resistance, or different glove material) may be assigned by the Hazard Analysis.

- Gloves are to be inspected prior to, and throughout use.
- Gloves are to be removed prior to leaving the laboratory using the one-hand technique. Laboratory personnel shall wash hands immediately after glove use.
- Care should be taken regarding handling of objects (pens, phones, doorknobs) that were handled while donning gloves.

3.5.4 Foot Protection

Laboratory personnel transporting compressed gas cylinders shall use footwear with both toe and meta-tarsal protection.

3.5.5 Respiratory Protection

For activities where the Hazard Analysis designates the use of Respiratory Protection, Marywood Respiratory Protection Program shall be implemented. This Program has been developed to meet OSHA requirements specified at 29 CFR 1910.134. These requirements include:

- Appropriate selection of respirators
- Medical pre-qualification
- Training
- Fit Testing
- Proper use, inspection and maintenance

The above elements shall be conducted through the Health and Safety Office.

Section 5: Contingency Planning and Response

5.1 Fire Safety

As referenced in Section 3.1, all laboratories are equipped with various fire detection, notification and suppression equipment. This includes detectors, pull stations, alarms, and extinguishers. Additionally, Marywood has developed and implemented various response plans, including emergency evacuation plans and maps that are either available for review or posted in applicable areas. All laboratory personnel shall be aware of the location of equipment and procedures for responding, alarming or evacuating.

Planning:

- Ensure fire extinguishers are adequate for all fire classes presented by the chemicals within the laboratory.
- Follow provisions listed in Section 3.3.1 for storing and handling of flammable materials.
- Know where your primary and secondary exits routes are located.
- Know where to report during an evacuation.
- Know how and where to report emergencies.
- Participate in routine emergency drills.

Responding:

- Follow the recommended guidelines for responding to a fire **[R · A · C · E]**.
  - **R**escue
  - **A**larm
  - **C**onfine
  - **E**xtinguish
- Only attempt to put out a fire if you are trained and properly equipped.
- Only attempt to extinguish fires in the incipient (growth) stage.
- Ensure the extinguisher is suitable for the class (A, B, C, D, K) and size of fire.

Evacuating:

- Always evacuate at the sound of the alarm.
- If you discover a fire, pull the nearest fire alarm.
- Collect your immediate belongings and exit by the nearest designated route.
- Support those that may need assistance.
- Persons requiring special assistance may be directed to the closest Area of Rescue Assistance then notify responders.
- Close but DO NOT LOCK doors as you leave.
- DO NOT USE ELEVATORS.
- Do not return to the building until directed by Emergency Responders.

At the conclusion of the incident, complete the Incident Report Form and submit to the Lab Manager to facilitate a review. This review will identify any facility improvements, training, procedural changes, etc. necessary to minimize future occurrences or enhance response.

A	**Common Combustibles**	
B	**Flammable Liquids**	
C	**Energized Electrical**	
D	**Combustible Metals**	
K	**Kitchen Fires**	
Classes of Fire		

5.2 Exposure Response

Information regarding response measures resulting from a chemical exposure is found in the chemical's M/SDS. Measures may include: removal of the victim from the area to a fresh air environment or CPR for inhalation of chemicals; decontamination using drench showers or application of burn gel for corrosive exposures; use of eye washes; basic first aid using provided first aid kits; etc. All response shall be in accordance with Marywood's Emergency Response Plan and Emergency Desk Reference, summarized below.

Life Threatening Injuries	➢ Call Campus Safety or 911. ➢ Provide as much information as possible about the injury and victim. ➢ Campus Safety will respond and alert medical responders. ➢ If trained in First aid/CPR, act within your expertise. ➢ Remain calm and stay with the person.
Non-Life Threatening Injuries	➢ Call Campus Safety or 911 when any medical assistance may be necessary. ➢ Employees must report all work-related injuries to their immediate supervisor and Human Resources. ➢ Students or visitors must report all injuries to Campus Safety.

5.2.1 First Aid

First Aid kits are provided in all laboratories. These kits are stocked to meet minimum requirements specified by ANSI at Z308.1 and will be inspected monthly.

5.2.2 Eye Washes

All laboratories are equipped with plumbed eye washes designed to provide temporal water supply for the minimum 15 minutes per eye recommended by medical industry for chemical exposures. The units are inspected and tagged on a weekly basis to ensure proper operation, flow, water clarity and temperature. For chemical exposures to the eye(s), the victim must flush each affected eye for at least 15 minutes, using the thumb and forefinger to hold eyelids away from the eyeball and moving eyes continuously.

As referenced in Section 3.2.4, housekeeping practices shall ensure unimpeded access to the eye wash stations. The eye washes will be included in the Laboratory Inspection Program.

5.2.3 Drench Showers

All laboratories are equipped with plumbed drench showers for large exposures to liquid and solid chemicals. Showers are inspected/tagged on a weekly basis and designed to provide constant temporal water supply and collection of water for proper drainage. For small or large skin exposures to chemicals, flooding of the affected areas for 15 minutes (minimum) should occur during/after removing the chemical and any clothing or jewelry. The victim should use caution to not spread the chemical to other parts of the body (such as when removing clothing).

As referenced in Section 3.2.4, housekeeping practices shall ensure unimpeded access to the shower stations. Emergency drench showers will be included in the Laboratory Inspection Program.

5.3 Chemical Release Procedures

All spills, regardless of size, shall be address promptly. This Plan references the American Chemical Society Guide for Chemical Spill Response Planning in the Laboratory. This guideline defines two (2) spill classifications: (1) Simple; and, (2) Complex. Knowing the differences between simple and complex will determine the level response actions. Simple spills may be cleaned by trained laboratory personnel that were involved with the incident. Complex spills must be addressed by outside personnel trained in hazardous materials response.

- Simple: Does not spread rapidly, does not danger people except be direct contact, and does not danger the environment.
- Complex: Any spill that does not meet the above definition for a Simple Spill, or cannot be classified due to unknown characteristics.

The following steps shall be implemented in the event of a release:

I. Upon identification of a spill, notify the instructor and other laboratory personnel in the area.
II. Determine whether the spill is Simple or Complex. The matrix found in Figure 5 may be used as a guide in determining if a spill Simple or Complex.
    1. Evaluate Risks to Human Health, Property and the Environment.
    2. Evaluate Quantities
    3. Evaluate Potential Impacts
III. Handle Simple Spills in accordance with protocols listed in Section 5.2.2. Protocols for Complex Spills are listed in Section 5.2.3.
IV. Dispose of materials in accordance with the Hazardous Waste Management Plan.
V. All spills shall be reported to the laboratory instructor, principal investigator or supervisor in the Science Department incident report form and are forwarded to the Lab Manager for review.

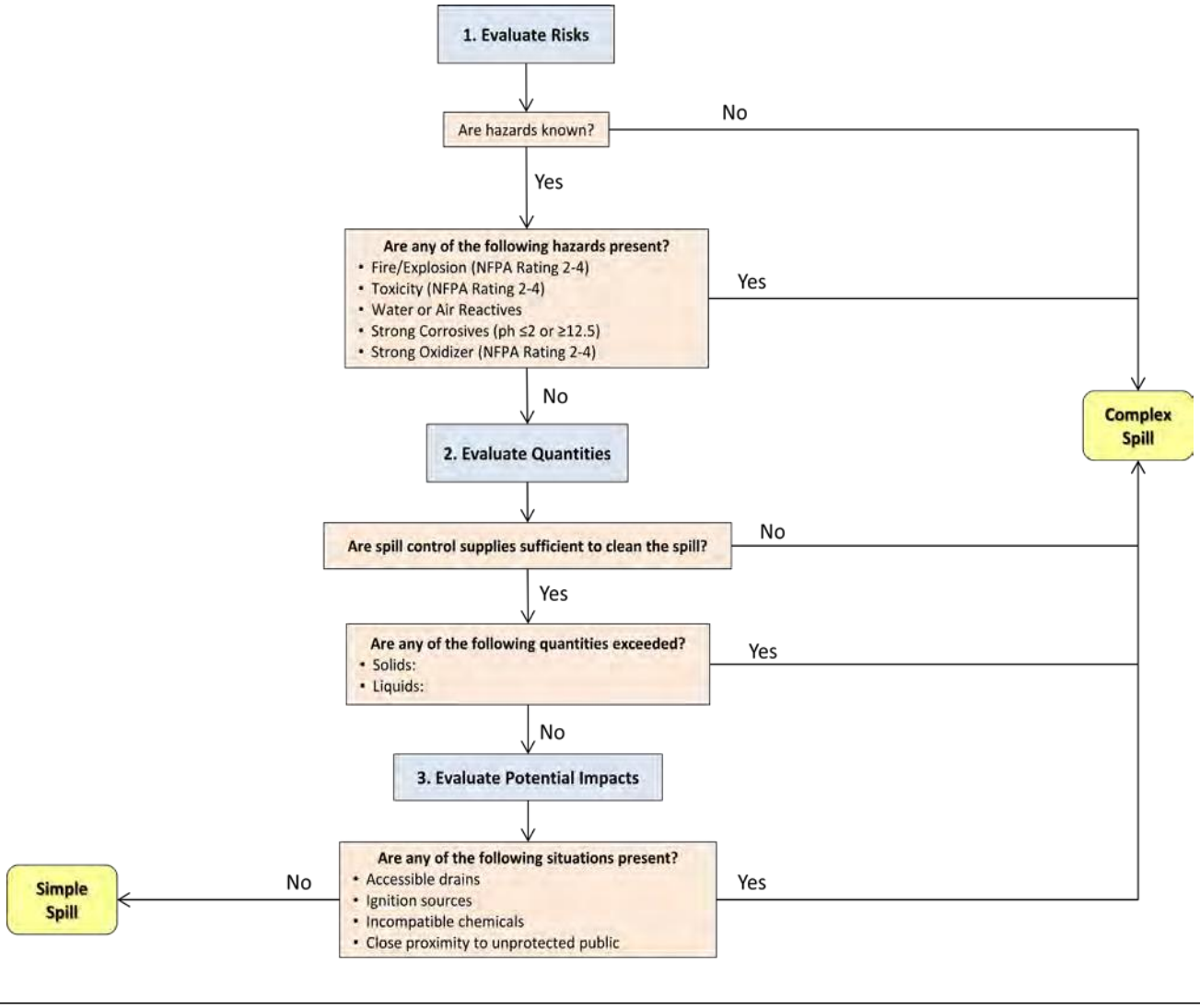


Figure 5: Simple vs. Complex Spill Matrix

5.3.1 Spill Kits

Spill kits are provided for each laboratory. These kits are suitable for chemicals used in each area, are easily accessible and inspected on a monthly basis. Spill kits may contain PPE (gloves, goggles), absorbents, adsorbents, collection devices (pans, brooms, aspirators, etc.), neutralizing agents, and containers. In the event an item is used from any spill kit, it shall be replaced in a timely manner. Spill kits are inspected monthly and will be included in the Laboratory Inspection Program.

5.3.2 Simple Spills

Procedures for Simple Spills, as defined in 5.2.1 are listed below.

- **NOTIFY:** Immediately notify the Instructor or laboratory supervisor and other laboratory personnel of the spill and confirm the spill meets the definition of a Simple Spill. Restrict access to the area.
- **PERSONAL PROTECTION:** Don PPE consisting of, at a minimum, double layer chemical resistant gloves and goggles. For certain quantities of liquid spills, additional arm/body protection and face shields may be warranted. Ensure other hazards are addressed, such as broken glass.
- **CONTROL AIRBORNE DUSTS/VAPORS:** Prevent the spread of dusts and vapors via closing doors, increasing ventilation or moving to a fume hood (if possible).
- **CONTROL LIQUIDS:** Control the spread of liquids. Construct a dike around the outside edges of the spill and use absorbent materials such as vermiculite, or spill pillows.
- **CORROSIVES:** Neutralize Acids and Bases. Neutralize acids with soda ash or sodium bicarbonate. Bases can be neutralized with citric acid or ascorbic acid. Use pH paper to determine when acid or base spills have been neutralized. Spills of most liquid acids or bases, once neutralized by trained laboratory personnel, can be mopped up and rinsed down the drain (to the sanitary sewer). ***NOTE:** This should only be performed by trained individuals because the neutralization process is often vigorous, causing splashes and yielding large amounts of heat.
- **ABSORB**: Add absorbents to the spill, working from the spill's outer edges circling toward the center. Absorbent materials are included in spill kits and include vermiculite, spill pillows and pads. ***NOTE:** Special absorbents are required for chemicals such as hydrofluoric and concentrated sulfuric acids.
- **CONTAINERIZE:** Spilled chemical liquids and solids, in addition to spill equipment that contacted the chemical, are to be containerized using the collection media provided in the spill kit or other specialized container. Additional packaging may be required before the waste can be transported from the laboratory. For spills of powders or solid materials, a dust suppressant may be necessary. Labeling requirements described in this Plan and the Hazardous Waste Management Plan apply.
- **DECONTAMINATE:** After gross removal of the chemical, wipe the exposed surfaces using appropriate (compatible) solutions. This material must also be handled as a waste product.
- **DISPOSE:** All containerized chemicals, PPE, spill control and decontamination equipment shall be handled in accordance with the Hazardous Waste Management Plan.
- **HYGIENE:** After removing PPE, wash hands and face in accordance with hygiene practices outlined in Section 3.2.5.
- **CLOSE OUT/REPORTING:** Complete the incident report form and forward to the Lab Manager. Ensure all spill kit materials are restocked.

5.3.3 Complex Spills

Complex spills will require outside assistance from the fire department or in-house/contracted hazardous materials teams. Follow protocols identified in the Emergency Response Plan, as summarized below:

For Immediately dangerous situations:

- Pull the fire alarm
- Evacuate the building, closing doors behind you
- Do not return to the building until directed by emergency responders

If there is no immediate danger:

- Evacuate the room and call Campus Safety
- Report any chemical or incident information available
  - Name
  - M/SDS
  - Quantities, container type
  - Hazards
  - Injuries
- Do not return until directed by Campus Safety

After the incident is cleared, complete the incident report form and forward to the Lab Manager.

5.4 Incident Reporting

All incidents, including safety concerns, injuries, spills and near misses, shall be reported as soon as practical. Report includes the completion of the Incident Report Form found in Appendix G of this Plan, and forwarding to the Lab Manager and Department Administration. The Chemical Hygiene Officer and the Health and Safety Office shall be responsible for review of each form. This review will facilitate any corrective actions necessary, such as modification of this Plan, purchasing additional equipment, additional training, or re-evaluation of hazards (e.g. Hazard Evaluations) by the Chemical Hygiene Officer or the Safety Committee.

5.5 Emergency Equipment Inspections

All emergency and safety equipment shall be inspected as directed by regulations or standard industry practice as directed by the Laboratory Inspection Program.

Inspections shall only be performed by individuals knowledgeable and/or certified where required. All equipment will be tagged after successful inspections. Equipment that is damaged shall be taken out of service and immediately reported to the controlling individual. Records for all inspections will be forwarded twice per year to the Health and Safety Office.

5.6 Critical Operations Shutdown

In accordance with the Emergency Evacuation Plan, any operation designated as a Critical Operation shall be reported to the Health and Safety Office for a review. This review shall determine protocols required to ensure proper shutdown and evacuation of laboratory personnel in the event of an emergency.

The OSHA
"Occupational Exposure to Hazardous Chemicals in Laboratories" Standard
Can be accessed at:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106

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§ 1910.1450 Occupational exposure to hazardous chemicals in laboratories.

(a) *Scope and application.* (1) This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

(2) Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

A current list of OSHA Permissible Exposure Limits (PEL) is found at:

https://www.osha.gov/dsg/topics/pel/index.html

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A current list of ACGIH Threshold Limit Values (TLV) is found at:

http://www.acgih.org/

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Appendix C: Science Department Laboratory Safety Training Record
Chemical Hygiene Plan

Name:
Position:

Training Title	Required	Completion Date	Retrain	Retrain	Retrain	Retrain	Retrain
BLR Training							
Biosafety in the Laboratory	X						
Chemical Hygiene Plan	X						
Chemical Safety for Lab Workers	X						
Compressed Gas Cylinders in the Laboratory	X						
Electrical Safety in the Laboratory	X						
Ergonomics for the Laboratory	X						
Hazardous Waste Safety In the Laboratory	X						
Laboratory Hazard Identification	X						
Laboratory Hoods	X						
Laboratory PPE	X						
Lab Safety Orientation	X						
Laboratory Security	X						
The OSHA Laboratory Standard	X						
Working with Flammables and Reactives in the Laboratory	X						
Moodle Training							
Reading Laboratory Signs and Labels							
Effective Use of Autoclaves							
Biological Waste Disposal							
Microbiological Media Preparation							
Vertere Inventory Training							
Fire Prevention							
Cocciardi Training(yearly)							
Chemical Hygiene							
Blood Borne Pathogen							
Fire Safety							
United Educators Training							
Teaching Science Safely							

Reviewed by:						
Date:						

Marywood UNIVERSITY	**Appendix D: New Chemical Procurement Request Form and Purchase Order Requisition Standard Operating Procedure** Chemical Hygiene Plan

Requestor: _____ _____
Name Title/Department

Building: CNHS HPL **Room:** _____

Chemical Name: _____

Amount: _____ **Storage Conditions:** _____

Is the chemical an OSHA Particularly Hazardous Chemical: YES NO

Proposed Use: _____

_____

_____

How often will chemical be used?: _____

Description of Safety Control Measures Required: _____

_____

_____

Other Relevant information on use or safety: _____

_____

_____ _____
Signed **Date**

*Please attach the most recent Safety data Sheet (SDS) with your request.
**Return this completed form to Deanne Dulik Garver, PhD, Chemical Hygiene Officer, CNHS 328, extension 2564.

FOR CHEMICAL HYGIENE OFFICER USE ONLY			
Request Received:			
Request Reviewed:			
Status:	APPROVED	DENIED	MORE INFORMATION NEEDED

Purchase Orders for Laboratory and Research Supplies

Overview

In order to streamline Science Department purchase order procedures, a standard operating procedure for the ordering of laboratory supplies is essential. This procedure is designed to eliminate unnecessary ordering and guarantee all chemicals and supplies are received through a central location. This will ensure that proper Safety Data Sheets (SDS) are obtained prior to ordering and ensure proper storage and handling of received materials.

Applicability

This procedure applies to all faculty members, principal investigators, student researchers or student laboratory assistants who need to order laboratory supplies.

Procedure

1. Purchase orders requisition forms must be completed for requested items. They may be obtained on the Marywood University website at: http://www.marywood.edu/dotAsset/76960.pdf
2. The following information must be included on the requisition:
    - Vendor Name
    - Item # of requested item(s)
    - Item description, including size, volume, etc.
    - Quantity
    - Price, if quoted from vendor with price quote attached to PO requisition, where applicable. An online cart may be attached when a quote is unavailable.
    - Date when material(s) are required
    - If the order is for research purposes, the Principal Investigator will signify approval of the requisition by his/her signature and the proper budget number designation will be assigned.
3. All PO requisitions are submitted to the Laboratory Manager (LM).
4. The LM will examine items requested, batch incoming POs if possible, and determine necessity of the item (based on current inventory) and gain best pricing/quotes where necessary.
5. The LM will obtain SDS on any new chemical and review it for storage and handling recommendations. A chemical procurement form must be filed with the Chemical Hygiene Officer prior to the ordering of any new chemical.
6. If the order is for general lab supplies/chemicals, the PO requisition will be provided to the Department Chair. The Department Chair will signify approval of the requisition by his/her signature and the proper budget number designation will be assigned. The Department Chair will return the PO requisition to the LM.
7. The LM will submit the PO requisition to Fiscal Affairs (Purchasing Agent/Grants Accountant) for processing and assignment of a PO number.
8. Purchasing will return the completed PO to the LM, who will review the document for errors.
9. The order will be placed by the LM via fax, phone or online. All orders will be tracked by the LM.

10. All orders will be inspected upon delivery by the LM for accuracy and damage. The LM will resolve any problems with orders.
11. The LM will notify the instructor upon the arrival of their items. The LM will log chemicals into the inventory and deliver them to the appropriate location for storage.
12. The LM will sign, date and mark "OK to Pay" the PO green copy. This should then be copied. The green copy will be sent to purchasing.
13. The LM will file the remaining PO copy and original packing slip according to the assigned budget number. These files shall be accessible to the Science Department Chair, Principle Investigator and the secretary for budget monitoring purposes.

Marywood UNIVERSITY

Appendix E: Hazard Analysis/SOP
Chemical Hygiene Plan

Chemical/Procedure Name:	

General			
Faculty/Principal Investigator:			
Course Name:		**Course Number:**	
Procedure Description:			

Hazards

	Chemical								Physical				
Chemical/Equipment	**Health**	**Flammable**	**Corrosive**	**Sensitizer**	**Acute Toxin**	**Water Reactive**	**Pyrophoric**	**Shock-Sensitive**	**Open Flame**	**Electrical**	**Equipment**	**Temperature**	**Other**

Route of Entry *(check all that apply)*

Inhalation ☐ Skin Contact ☐ Injection ☐ Ingestion ☐ Eye Contact ☐

Additional Materials to Review *(check all that apply)*

Safety Data Sheet (SDS) ☐ Experiment Protocol ☐ Other ☐ _____

Engineering Controls *(check all that apply)*

Fume Hood ☐ Biosafety Cabinet ☐ Other ☐ _____

Personal Protective Equipment *(check all that apply)*	
Eyes:	Safety Goggles ■ Face Shield ☐ Other ☐ _____
Clothing:	Lab Coat ■ Chemical Apron ☐ Other ☐ _____
Gloves:	Single ☐ Double ☐ Type: _____
Respirator:	Respirator ☐ Type:_____ NOTE: *contact EHS Office*
Requirements:	Standard requirements include appropriate footwear, no loose clothing, and appropriate clothing.

Use, Handling and Disposal	
Authorized Supervision:	Faculty ☐ Lab Staff ☐ GA ☐ Other ☐ _____
	Personnel must not work alone ☐
Storage Requirements:	
Specified Handling:	
Decontamination:	
Disposal:	

Emergency Procedures	
Medical:	
Fire:	
Spill:	
Exposure:	

Training
All laboratory personnel who handle this chemical or are involved with this experiment must be informed of the specific hazards and designated control measures. Laboratory personnel are to demonstrate specific competency and familiarity regarding this procedure prior to use. The Faculty Member/Principal Investigator is responsible for ensuring all laboratory personnel handling this chemical or using this procedure are trained in the following: ▪ Review of this SOP ▪ Review of the Chemical Hygiene Plan ▪ Signs and symptoms of exposure ▪ Review of the applicable SDS(s) ▪ Use of equipment

Developed By:			
Date:		**Revision 1:**	
		Revision 2:	
		Revision 3:	
		Revision 4:	
		Revision 5:	

Marywood UNIVERSITY

Appendix F: Particularly Hazardous Substance (PHS) Review Form
Chemical Hygiene Plan

PHS Name:	

General			
Faculty/Principal Investigator:			
Course Name:		Course Number:	
Procedure Description:			

PHS Hazard			
☐ Reproductive Toxin	☐ Acutely Toxic	☐ Select Carcinogen	☐ Other: _____

Other Hazards

Chemical/Equipment	Chemical								Physical				
	Health	Flammable	Corrosive	Sensitizer	Acute Toxin	Water Reactive	Pyrophoric	Shock-Sensitive	Open Flame	Electrical	Equipment	Temperature	Other

Route of Entry *(check all that apply)*

Inhalation ☐ Skin Contact ☐ Injection ☐ Ingestion ☐ Eye Contact ☐

Additional Materials to Review *(check all that apply)*

Safety Data Sheet (SDS) ☐ Experiment Protocol ☐ Other ☐ _____

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Particularly Hazardous Substance (PHS) Review Form
Chemical Hygiene Plan

Engineering Controls *(check all that apply)*
Fume Hood ■ Biosafety Cabinet ☐ Other ☐ _____

Signage Requirements *(check all that apply)*	
■ AUTHORIZED PERSONNEL ONLY	
☐ DANGER, CANCER HAZARD – SUSPECT AGENT	☐ DANGER, REPRODUCTIVE TOXIN
☐ DANGER, CANCER HAZARD – REGULATED CARCINOGEN	☐ DANGER, ACUTE TOXIN
☐ Other _____	

Personal Protective Equipment *(check all that apply)*	
Eyes:	Safety Goggles ■ Face Shield ☐ Other ☐ _____
Clothing:	Lab Coat ■ Chemical Apron ☐ Other ☐ _____
Gloves:	Single ☐ Double ☐ Type: _____
Respirator:	Respirator ☐ Type: _____ NOTE: *contact EHS Office*
Requirements:	Standard requirements include appropriate footwear, no loose clothing, and appropriate clothing.

Use, Handling and Disposal	
Authorized Supervision:	Faculty ☐ Lab Staff ☐ GA ☐ Other ☐ _____
	Personnel must not work alone ☐
Report of Use:	Required ■
Storage Requirements:	
Specified Handling:	
Decontamination:	
Disposal:	

Emergency Procedures	
Medical:	
Fire:	
Spill:	
Exposure:	

Training

All laboratory personnel who handle this chemical or are involved with this experiment must be informed of the specific hazards and designated control measures. Laboratory personnel are to demonstrate specific competency and familiarity regarding this procedure prior to use. The Faculty Member/Principal Investigator is responsible for ensuring all laboratory personnel handling this chemical or using this procedure are trained in the following:

- Review of this SOP
- Review of the Chemical Hygiene Plan
- Signs and symptoms of exposure
- Review of the applicable SDS(s)
- Use of equipment

Developed By:			
Date:		**Revision 1:**	
		Revision 2:	
		Revision 3:	
		Revision 4:	
		Revision 5:	

Marywood UNIVERSITY

Particularly Hazardous Substance (PHS) Review Form
Chemical Hygiene Plan

Report of Use			
Name:			
Date:		Principal Investigator:	
Use Summary:			
Issues:			

Chemical Hygiene Officer: _____ _____
Print Name *Signature*

Date: _____

Marywood UNIVERSITY	**Appendix G: Science Department – Laboratory Incident/Accident Report** Chemical Hygiene Plan

Today's Date: _____ Date of Incident: _____ Time of Incident: _____

Instructor, PI or Supervisor _____ Witnesses: _____

Course #: _____ Location where the incident/accident occurred: _____

Person(s) Involved:

Description of the incident/accident:

Was the incident related to any lab activity? If so, please explain. Include in response: was personal protective equipment assigned/used and were written procedure in place and followed.

Were chemicals involved? Is so, please explain what chemicals were being used in the laboratory and how they were being used.

If chemical exposure occurred, what was the route of entry (inhalation, skin (or eye) absorption, ingestion, or injection)?

Was there any bodily injury? If so, please explain.

Was there a pre-existing medical condition that contributed to the incident? If so, explain.

Describe Response Measures (was Campus Safety/Student Health Services contacted, was the person(s) involved transported to Student Health Services/ER, was first aid administered in the lab)

Probable cause of incident/accident?

Action taken:

Signature of person(s) injured:

Signature of instructor:

Submit completed form to Science Department Laboratory Manager

Acids Standard Operating Procedure

Overview

Acids must be handled with extreme care. All concentrated strong acids are corrosive substances. They can destroy body tissues by direct contact with skin, eyes and lungs. Acids are also strong oxidizers and may interact with flammable or combustible materials to produce spontaneous fires. Acid fumes may react with certain chemicals such as sulfides or cyanides, to evolve highly poisonous gases. Following this SOP will ensure the safe handling, storage and disposal of concentrated acids and their solutions.

Applicability

This procedure applies to all University Faculty, Staff, and Students and any other university employee who is involved with the ordering, storage, or use of laboratory chemicals/reagents.

Responsibilities

Cocciardi & Associates, Inc. provides technical assistance for lab personnel about the safe handling, storage and disposal of acids and training as needed.

The Chemical Hygiene Officer and Science Department Laboratory Manager ensure that acids are properly managed and disposed in accordance with this procedure. Training for applicable personnel will occur annually and when changes are made to this procedure. Records of training are retained by the Laboratory Manager.

Purchasing Considerations

- Avoid purchasing large quantities of acid. The bottles should be no larger than 1L.
- Purchase diluted solutions when possible.
- We currently use the following acids:

    1. Acetic Acid (CH_3COOH)
    2. Hydrochloric acid (HCl)
    3. Phosphoric acid (H_3PO_4)
    4. Sulfuric acid (H_2SO_4)
    5. Formic Acid (CH_2O_2)
    6. Nitric Acid (HNO_3) – is an oxidizing chemical and is handled as a strong acid.

Storage and Use Requirements

- **Acids should be handled with care.** They are generally highly corrosive and cause severe burns upon contact with body tissue.
- Concentrated hydrochloric acid may react violently with metals with the generation of highly flammable hydrogen gas, which may explode. Reactions with oxidizers may produce chlorine or bromine.
- Concentrated Acetic acid reacts with strong oxidizers and may cause a fire.
- Acids are stored separately from all other chemicals in special acid cabinets. The lids must be tightly fastened (esp. HCl)
- Acetic acid and sulfuric acid are not stored together. Mixing these two acids may cause an explosion.
- Concentrated acids are transported on lab carts or carried in plastic secondary containers.
- Solution preparation from concentrated acid should be performed in a fume hood. Double glove with extended cuff gloves, vinyl apron over lab coat, and full face shield over goggles are worn when handling strong acids (>1M).

- Students in lab courses must wear a vinyl apron over lab coats, goggles and gloves when handling acids to prevent any possibility of skin contact. Experiments using acids must be performed in a fume hood.
- Nitric Acid is an oxidizer and is handled as a strong acid.
- Students performing experiments which call for small amounts of concentrated acids (1-2mL) must use the dropper tube method to avoid handling the bottle of concentrated acid.
- A saturated solution of sodium bicarbonate (baking soda) should be available on the lab cart when acids are used. This solution may be used to neutralize small spills.

Special Instructions for the Preparation of Dilute Acids

The general rule is: **ALWAYS ADD THE CONCENTRATE TO WATER, NEVER THE REVERSE. ADD THE CONCENTRATE SLOWLY WITH STIRRING AND COOLING.**

1. Place a large beaker (800mL or larger) in a water or ice bath.
2. Add measured amount of distilled water and cool down.
3. Measure concentrated acid in graduated cylinder (Wear goggles with face shield, lab coat with vinyl apron and long acid resistant gloves.
4. Pour concentrated acid slowly with stirring into the cold distilled water.
5. Allow the diluted solution to cool further.
6. Continue the dilution with distilled water as necessary.

First Aid

- In case of contact with eyes, immediately wash the eyes with large amounts of water for 15 minutes, while holding eyelids open. Seek medical attention by dialing 911. If contact lenses are worn remove them immediately.
- In the event of skin contact, remove contaminated clothing and wash with flowing water for at least 15 minutes. If irritation persists after washing, seek medical attention.
- If a person breathes in large amounts of the chemical, move the victim to fresh air at once. If breathing has stopped, seek medical attention as soon as possible by dialing 911.
- If the chemical is swallowed, seek medical attention immediately by dialing 911.

Disposal Requirements

- All waste containing acid is placed in an appropriate container, clearly labeled and disposed of as hazardous waste.
- Small spills are diluted with water and then neutralized with a suitable agent such as sodium bicarbonate or the acid spill kit. An absorbent such as vermiculite is then used. The waste is collected in an appropriate container and disposed of as a hazardous waste.
- Large spills of concentrated acids require immediate evacuation and activation of the Hazmat team by calling security at x. 6242.

References:

1. Academic Laboratory Chemical Hazards Guidebook, Mahn, William J., Von Nostrand Reinhold: New York 1991
2. Prudent Practices in the Laboratory, Handling and Disposal of Chemicals, National Research Council, National Academy Press: Washington, D.C., 2011
3. Handbook of Chemical and Environmental Safety in Schools and Colleges, The Forum for Scientific Excellence, Inc., J.B. Lippincott Company: Philadelphia, 1990

Strong Bases SOP

Overview

A strong base is a base which hydrolyzes completely, raising the pH of the solution toward 14. Strong bases, like strong acids, attack living tissue and cause serious burns. They react differently with skin than acids do, and can cause more serious deep tissue damage than concentrated acids. Strong bases must be handled with extreme care. Following this SOP will ensure the safe handling, storage and disposal of strong bases and their solutions.

Applicability

This procedure applies to all University Faculty, Staff, and Students and any other university employee who is involved with the ordering, storage, or use of laboratory chemicals/reagents.

Responsibilities

Cocciardi & Associates, Inc. provides technical assistance for lab personnel about the safe handling, storage and disposal of bases and training as needed.

The Chemical Hygiene Officer and Science Department Laboratory Manager ensure that bases are properly managed and disposed in accordance with this procedure. Training for applicable personnel will occur annually and when changes are made to this procedure. Records of training are retained by the Laboratory Manager.

Purchasing Considerations

- Avoid purchasing large quantities of sodium hydroxide and potassium hydroxide. The bottles should be no larger than 1L.
- Purchase diluted solutions when possible.

- We currently use the following strong bases:
    1. Sodium Hydroxide (NaOH)
    2. Potassium Hydroxide (KOH)
    3. Ammonium Hydroxide (Ammonia in water, $NH_{3(g)}$ or NH_4OH)

Storage and Use Requirements

- **Strong bases should be handled with care.** They are generally highly corrosive and cause severe burns upon contact with body tissue. They are more dangerous than acid solutions.
- Strong bases in solid form are kept in the corrosive cabinet.
- Solutions are stored in a separate corrosive cabinet.
- Diluted solutions are stored in **plastic bottles not glass** since they will etch glass. Lids must be fastened tightly to avoid absorption of carbon dioxide.
- Strong bases are transported on lab carts or carried in plastic secondary containers.
- Solution preparation from pellets should be performed in a fume hood. Double glove with extended cuff gloves, vinyl apron over lab coat, and full face shield over goggles are worn when handling strong bases.
- Experiments that involve a primary standard (such as 0.1N sodium hydroxide) for titration should be dispensed from the primary container (4L cube). Secondary containers should not be used since this may change the concentration of the standard.

- Students in lab courses must wear a vinyl apron over lab coats, goggles and gloves when handling strong bases to prevent any possibility of skin contact. Experiments using strong bases must be performed in a fume hood.
- **Ammonia** is a weak base, but must be handled with the same precautions as strong bases due to the dangerous nature of its vapor.

Special Instructions for the Preparation of Solutions of Sodium Hydroxide and Potassium Hydroxide

The general rule is: **ALWAYS ADD THE CONCENTRATE TO WATER, NEVER THE REVERSE. ADD THE CONCENTRATE SLOWLY WITH STIRRING AND COOLING.**

7. Place a large beaker (800mL or larger) in a water or ice bath.
8. Add measured amount of distilled water and cool down.
9. Weigh out the sodium hydroxide or potassium hydroxide on paper or plastic weigh boat as rapidly as possible.
10. Add pellets slowly with CONSTANT STIRRING until it is dissolved. COOL. For large amounts of solution, a mechanical stirring bar may be used provided a watch glass covers the beaker to avoid splashing.

First Aid

- In case of contact with eyes, immediately wash the eyes with large amounts of water for 15 minutes, while holding eyelids open. Seek medical attention by dialing 911. If contact lenses are worn remove them immediately.
- In the event of skin contact, remove contaminated clothing and wash with flowing water for at least 15 minutes. If irritation persists after washing, seek medical attention.
- If a person breathes in large amounts of the chemical, move the victim to fresh air at once. If breathing has stopped, seek medical attention as soon as possible by dialing 911.
- If the chemical is swallowed, seek medical attention immediately by dialing 911

Disposal Requirements

- All waste containing strong bases are placed in an appropriate container, clearly labeled and disposed of as hazardous waste.
- Small spills are diluted with water and then neutralized with the appropriate spill kit. An absorbent such as vermiculite is then used. The waste is collected in an appropriate container and disposed of as a hazardous waste.
- Large spills require immediate evacuation and activation of the Hazmat team by calling security at x. 6242.

References:

4. Academic Laboratory Chemical Hazards Guidebook, Mahn, William J., Von Nostrand Reinhold: New York 1991
5. Prudent Practices in the Laboratory, Handling and Disposal of Chemicals, National Research Council, National Academy Press: Washington, D.C., 2011
6. Handbook of Chemical and Environmental Safety in Schools and Colleges, The Forum for Scientific Excellence, Inc., J.B. Lippincott Company: Philadelphia, 1990

Flammables

Overview

Flammable substances are those that readily catch fire and burn in air. They may be solid, liquid, or gaseous. Flammable liquids and solids are a potential hazard in most laboratories at Marywood University. They are used extensively, and their vapors can ignite readily and burn rapidly. Following this SOP will ensure the safe handling, storage, and disposal of flammables.

Applicability

This procedure applies to all University Faculty, Staff, and Students and any other university employee who is involved with the ordering, storage, or use of laboratory chemicals/reagents.

Responsibilities

Cocciardi & Associates, Inc. provides technical assistance for lab personnel about the safe handling, storage and disposal of flammable chemicals and training as needed.

The Chemical Hygiene Officer and Science Department Laboratory Manager ensure that flammable chemicals are properly managed and disposed in accordance with this procedure. Training for applicable personnel will occur annually and when changes are made to this procedure. Records of training are retained by the Laboratory Manager.

Purchasing Considerations

- Avoid purchasing large quantities of liquid or solid flammables.
- Limit the container size to one liter or less for liquid flammables.
- Limit the container size to the smallest amount possible for solid flammables.
- Avoid purchase of sodium metal. Sodium metal may not be purchased or used without permission of the Chemical Hygiene Officer.

Storage and Use Requirements (Liquid Flammables)

- All flammable liquids are stored in flammable liquid storage cabinets, when not in use. Storage of liquid flammables is confined to the flammable cabinets located in CNHS 97, 105, 106,107, 108, 300,301,302, 307 and 309.
- Flammables should not be stored in refrigerators. If a flammable requires refrigeration it should be stored in the explosion-proof refrigerator in CNHS 302.
- Flammables are transported on lab carts or carried in plastic secondary containers.
- Pouring of flammables must be performed in a fume hood.
- Experiments involving the use of flammables should be conducted in a fume hood.
- Secondary containers of flammables should be properly labeled with the appropriate flammable warning. Container size should be kept as small as possible.
- **Caution: Open flames are not the only source of ignition for flammable liquids.** All sources of ignition (lighted matches, open flames, hot plates, electrical equipment and stirrers) should be eliminated when using flammables in a fume hood.

- Experiments involving the heating of flammables should use steam bath or heating mantle of the appropriate size. Never heat or evaporate flammables with an open flame or hotplate in the fume hood. Use steam provided in the fume hood for evaporations.

Storage and Use (Flammable Solids)

- Most flammable solids used at Marywood University may ignite when exposed to air or moisture.
- A solid flammable is stored as indicated on its specific Safety Data Sheet (SDS) and its container is stored in the solids flammable cabinet in CNHS 302. A copy of the SDS should be made available on the chemical cart in the lab when flammable solids such as Magnesium, Sodium and Calcium Carbide are in use.
- **Solid Flammable Metal fires cannot be put out with water.** Class D fire extinguisher is available in CNHS 302 closet where the flammable solids are stored. This Class D extinguisher is mobile and is placed in the laboratory when solid flammables are in use.
- All flammable solids are stored in flammable solid storage cabinet, when not in use. Storage of solid flammables is confined to the solids flammable cabinet in CNHS 302.
- Only a minimal amount of flammable solids required for the experiment should be placed in the lab.

Use of Specific Solid Flammable Metals

1. **Magnesium Metal**
   - **Avoid the use of magnesium powder**. Experiments involving magnesium should use magnesium ribbon.
   - Magnesium is kept in its original container with the lid taped and is stored in the solids flammable cabinet in CNHS 302.
   - The Chemical Hygiene Officer shall dispose of magnesium metal, by reacting it with 3M hydrochloric acid in a fume hood. The resulting solution is collected and stored with other hydrochloric acid waste containing magnesium salts and is disposed of as a hazardous waste.

2. **Calcium Metal**
   - Calcium is a flammable solid which reacts with atmospheric moisture.
   - **Avoid the use of calcium powder**. When possible use small calcium turnings in its place.
   - Calcium should be stored in the solids flammable cabinet in CNHS 302.
   - **Large pieces of calcium metal should not be placed in the lab area.**
   - The Chemical Hygiene Officer shall dispose of calcium metal by reacting it with 3M hydrochloric acid in the fume hood. The resulting solution is collected and stored with other hydrochloric acid waste containing calcium salts and is disposed of as a hazardous waste.

3. **Calcium Carbide**
   - Calcium carbide is a flammable water reactive solid which releases acetylene gas when exposed to moisture.
   - Calcium carbide should be stored in its original container in the solids flammable cabinet in CNHS 302.
   - Secondary containers for lab use should be appropriately labeled and should have a tight fitting lids that is taped.
   - Calcium carbide should be weighed rapidly in a glass container.
   - The Chemical Hygiene officer shall dispose of calcium carbide by reacting it with water in the fume hood. The resulting calcium hydroxide/ calcium carbonate slurry is stored as collected and is disposed of as a hazardous waste.

First Aid

- In case of accidental exposure, please consult the individual chemical's Safety Data Sheet (SDS) for specific first aid instructions since each chemical may have specific required actions. The first aid section will describe first aid that may be administered by a lay person and will also convey specific medical information concerning treatment and diagnostic procedures for trained medical personnel.
- In case of contact with eyes, immediately wash the eyes with large amounts of water for 15 minutes, while holding eyelids open. Seek medical attention by dialing 911. If contact lenses are worn remove them immediately.
- In the event of skin contact, remove contaminated clothing and wash with flowing water for at least 15 minutes. If irritation persists after washing, seek medical attention.
- If a person breathes in large amounts of the chemical, move the victim to fresh air at once. If breathing has stopped, seek medical attention as soon as possible by dialing 911.
- If the chemical is swallowed, seek medical attention immediately by dialing 911.

Disposal/Spill Requirements

- **Never dispose of flammables in sinks or drains.**
- All waste containing flammables are placed in an appropriate container, clearly labeled and disposed of as hazardous waste.
- In case of spill, please consult the individual chemical's Safety Data Sheet (SDS) for specific accidental release measures and disposal instructions since each chemical have specific required actions.
- If a flammable material is spilled, advise everyone in the area to immediately turn off all electrical equipment and evacuate the area until the clean up is complete.
- Small spills are diluted with water and then neutralized with the appropriate spill kit. An absorbent such as carbon is then used. The waste is collected in an appropriate container and disposed of as a hazardous waste.
- Large spills require immediate evacuation and activation of the Hazmat team by calling security at x. 6242.

References:

7. Academic Laboratory Chemical Hazards Guidebook, Mahn, William J., Von Nostrand Reinhold: New York, 1991
8. Prudent Practices in the Laboratory, Handling and Disposal of Chemicals, National Research Council, National Academy Press: Washington, D.C., 2011
9. Handbook of Chemical and Environmental Safety in Schools and Colleges, The Forum for Scientific Excellence, Inc., J.B. Lippincott Company: Philadelphia, 1990
10. Chemical Safety in the Laboratory, Hall, Stephen K., CRC Press: New York, 1994
11. Handbook of Chemical Health and Safety, Alaimo, Robert J., American Chemical Society: Washington, D.C. 2001

Health Hazards

Overview
All health hazards should be handled as a chemical with high acute toxicity or moderate chronic toxicity. These required special handling as described by Mahn in the **Academic Laboratory Chemical Hazards Guidebook.**

Health Hazards in use at Marywood University are classified as:

1) Liquids: The Chlorinated and Brominated hydrocarbons and the Amines. These chemicals may not be used without the permission of the Chemical Hygiene Officer.
2) Solids:
    - Heavy metals: lead, cadmium and mercury
    - Chlorinated organics
    - Amine derivatives
    - Thiol derivatives
    - All Oxidant compounds: Chromiums, ammoniacal silver nitrate solutions, nitrates, perchlorates, dichromates, and the perchlorates.
    - All Nickel Compounds
    - All Barium Compounds

3) Dyes both solid and solutions including Microbiological Dried Media.

Applicability
This procedure applies to all University Faculty, Staff, and Students and any other university employee who is involved with the ordering, storage, or use of laboratory chemicals/reagents.

Responsibilities
Cocciardi & Associates, Inc. provides technical assistance for lab personnel about the safe handling, storage and disposal of health hazards and training as needed.

The Chemical Hygiene Officer and Science Department Laboratory Manager ensure that health hazards are properly managed and disposed in accordance with this procedure. Training for applicable personnel will occur annually and when changes are made to this procedure. Records of training are retained by the Laboratory Manager.

Purchasing Considerations

- Health Hazard chemicals should be purchased in minimal quantities.
- Handling should be kept to a minimum.
- If possible, solutions of desired concentration should be purchased rather than solids, which must be weighed, etc.

Storage and Use Requirements
Health hazards should be handled with care.

- Handling should be kept to a minimum.
- Before beginning a laboratory procedure, each worker is advised to consult the SDS.
- Two people should be present at all times when handling a substance that is highly toxic.
- All health hazards are stored separately in a designated area for health hazards unless another storage concern overrides the health concern (for example oxidants). These areas have restricted access.

- All volatile substances and those involving solid or liquid toxic substances that may create aerosols should be conducted in a fume hood.
- All solids must be weighed in a fume hood.
- All solutions must be prepared in a fume hood. Solutions must be labeled with the same hazard warning as the solid container.
- Liquid health hazards should be transferred to secondary containers in the hood.
- The working surface used should have a removable absorbent disposable plastic backed liner.
- Carts must be used to transport materials from the main storage room to the prep area.
- All Oxidants are treated as health hazards.
- Lab coat, gloves, goggles and fume hoods should always be used when working with oxidants.
- Protect hands and forearms with double long cuff nitrile gloves so that there is no skin exposure.
- If a toxic substance contacts the skin, the area should be washed well with water or a safety shower should be used for 15 minutes.
- If a major spill occurs the area should be evacuate and the HAZMAT team should be contacted for clean up. HAZMAT team is activated by calling security at x. 6242.
- After working with health hazards, remove gloves and wash hands immediately.

First Aid

- In the case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
- In case of contact with eyes, immediately wash the eyes with large amounts of water for 15 minutes, while holding eyelids open. Seek medical attention by dialing 911. If contact lenses are worn remove them immediately.
- In the event of skin contact, remove contaminated clothing and wash with flowing water for at least 15 minutes. Seek medical attention by dialing 911.
- If a person breathes in large amounts of the chemical, move the victim to fresh air at once. If breathing has stopped, seek medical attention as soon as possible by dialing 911. Do not attempt mouth-to-mouth resuscitation if victim has ingested or inhaled the substance. Artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device may be used.
- If the chemical is swallowed, seek medical attention immediately by dialing 911. These substances are Poison. Do not induce vomiting unless instructed to do so by medical personnel.

Disposal Requirements

- All waste considered to be a health hazard is placed in an appropriate container, clearly labeled and disposed of as hazardous waste.
- If a major spill occurs the area should be evacuate and the HAZMAT team should be contacted for clean up. HAZMAT team is activated by calling security at x. 6242.
- Small Spills should be wiped up with a wet paper towel and disposed of as hazardous waste.

Special Considerations:

1. **Chlorinated Solvents**

    - Chlorinated solvents currently used are chloroform and dichloromethane. These should be purchased in small containers and transported in secondary containers or on a cart to minimize spills.
    - All work involving these solvents should be conducted in a fume hood.
    - When ready for disposal, they should be labeled as mixed chlorocarbons and may also be mixed with other chlorinated hydrocarbons such as p-dichlorobenzene and disposed of as hazardous waste.

2. Chromium compounds

- Even though chromium compounds are stored as oxidizers, they should be treated as acute health hazards.
- Where possible Chromium (VII) salts should be purchased as solutions.

3. Dyes

- Most dyes are carcinogens.
- Powders should be weighed in a fume hood and any small spills must be cleaned up promptly.
- Always work on a disposable surface (bench liners).
- Where possible buy prepared solutions instead of solid powders.

4. **Microbiological Media**

- Powdered Microbiological Media poses an inhalation hazard and should not be used on an open lab bench.
- Powders should be weighed in a fume hood and any small spills must be cleaned up promptly.
- Solutions should be prepared and mixed in fume hood.
- Always work on a disposable surface (bench liners) and wet wipe hood and other lab surfaces after use or at the end of the day.

5. **Beta - Mercaptoethanol (2-Mercaptoethanol, BME)**

- BME is a flammable liquid and severe health hazard.
- BME is stored in a secondary container in a flammable cabinet in CNHS 302.
- BME must be dispensed in a fume hood and is extremely hazardous if inhaled.

References:

12. Academic Laboratory Chemical Hazards Guidebook, Mahn, William J., Von Nostrand Reinhold: New York 1991
13. "Prudent Practices in the Laboratory, Handling and Disposal of Chemicals", National Research Council, National Academy Press: Washington, D.C., 2011

Oxidizing Chemicals

Overview

Oxidizing Chemicals are materials that promote combustion or spontaneously evolve oxygen at room temperature or with slight heating. This class of chemicals includes peroxides (see peroxide-forming chemicals SOP), chlorates, perchlorates, nitrates and permanganates. Strong oxidizers are capable of forming explosive mixtures when mixed with combustible, organic or easily oxidized materials.

Applicability

This procedure applies to all University Faculty, Staff, and Students and any other university employee who is involved with the ordering, storage, or use of laboratory chemicals/reagents.

Responsibilities

Cocciardi & Associates, Inc. provides technical assistance for lab personnel about the safe handling, storage and disposal of peroxide-forming chemicals and training as needed.

The Chemical Hygiene Officer and Science Department Laboratory Manager ensure that peroxide-forming chemicals are properly managed and disposed in accordance with this procedure. Training for applicable personnel will occur annually and when changes are made to this procedure. Records of training are retained by the Laboratory Manager.

Purchasing Considerations

Avoid purchasing the following oxidizers.

1. Ammonium dichromate
2. All metal perchlorates and Perchloric acid
3. Ammonium Nitrate
4. Picric Acid

No ordering of the above chemicals should occur without consulting with the Chemical Hygiene Officer.

Storage and Use Requirements

Oxidizers should be handled with care.

- They are generally corrosive.
- Oxidizers should be stored separately from all other chemicals.
- Lab coats, goggles and gloves must be worn when handling oxidizers to prevent any possibility of skin contact.
- Oxidizers should always be handled in a fume hood. Weigh oxidizers in the fume hood to avoid breathing their dust.
- These materials present a fire and explosion hazard when in contact with organic or combustible materials. Avoid contact with paper, corks and rubber stoppers.
- Do not use weigh paper or a plastic weigh dish for weighing oxidizing chemicals. Weigh oxidizers on a watch glass or ceramic crucible.
- Strong oxidizing agents, such as chromic acid, should be stored and used in glass or other inert, and preferably unbreakable, containers.
- Reaction vessels containing appreciable amounts of oxidizing materials should never be heated in oil baths, but rather on a heating mantle or sand bath.
- The hazards associated with use of perchloric acid are particularly severe. Never work with perchloric acid without consulting with the Chemical Hygiene Officer.

First Aid

- In case of contact with eyes, immediately wash the eyes with large amounts of water for 15 minutes, while holding eyelids open. Seek medical attention by dialing 911. If contact lenses are worn remove them immediately.
- In the event of skin contact, remove contaminated clothing and wash with flowing water for at least 15 minutes. If irritation persists after washing, seek medical attention.
- If a person breathes in large amounts of the chemical, move the victim to fresh air at once. If breathing has stopped, seek medical attention as soon as possible by dialing 911.
- If the chemical is swallowed, seek medical attention immediately by dialing 911

Disposal Requirements

- Small spills should be reported immediately to The Chemical Hygiene Officer or Science Department Laboratory Manager. The spill may be wiped up with very wet paper towel**. The paper towel cannot be allowed to dry.** The towels must be placed in a large glass jar, labeled and disposed of as hazardous waste.
- Large spills require immediate evacuation and activation of the Hazmat team by calling security at x. 6242.
- All waste containing oxidizing chemicals is to be disposed of as hazardous waste.

Use of Specific Oxidizing Chemicals

6. **Dichromates**
   - Use of dichromates is limited to sodium and potassium dichromate.
   - General storage and use of dichromates may be found in the Storage and Use Requirements section of this SOP.
   - The use of any other dichromate is prohibited without the prior approval of the Chemical Hygiene Officer.

7. **Nitrates**
   - General storage and use of nitrates may be found in the Storage and Use Requirements section of this SOP.
   - The use of ammonium nitrate is prohibited without the prior approval of the Chemical Hygiene Officer.

8. **Nitric Acid**
   - Nitric acid should be considered a storage hazard. It is to be stored in its own cabinet in CNHS 302.
   - Handling requirements for nitric acid are found in the acid SOP.

9. **Permanganates**
   - Permanganate use is limited to potassium permanganate.
   - Any other permanganate may only be used with the prior approval of the Chemical Hygiene officer.
   - General storage and use of permanganates may be found in the Storage and Use Requirements of this SOP.

10. **Perchlorates**
    - Perchlorates should not be used without the prior approval of the Chemical Hygiene Officer.
    - Perchlorates should never be allowed to contact acids, particularly the organic acids, since perchloric acid will then be formed in a nearly anhydrous from. This is even more hazardous than the aqueous solution of the acid.
    - Perchlorates (ex. Magnesium perchlorate known as Anhydrone) should not be used as a drying agent if there is a possibility of contact with organic compounds or a strong dehydrating acid.

11. **Perchloric Acid**
    - Perchloric acid should never be used without the prior approval of the Chemical Hygiene Officer. It is extremely dangerous chemical to use.
    - It is routinely used in biochemistry labs or for research.
    - The dangers of working with this chemical are well documented and the literature has many examples of situations where fires, explosions, injuries and even death have occurred because of careless or uneducated use of perchloric acid in the laboratory.
    - **A special SOP is required for work with perchloric acid.**

Examples of Oxidizing Materials

Oxidizers may be grouped into 4 classes based on their ability to affect the burning rate of combustible materials or undergo self-sustained decomposition. This classification system was established by the National Fire Protection Association (NFPA 43A, 1980) as a means to provide information on safe storage of oxidizing materials. These materials are classified according to the following guidelines shown in Table 1 below. Also shown (Table 2) are typical examples of each class of oxidizing materials.

TABLE 1 - Classification System for Oxidizing Materials

Class Rating	Hazard Description
Class 1	An oxidizing material whose primary hazard is that it may increase the burning rate of combustible material with which it comes in contact.
Class 2	An oxidizing material that will moderately increase the burning rate or which may cause spontaneous ignition of combustible material with which it comes in contact.
Class 3	An oxidizing material that will cause a severe increase in the burning rate of combustible material with which it comes in contact or which will undergo vigorous self-sustained decomposition when catalyzed or exposed to heat.
Class 4	An oxidizing material that can undergo an **explosive reaction** when catalyzed or exposed to heat, shock or friction.

TABLE 2- Oxidizing Materials
(as Classified by the NFPA)
Marywood University has highlighted chemicals in inventory

Class 1 Examples	Class 2 Examples	Class 3 Examples	Class 4 Examples
aluminum nitrate potassium dichromate ammonium persulfate potassium nitrate barium chlorate potassium persulfate barium nitrate silver nitrate barium peroxide sodium carbonate peroxide calcium chlorate sodium dichloro-s-triazinetrione calcium nitrate sodium dichromate calcium peroxide sodium nitrate cupric nitrate sodium nitrite hydrogen peroxide (8-27.5%) sodium perborate lead nitrate sodium perborate tetrahydrate lithium hypochlorite sodium perchlorate monohydrate lithium peroxide sodium persulfate magnesium nitrate strontium chlorate magnesium perchlorate strontium nitrate magnesium peroxide strontium peroxide nickel nitrate zinc chlorate nitric acid (<70% conc.) zinc peroxide perchloric acid (<60% concen.)	calcium hypochlorite (<50% wgt) potassium permanganate chromium trioxide (chromic acid) sodium chlorite (<40% wgt.) halane sodium peroxide hydrogen peroxide (27.5-52% conc.) sodium permanganate nitric acid (>70% conc.) trichloro-s-triazinetrione	ammonium dichromate potassium chlorate hydrogen peroxide (52-91% conc.) potassium dichloroisocyanurate calcium hypochlorite (>50% wgt.) sodium chlorate perchloric acid (60-72.5% conc.) sodium chlorite (>40% wgt.) potassium bromate sodium dichloro-s-triazinetrion	ammonium perchlorate ammonium permanganate guanidine nitrate hydrogen peroxide (>91% conc.) perchloric acid (>72.5%) potassium superoxide

References:

14. NFPA: NFPA 430-2004, Code for the Storage of Liquid and Solid Oxidizing Materials
15. Academic Laboratory Chemical Hazards Guidebook, Mahn, William J., Von Nostrand Reinhold: New York 1991
16. "Prudent Practices in the Laboratory, Handling and Disposal of Chemicals", National Research Council, National Academy Press: Washington, D.C., 2011

Marywood UNIVERSITY	**Science Department Chemical Standard Operating Procedures**

Peroxide-Forming Chemicals

Overview

Peroxide-forming chemicals are a class of compounds that have the ability to form shock-sensitive explosive peroxide crystals. Some of the organic solvents commonly used in Marywood University's (MU) laboratories have the potential to form explosive peroxide crystals, diethyl ether and tetrahydrofuran are two of the more common peroxide-forming chemicals used at MU. Therefore, it is extremely important that this procedure be followed regarding the identification, handling, storage, and disposal of peroxide-forming chemicals.

Under normal storage conditions the materials listed in this document have the potential to generate and accumulate peroxide crystal formations, which may violently detonate when subjected to thermal or mechanical shock. Peroxide-forming chemicals react with oxygen – even at low concentrations – to form peroxy compounds. The risk associated with peroxide formation increases if the peroxide crystallizes or becomes concentrated by evaporation or distillation. Factors that affect rate of peroxide formation include exposure to air, light and heat, moisture, and contamination from metals.

Peroxide crystals may form on the container plug or the threads of the lid and detonate when the lid is twisted. Do not open a liquid organic peroxide or peroxide-forming chemical if crystals or a precipitate are present.

Applicability
This procedure applies to all University Faculty, Staff, and Students and any other university employee who is involved with the ordering, storage, or use of laboratory chemicals/reagents.

Definitions
A peroxide is a chemical that contains a peroxo (O-O) unit, one that has the chemical formula of $O2^{2-}$.

Responsibilities
Cocciardi & Associates, Inc. provides technical assistance for lab personnel about the safe handling, storage and disposal of oxidizers and training as needed.

The Chemical Hygiene Officer and Science Department Laboratory Manager ensure that oxidizers are properly managed and disposed in accordance with this procedure. Training for applicable personnel will occur annually and when changes are made to this procedure. Records of training are retained by the Laboratory Manager.

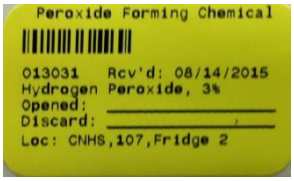
Procedure
Purchasing Considerations

- When possible, purchase only peroxide-forming chemicals which contain a peroxide formation inhibitor (e.g., tetrahydrofuran or diethyl ether inhibited with butylated hydroxytoluene (BHT)).
- Only purchase quantities of peroxide-forming chemicals that you expect to use within expiration and disposal timeframes.

Labeling Requirements

- All bottles of peroxide-forming chemicals are marked with date of receipt upon arrival by the Laboratory Manager.
- When the bottle is first opened, the container must be marked with the date opened and the disposal date.
- Any secondary containers of peroxide-forming chemicals must also have the date received, date opened and disposal date marked on the container.

Example Label



Storage and Use Requirements

- Do not store peroxide-forming chemicals in direct sunlight as light can accelerate the chemical reactions that form peroxides.
- If the peroxide-forming chemical is flammable and requires refrigeration, then the explosion-proof refrigerator in CNHS 302 must be used.
- Do not distill, evaporate or concentrate a peroxide-forming chemical until you have first tested it for the presence of peroxides. (Peroxides are usually less volatile than their parent material and will tend to concentrate in the hot distillation pot).
- **Any potential peroxide former that is within one month of its disposal date or a bottle that is opened and is missing its disposal date must be tested for the presence of peroxides. Notify the Chemical Hygiene Officer or the Lab Manager immediately if one of these conditions exists.**
- To test for the presence of peroxides one of the following tests will be performed by the Chemical Hygiene Officer.

1) Mix 3 mL of the material to be tested with 3 mL glacial acetic acid. Add 5% solution of potassium iodide drop wise. Shake. A yellow to brown color means peroxides have formed. Run a negative control with glacial acetic acid and potassium iodide alone and compare. **OR**
2) Use the Sigma Cat. No. 37206 Quantofix® Peroxide test sticks. Follow the procedure in the package.
    - Remove only the required number of test sticks from the tube and immediately replace the container stopper.
    - Without touching the test field, dip the test stick into the test solution for 1 second. For organic solvents, the test pad is wetted with one drop of distilled water after evaporation of the solvent.
    - Wait 5 seconds, and then compare the test field with the color scale. If hydrogen peroxide is present, the test field will turn blue.
    - Color changes after 1 minute are not to be considered positive.
    - A 3 mg/l solution of Hydrogen peroxide should be used as a positive control. This solution is made by diluting 1.5ml of 30% hydrogen peroxide with 1000mL distilled water. Then 3 ml of this solution is diluted with 500ml of distilled water (=3mg/l). Testing should yield a blue coloration.
    - Distilled water should be used as a negative control. No blue coloration should form upon testing.
    - The test sticks should be disposed of in the event the controls do not work.

- **NEVER UNDER ANY CIRCUMSTANCES** touch or attempt to open container of a peroxide-forming liquid if there are crystals around the cap and/or in the bottle. The friction of screwing the cap may detonate the bottle. If you encounter such a bottle, contact the Chemical Hygiene Officer immediately for removal. **DO NOT TOUCH OR MOVE THE SUSPECT BOTTLE YOURSELF FOR ANY REASON.**

First Aid

- In case of contact with eyes, immediately wash the eyes with large amounts of water for 15 minutes, while holding eyelids open. Seek medical attention by dialing 911. If contact lenses are worn remove them immediately.
- In the event of skin contact, remove contaminated clothing and wash with flowing water for at least 15 minutes. If irritation persists after washing, seek medical attention.
- If a person breathes in large amounts of the chemical, move the victim to fresh air at once. If breathing has stopped, seek medical attention as soon as possible by dialing 911.
- If the chemical is swallowed, seek medical attention immediately by dialing 911.

Disposal Requirements

- There are four classes of peroxide-forming chemicals based upon the peroxide formation hazard:

Class A – Severe Peroxide Hazard
Class B – Concentration Hazard
Class C – Shock and Heat Sensitive
Class D – Potential Peroxide-Forming Chemicals

- Peroxide-forming chemicals must be disposed within the timeframes specified in the table below regardless if the container is unopened. Disposal must occur within the timeframe allowed once the container is received or opened, whichever the earlier of the two dates.
- All peroxide-forming chemicals in secondary containers must be disposed of at the end of each semester.

	Class A	Class B	Class C	Class D
Date Opened	3 months	6 months	6 months	Only if peroxide crystals are present
Date Received	1 year	1 year	1 year	Only if peroxide crystals are present

- **NOTE:** If the peroxide-forming chemical has a visible peroxide formation or is greater than a year old, contact the Science Department Laboratory Manager, Chemical Hygiene Officer or Cocciardi and Associates immediately. ***Do not move or handle these containers.***
- Marywood University has contractors available to test and, if necessary, stabilize peroxide-forming chemicals.
- All peroxide-forming chemicals Marywood University may have in stock are highlighted in yellow.

Peroxide Forming Chemical Lists

Class A – Severe Peroxide Hazard

Spontaneously decompose and become explosive with exposure to air without concentration.

Butadiene (liquid monomer)	Isopropyl ether	Sodium amide (sodamide)
Chloroprene (liquid monomer)	Potassium amide	Tetrafluoroethylene (liquid monomer)
Divinyl acetylene	Potassium metal	Vinylidene chloride

Class B – Concentration Hazard

Require external energy for spontaneous decomposition. Form explosive peroxides when distilled, evaporated or otherwise concentrated.

Acetal	Diethyl ether	4-Methyl-2-pentanol
Acetaldehyde	Dioxanes	2-Pentanol
Benzaldehyde	Ethylene glycol dimethyl ether (glyme)	4-Penten-1-ol
Benzyl alcohol	Furan	1-Phenylethanol
2-Butanol	4-Heptanol	2-Phenylethanol
2-Butanone (methyl ethyl ketone)	2-Hexanol	2-Propanol (isopropyl alcohol)
Cumene	Heptaldehyde	Propionaldehyde
Cyclohexanol	Heptanal	Tetrahydrofuran
Cyclohexene	Hexanal	Tetrahydronaphthalene
2-Cyclohexen-1-ol	Isobutyladehyde (2-methylpropanal)	Vinyl ethers
Decahydronaphthalene	Methylacetylene	Other secondary alcohols
Diacetylene	3-Methyl-1-butanol (isoamyl alcohol)	Any aldehyde (says aldehyde or ends in (al)
Dicyclopentadiene	Methylcyclopentane	
Diethylene glycol dimethyl ether (diglyme)	Methyl isobutyl ketone	

Class C – Shock and Heat Sensitive

Highly reactive and can auto-polymerize as a result of internal peroxide accumulation. The peroxides formed in these reactions are extremely shock and heat sensitive.

Acrylic acid	Chlorotrifluoroethylene	Vinyl acetate
Acrylonitrile	Methyl methacrylate	Vinylacetylene (gas)
Butadiene (gas)	Styrene Vinylpyridine	Vinyladiene chloride
Chloroprene	Tetrafluoroethylene (gas)	Vinyl chloride (gas)

Class D – Potential Peroxide Forming Chemicals

May form peroxides but cannot be clearly categorized in Class A, B, or C.

Acrolein	p-Chlorophenetole	2,5-Hexadiyn-1-ol
Allyl ether	Cyclooctene	4,5-Hexadien-2-yn-1-ol
Allyl ethyl ether	Cyclopropyl methyl ether	n-Hexyl ether
Allyl phenyl ether	Diallyl ether	o.p-Iodophenetole
p-(n-Amyloxy)benzoyl chloride	p-Di-n-butoxybenzene	Isoamyl benzyl ether
n-Amyl ether	1,2-Dibenzyloxyethane	Isoamyl ether
Benzyl n-butyl ether	p-Dibenzyloxybenzene	Isobutyl vinyl ether
Benzyl ether	1,2-Dichloroethyl ethyl ether	Isophorone
Benzyl ethyl ether	2,4-Dichlorophenetole	b-Isopropoxypropionitrile
Benzyl methyl ether	Diethoxymethane	Isopropyl-2,4,5-trichlorophenoxy acetate
Benzyl-1-napthyl ether	2,2-Diethoxypropane	n-Methylphenetole
1,2-Bis(2-chloroethoxyl)ethane	Diethyl ethoxymethylenemalonate	2-Methyltetrahydrofuran
Bis(2-ethoxyethyl)ether	Diethyl fumarate	3-Methoxy-1-butyl acetate
Bis(2-(methoxyethoxy)ethyl) ether	Diethyl acetal	2-Methoxyethanol
Bis(2-chloroethyl) ether	Diethylketene	3-Methoxyethyl acetate
Bis(2-ethoxyethyl) adipate	Diethoxybenzene (m-,o-,p-)	2-Methoxyethyl vinyl ether
Bis(2-methoxyethyl) carbonate	1,2-Diethoxyethane	Methoxy-1,3,5,7-cyclooctatetraene
Bis(2-methoxyethyl) ether	Dimethoxymethane	b-Methoxypropionitrile
Bis(2-methoxyethyl) phthalate	1,1-Dimethoxyethane	m-Nitrophenetole
Bis(2-methoxymethyl) adipate	Di(1-propynl) ether	1-Octene
Bis(2-n-butoxyethyl) phthalate	Di(2-propynl) ether	Oxybis(2-ethyl acetate)
Bis(2-phenoxyethyl) ether	Di-n-propoxymethane	Oxybis(2-ethyl benzoate)
Bis(4-chlorobutyl) ether	1,2-Epoxy-3-isopropoxypropane	b,b-Oxydipropionitrile
Bis(chloromethyl) ether	1,2-Epoxy-3-phenoxypropane	1-Pentene
2-Bromomethyl ethyl ether	p-Ethoxyacetophenone	Phenoxyacetyl chloride
beta-Bromophenetole	1-(2-Ethoxyethoxy)ethyl acetate	a-Phenoxypropionyl chloride
o-Bromophenetole	2-Ethoxyethyl acetate	Phenyl-o-propyl ether
p-Bromophenetole	(2-Ethoxyethyl)-a-benzoyl benzoate	p-Phenylphenetone
3-Bromopropyl phenyl ether	1-Ethoxynaphthalene	n-Propyl ether
tert-Butyl methyl ether	o,p-Ethoxyphenyl isocyanate	n-Propyl isopropyl ether
n-Butyl phenyl ether	1-Ethoxy-2-propyne	Sodium 8-11-14-eicosatetraenoate
n-Butyl vinyl ether	3-Ethoxypropionitrile	Sodium ethoxyacetylide

Chloroacetaldehyde diethylacetal	2-Ethylacrylaldehyde oxime	Tetrahydropyran
2-Chlorobutadiene	2-Ethylbutanol	Triethylene glycol diacetate
1-(2-Chloroethoxy)-2-phenoxyethane	Ethyl-b-ethoxypropionate	Triethylene glycol dipropionate
Chloroethylene	Ethylene glycol monomethyl ether	1,3,3-Trimethoxypropene
Chloromethyl methyl ether	2-Ethylhexanal	1,1,2,3-Tetrachloro-1,3-butadiene
beta-Chlorophenetole	Ethyl vinyl ether	4-Vinyl cyclohexene
o-Chorophenol	Hexachlorobutadiene	Vinylene carbonate

References:

1. National Safety Council: Data Sheet I-655 Rev. 87
2. NFPA: RCD9:2002 Edition, Code for the Storage of Organic Peroxide Formulations
3. "Academic Laboratory Chemical Hazards Guidebook", Mahn, William J., Von Nostrand Reinhold: New York, 1991