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1.0 Introduction

1.1 Purpose

The purpose of this document is to provide general guidance to all laboratory employees regarding the safe handling, use, and storage of hazardous chemicals. It is the goal of the Environmental Health and Safety Office to support the mission of Emory University and to comply with all federal and state regulations by ensuring that all employees are protected from workplace hazards, and that their potential for exposure and injury is minimized. These goals are to be accomplished through the implementation of hazard controls such as elimination, substitution, administrative and engineering controls, and where necessary, the use of personal protective equipment as prescribed in the OSHA Laboratory Standard – 29 CFR 1910.1450 - Occupational Exposure to Hazardous Chemicals in Laboratories, otherwise known as the OSHA Laboratory Standard. The OSHA Laboratory Standard requires the development of a Chemical Hygiene Plan, or CHP, to achieve these goals.

1.2 How to Use This Manual

The CHP is a reference for the safe handling of hazardous chemicals in the laboratory. The CHP applies to all engaged in laboratory use of hazardous chemicals. The information contained in the CHP is prescribed by the OSHA Lab Standard and supersedes, for laboratories, the requirements of all other OSHA health standards in subpart Z. Most relevant are the sections on Laboratory Practices, Standard Operating Procedures for Hazardous Chemicals, Medical Consultation and Medical Examinations and Emergency Procedures. Appendix A provides an overview of toxicology, and the various effects that chemical exposures can have on the body.

1.3 Scope

This CHP applies to all who work in laboratories or laboratory related work areas (i.e., equipment rooms, common cold rooms, chemical storage rooms, etc.) where hazardous chemicals are handled, used, and/or stored.

This CHP does not directly apply to Emory University employees who do not work in laboratories or laboratory related work areas. Those employees are covered under the OSHA Hazard Communication Standard & EHS-300, Hazardous Communication Program. available at https://ehso.emory.edu/guidance/forms-documents.html.

1.4 Glossary of Terms

American Conference of Governmental Industrial Hygienists (ACGIH). The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLVs) for numerous chemicals and physical agents and includes Biological Exposure Indices (BEI).

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.

Acute. Severe, often dangerous exposure conditions in which relatively rapid changes occur.

Acute Exposure. An intense (large dose or highly concentrated) exposure over a relatively short period of time.

Acute Toxicity. Contact by skin or ingestion that produces adverse health effects within 24 hours or within 4 hours by inhalation. Can be one or more doses.

American National Standards Institute (ANSI). The American National Standards Institute is a voluntary membership organization that develops national consensus standards for a wide variety of devices and procedures.

Asphyxiant. A chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants such as nitrogen either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.

Biohazard. Infectious agents that present a risk or potential risk to the health of humans or other animals, either directly through infection or indirectly through damage to the environment.

Boiling Point. The temperature at which the vapor pressure of a liquid equals atmospheric pressure or at which the liquid changes to a vapor. If a flammable material has a low boiling point, it indicates a special fire hazard.
According to OSHA, the boiling point of a liquid at a pressure of 14.7 pounds per square inch absolute (p.s.i.a.) (760 mm).

Ceiling "C." A description usually seen in connection with a published exposure limit. It refers to the concentration that should not be exceeded, even for an instant. It may be written as Threshold Limit Value or TLV-C—Ceiling (See also THRESHOLD LIMIT VALUE).

Carcinogen. A substance that induces or increases cancer incidence in animals or humans. (See SELECT CARCINOGEN).

C.A.S. Number. Identifies a particular chemical by the Chemical Abstracts Service, a service of the American Chemical Society that indexes and compiles abstracts of worldwide chemical literature called "Chemical Abstracts."

Chemical Fume Hood. A ventilated enclosure with five sides and a moveable sash or fixed partial enclosure on the remaining side constructed to prevent or minimize escape of exhaust fumes, gases, vapors, mists, and particulate matter generated within the hood interior.

Chemical Hygiene Officer (CHO). An employee who is designated by the employer and who is qualified by training and 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 (CHP). A written program developed and implemented by the Chemical Hygiene Officer which sets forth procedures, equipment, personal protective equipment, and work practices capable of protecting personnel from the health hazards presented by the hazardous chemicals used in that particular workplace.

Chronic Exposure. A persistent, prolonged, repeated exposure occurring over a period of days, weeks, or years.

Combustible. According to NFPA, combustible liquids are an ignitable liquid classified as a Class II or Class III liquid. They do not ignite as easily as flammable liquids however combustible liquids can be ignited under certain circumstances.

Class IIIA liquids have a closed-cup flash point at or above 140 °F (60 °C) and below 200 °F (93.4 °C).
Class IIIB liquids have a closed-cup flash point at or above 200 °F (93.4 °C).

According to DOT, combustible liquids are any liquids that do not meet the definition of any other hazard class and have a flash point above 140 °F (60 °C) and below 200 °F (93.4 °C). This also includes a flammable liquid with a flash point at or above 100 ºF (38 ºC) that does not meet the definition of any other hazard class.

A combustible material is any material that will ignite and burn.
Substances such as wood, paper, etc., are termed "Ordinary Combustibles."

Compressed Gas.
A non-flammable, nonpoisonous compressed gas is any material or mixture with a pressure of 200 kPa (29.0 psia/43.8 psia) or greater at 68°F (20°C) and does not meet the DOT definition of flammable or poisonous gas.
A gas is defined by DOT as poisonous at 68°F (20°C) or less and a pressure of 101.3 kPa (14.7 psia), and is a health hazard during transportation, or is presumed to be toxic

to humans with an LC_{50} value of not more than 5000 mL/m^3.
(See FLAMMABLE GAS). According to OSHA, a gas which when under pressure is entirely gaseous at -8ºF (-50ºC), including all gases with a critical temperature ≤ -58ºF (50ºC).

Concentration. The amount of a material in a stated unit of measure. For example, 5 parts (of acetone) per million (parts of air).

Corrosive. A substance that, according to the DOT, causes irreversible destruction or permanent changes to human skin at the site of contact; or is highly corrosive to steel or aluminum (exceeding 6.25 mm a year at a test temperature of 130°F (55°C)). Corrosive material is regulated by the EPA as hazardous waste.

Cutaneous/Dermal. Pertaining to or affecting the skin.

Cytotoxin. A substance toxic to cells in culture or to cells in an organism.

Decomposition. The breakdown of a chemical or substance into different parts or simpler compounds. Decomposition can occur due to heat, chemical reaction, decay, etc.

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

Dermatitis. An inflammation of the skin.

Dilution Ventilation. See GENERAL VENTILATION.

Department of Transportation (DOT). The United States Department of Transportation is the Federal agency that regulates the labeling and transportation of hazardous materials.

Dyspnea. Shortness of breath, difficult or labored breathing.

EHSO. Environmental Health and Safety Office.

Emergency. Any occurrence such as, but not limited to, equipment failure, ruptures of containers or failure of control equipment which results in an 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 their assignments.

Environmental Protection Agency (EPA). The Environmental Protection Agency is the governmental agency responsible for administration of laws to control and/or reduce pollution of air, water, and land systems.

Epidemiology. The study of disease in human populations.

Erythema. A reddening of the skin.

Evaporation Rate. The ratio of time at which a material is converted to vapor (evaporates) at a given temperature and pressure when compared to the evaporation rate of a reference liquid. Health and fire hazard evaluations of materials involve consideration of evaporation rates as one aspect of the evaluation.

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

Eye Irritant. A substance that can cause reversible changes in the eye within 21 days of contact.

Flammable Gas. Any material that is a gas at 68°F (20°C) or less at an absolute pressure of 101.3 kPa (14.7 psia) and that has a boiling point of 68°F (20°C) or less at an absolute pressure of 101.3 kPa (14.7 psia), and is ignitable in a mixture with air at a concentration of 13% by volume or less; or at an ambient temperature and pressure forms a range of flammable mixtures with 12% air, regardless of the lower limit.

Flammable Liquid. A liquid with a flashpoint at or below 199.4°F (93°C), and further defined by OSHA in four categories.
Category 1 liquids have flashpoints below 73.4°F (23°C) and a boiling point at or below 95 °F (35 °C).
Category 2 liquids have flashpoints below 73.4°F (23°C) and a boiling point above 95 °F (35 °C).
Category 3 liquids have flashpoints at or above 73.4°F (23°C) and at or below 140 °F (60 °C).
Category 4 liquids have flashpoints above 140°F (60°C) and at or below 199.4 °F (93 °C).

NFPA defines flammable liquids as those with a closed-cup flash point below 100°F (37.8°C) and a vapor pressure that does not exceed 40 psi (276 kPa).

DOT defines flammable liquids as those with a flash point of not more than 140°F (60°C), or any material in a liquid phase with a flash point above 100°F (37.8°C).

Flammable Solid. A solid, other than a blasting agent or explosive, that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change or retained heat from manufacturing or processing, that has an ignition temperature below 212°F (100°C) or burns so vigorously and persistently it creates a serious hazard.

Flash Point. The lowest temperature at which a liquid gives off enough vapor to form an ignitable mixture and burn when a source of ignition (sparks, open flames, etc.) is present. Two tests are used to determine the flash point of a homogeneous liquid at 100°F (38°C): open cup and closed cup. The test method is indicated on the SDS after the flash point.

Fume. An airborne particulate that has condensed from the vapor state.
means a material which has a vapor pressure greater than 300 kPa (43.5 psia) at 50 °C (122 °F) or is completely gaseous at 20 °C (68 °F) at a standard pressure of 101.3 kPa (14.7 psia).

Gas. A material which has a vapor pressure greater than 300 kPa (43.5 psia) at 50 °C (122 °F) or is completely gaseous at 20 °C (68 °F) at a standard pressure of 101.3 kPa (14.7 psia).

General Ventilation. Also known as general exhaust ventilation, this is a system of ventilation consisting of either natural or mechanically induced fresh air movements to mix with and dilute contaminants in the workroom air. This is not the recommended type of ventilation to control contaminants that are highly toxic, when there may be corrosion problems from the contaminant, when the worker is close to where the contaminant is being generated, and where fire or explosion hazards are generated close to sources of ignition (See LOCAL EXHAUST VENTILATION).

Grams per Kilogram (g/kg). This indicates the dose of a substance given to test animals in toxicity studies. For example, a dose may be 2 grams (of substance) per kilogram of body weight (of the experimental animal).

Hazardous Chemical. A hazardous chemical is defined as any chemical, chemical compound, or mixture of compounds which is a physical and/or health hazard.

Health Hazard. Any chemical for which there is significant evidence that acute or chronic health effects may occur in exposed personnel. The term “health hazard” includes chemicals that are corrosives, irritants, sensitizers, mutagens, carcinogens, toxins, and agents that can damage the lungs, skin, eyes, or mucous membranes.

Ignitable. Liquid waste with a flash point less than 140°F (60°C), non-liquids that readily sustain combustion or cause fire. Ignitable material is regulated by the EPA as a hazardous waste.

Incompatible. The term applied to two substances to indicate that one material cannot be mixed with the other without the possibility of a dangerous reaction.

Ingestion. Taking a substance into the body through the mouth as food, drink, medicine, or unknowingly by contaminated hands or cigarettes, etc.

Inhalation. The breathing in of an airborne substance that may be in the form of gas, fumes, mists, vapors, dusts, or aerosols.

Irritants. A substance that produces an irritation effect when it contacts skin, eyes, nose, or respiratory system.

Laboratory. A facility where relatively small quantities of hazardous materials are used on a nonproduction basis.

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 Use of Hazardous Materials. The handling or use of chemicals in which the following conditions are met: (1) Chemical manipulations are carried out on a laboratory scale. (2) Multiple chemical procedures or chemicals are used. (3) The procedures involved are not part of a production process, nor simulate a production process. (4) Protective laboratory practices and equipment are available and in common use to minimize the potential for personnel exposure to hazardous chemicals.

Laminar Air Flow. Air flow in which the entire mass of air within a designated space moves with uniform velocity in a single direction along parallel flow lines with a minimum of mixing.

Lethal Concentration, LC_{50}. The concentration of an air contaminant that will kill 50% of the test animals in a group during a single exposure.

Lethal Dose LD_{50}. The dose of a substance or chemical that will kill 50% of the test animals in a group, generally within the first 30 days following exposure.

Local Exhaust Ventilation. A ventilation system that captures and removes air contaminants at the point they are being produced before they escape into the workroom air. The system consists of hoods, ductwork, a fan and possibly an air cleaning device.

Lower Explosive Limit (LEL). The concentration of a flammable vapor in air below which ignition will not occur. It is expressed in percent of vapor or gas in the air by volume. Below the LEL or LFL, the air/contaminant mixture is theoretically too “lean” to burn (See also UEL).

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

Melting Point. The temperature at which a solid changes to a liquid. A melting range may be given for mixtures.

Mutagen. Anything that can cause permanent change (or mutation) in the genetic material of a living cell.

Narcosis. Stupor or unconsciousness caused by exposure to a chemical.

National Fire Protection Association (NFPA). The National Fire Protection Association is a voluntary membership organization whose aims are to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Codes. Within these codes is Standard No. 704, “Identification of the Fire Hazards of Materials.” This is a system that rates the hazard of a material during a fire. These hazards are divided into health, flammability, and reactivity hazards and appear in a well-known diamond system using zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates severe hazard.

National Institute for Occupational Safety and Health (NIOSH). The National Institute for Occupational Safety and Health is a federal agency that among its various responsibilities, trains occupational health and safety professionals, conducts research on health and safety concerns, and tests and certifies respirators for workplace use.

Occupational Safety and Health Administration (OSHA). A Federal agency under the Department of Labor that publishes and enforces safety and health regulations for most businesses and industries in the United States.

Odor Threshold. The minimum concentration of a substance at which a majority of test subjects can detect and identify the substance's characteristic odor.

Oxidation. The process of combining oxygen with some other substance or a chemical change in which an atom loses electrons.

Oxidizer. Any material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials.

Oxygen Deficiency. An atmosphere having less than the normal percentage of oxygen found in normal air. Normal air contains 21% oxygen at sea level. OSHA defines oxygen deficient as less than 19.5% oxygen by volume.

Particularly Hazardous Substances. Particularly hazardous substances are select carcinogens, reproductive toxins, and chemicals with a high degree of acute toxicity.

Permissible Exposure Limit (PEL). An exposure limit that is published and enforced by OSHA as a legal standard. PEL may be either a time-weighted-average (TWA) exposure limit (8 hour), a 15-minute short term exposure limit (STEL), or a ceiling (C). The PELs are found in Tables Z-1, Z-2, or Z-3 of OSHA regulations 1910.1000 (See also TLV).

Personnel Protective Equipment (PPE). Any devices or clothing worn by the worker to protect against hazards in the environment. Examples include respirators, gloves, and chemical splash goggles.

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.

Polymerization. A chemical reaction in which two or more small molecules combine to form larger molecules that contain repeating structural units of the original molecules. A hazardous polymerization is the above reaction with an uncontrolled release of energy.

RAD. The unit of the ionizing radiation dose absorbed equal to 100 ergs per gram or 0.01 joules per kilogram of tissue.

Reactivity. A substance's susceptibility to undergoing a chemical reaction or change that may result in dangerous side effects, such as explosion, burning, and corrosive or toxic emissions. The conditions that cause the reaction, such as heat, force, and contact with water or other chemicals, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on the SDS. Reactive material is regulated by the EPA as hazardous waste.

Reproductive Toxins. Chemicals which affect the reproductive capabilities including adverse effects on sexual function, fertility, chromosomal damage (mutations) and effects on development of the offspring.

Respirator. A device which is designed to protect the wearer from inhaling harmful contaminants.

Respiratory Hazard. A specific concentration of an airborne contaminant that, when it enters the body by way of the respiratory system or by being breathed into the lungs, results in bodily function impairment.

Select Carcinogen. A chemical regulated by OSHA as a carcinogen, listed by the National Toxicology Program (NTP) as "known to be carcinogenic", or listed by the International Agency for Research on Cancer (IARC) as a Group 1 carcinogen. Also included are chemicals or processes listed in either Group 2A or 2B by IARC or under the category “reasonably anticipated to be carcinogens” by NTP and that cause statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

1. 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.
2. After repeated skin application of less than 300 mg/kg of body weight per week.
3. After oral dosages of less than 50 mg/kg of body weight per day.

Self-Reactive. A substance that is thermally unstable and can decompose exothermically even without air.

Sensitizer. A substance that may cause no reaction in a person during initial exposures, but afterwards, further exposures will cause an allergic response to the substance.

Short Term Exposure Limit. Represented as STEL or TLV-STEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures. Also, the daily TLV-TWA must not be exceeded.

Skin Irritant. A substance that can cause reversible damage to skin after up to 4 hours of contact.

“Skin” Notation. This designation sometimes appears alongside a TLV or PEL. It refers to the possibility of absorption of the chemical through the skin and eyes. Thus, protection of large surface areas of skin should be considered to prevent skin absorption.

Systemic. Spread throughout the body; affecting many or all body systems or organs;

not localized in one spot or area.

Teratogen. An agent or substance that may cause physical defects in the developing embryo or fetus when a pregnant female is exposed to that substance.

Threshold Limit Value (TLV). Airborne concentrations of substances devised by the ACGIH that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLVs are advisory exposure guidelines, not legal standards that are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLV's: Time Weighted Average (TLV-TWA), Short Term Exposure Limit (TLV-STEL) and Ceiling (TLV-C). (See also PEL).

Time Weighted Average (TWA). The employee's average airborne exposure in any 8-hour work shift for a 40-hour workweek. The average is determined by sampling for the contaminant throughout the working period. Represented as TLV-TWA.

Toxicity. The potential of a substance to exert a harmful effect on a biological mechanism in humans or animals. Toxic waste, as defined by the EPA's Toxicity Characteristic table, is regulated by the EPA as hazardous waste.

Unstable (Reactive). A chemical that, in its pure state or as commercially produced, can polymerize, corrode, decompose, or react vigorously in some hazardous way under shock conditions (i.e., dropping), certain temperatures, or pressures.

Upper Explosive Limit (UEL). The highest concentration (expressed in percent of vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present. Theoretically, above this limit the mixture is too "rich" to support combustion. The difference between the LEL and the UEL constitutes the flammable range or explosive range of a substance. That is, if the LEL is 1 ppm and the UEL is 5 ppm, then the explosive range of the chemical is 1 ppm to 5 ppm. (See also LEL).

Vapor. The gaseous state of substances which are normally in the liquid or solid state (at normal room temperature and pressure). Vapors evaporate into the air from liquids such as solvents. Solvents with low boiling points will evaporate.

Vapor Pressure. The pressure that a solid or liquid exerts when it is in equilibrium with its vapor at a given temperature.

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

1.5 Responsibilities

Emory University

Emory University and its employees, in accordance with the Occupational Safety and Health Act of 1970, Section 5 (General Duty Clause), have a shared responsibility for working safely in their work environment. Emory University must ensure that each of its employees is provided a place of employment that is free from recognized hazards that have the potential to cause death or serious physical injury by complying with all applicable occupational safety and health standards.

Emory employees must practice safe working behaviors and comply with all occupational safety and health standards, rules, and regulations. This CHP, as indicated in the Scope, applies to individuals working in laboratories or related areas, and will focus on these standards, rules, and regulations.

Environmental Health and Safety Office (EHSO)

The Environmental Health and Safety Office (EHSO) serves as an advocate for safety and health at Emory University, and ensures regulatory compliance with all applicable rules, regulations, and standards in the following areas:

- Research Safety
- Radiation Safety
- Environmental Compliance
- General Safety and Industrial Hygiene

Research Safety Program and Research Safety Director

The Research Safety Program & Director of Research Safety are responsible for ensuring compliance with all federal and state regulations in laboratory work areas through the following:

- Provision of safety manuals and guidelines, including the CHP.
- Development and provision of training programs to Principal Investigators (PIs), Lab Managers, Students, and Laboratory Staff.
- Development and implementation of a laboratory inspection program to document areas of non-compliance and to recommend corrective actions.
- Review and approval of chemical safety protocol applications for working with hazardous chemicals.
- Providing guidance to laboratory personnel regarding safe laboratory practices.

Industrial Hygiene Program

Industrial hygiene is the science of anticipating, recognizing, evaluating, and controlling workplace conditions that may cause workers' injury or illness. The Industrial Hygiene Program will:

- Conduct qualitative exposure assessments for hazardous chemicals.
- Use environmental monitoring and analytical methods to detect the extent of worker exposure to hazardous chemicals.

- Employ engineering, work practice controls, and other methods to control potential health hazards.
- Conduct respirator training and fit testing.

Chemical Hygiene Officer (CHO)
The Chemical Hygiene Officer (CHO) is a designated representative of EHSO. The responsibilities of the CHO include (but are not limited to):

- Developing a chemical hygiene program and the CHP in accordance with state and federal regulations.
- Evaluating the chemical hygiene program annually for effectiveness.
- Developing chemical hygiene education and training programs for PIs, Lab Managers, Students, and Staff.
- Reviewing standard operating procedures (SOPs) and hazard assessments.
- Conducting risk assessments in conjunction with the Industrial Hygiene Program for potential overexposures to hazardous chemicals.
- Evaluating areas of deficiency within laboratory work areas and recommending corrective actions.
- Evaluating the effectiveness of the Chemical Hygiene Plan using metrics to review the program (e.g., review of inspection findings, tracking/trending of laboratory accidents and incidents).
- Communicating with Department Chairs and PIs to gain end-user support on new initiatives.
- Delegating responsibilities to Research Safety Building Liaisons.

Research Health and Safety Committee
The Emory University Research Health and Safety Committee (RHSC) provides recommendations for safety policy for approval by the President or his/her designee, on matters relating to biosafety/chemical safety for all types of research (e.g., basic animal, human). This includes the control of health hazards associated with the intramural use of microbial agents and toxins, hazardous chemicals, as well as other workplace, facility, or environmental hazards to faculty, staff and students that may be associated with University activities. Additional responsibilities of the RHSC are covered in the RHSC Charter, available at http://www.ehso.emory.edu/documents.

EHSO Research Safety Building Liaisons
EHSO Research Safety Building Liaisons serve as points of contact for research faculty and lab personnel within the Research Safety Program for designated buildings. The responsibilities of EHSO Research Safety Building Liaisons include (but are not limited to):

- Communicating with PIs, Lab Managers, Students, and Staff regarding lab safety issues.
- Inspecting laboratories and laboratory-related areas (both validation and post-validation).
- Documenting and tracking inspection findings for trending analyses.

- Reporting inspection findings to PIs and Lab Managers and making recommendations regarding corrective actions.
- Administering training and education to laboratory personnel, as required.
- Informing PIs, Lab Managers, Students, and Laboratory Staff of all potentially hazardous conditions in laboratory areas.
- Facilitating laboratory waste collection, laboratory cleanouts, and laboratory moves when necessary.
- Investigating accidents, injuries, and near misses to determine root causes and the appropriate course to prevent reoccurrence.

Department Chairs
Department Chairs serve as representatives of their respective departments. Their responsibilities include (but are not limited to):

- Communicating with PIs, Lab Managers, Students, and Laboratory Staff regarding lab safety issues.
- Provides the Research Safety Director and the CHO with support to implement and maintain the CHP.
- Reporting any potentially hazardous conditions within the department to EHSO.

Principal Investigators (PIs)
Principal Investigators (PIs) are the direct employers of laboratory personnel (Lab Managers, Staff and Students). Their responsibilities include (but are not limited to):

- Providing the necessary training for each individual based on lab specific requirements including each research project or experiment that he/she will use hazardous chemicals.
- Ensuring that all laboratory personnel know how to access the CHP and understand the content within this CHP.
- Ensuring that laboratory personnel complete all required safety training and remain current with refresher training requirements.
- Wearing minimum personal protective equipment (PPE) (lab coat, gloves, closed toe shoes, eye protection) & additional PPE as required, when working in the presence with hazardous chemicals.
- Providing the appropriate PPE to protect employees from laboratory hazards, including chemical hazards.
- Ensuring that all required hazardous chemicals used in the lab have written standard operating procedures (SOPs) or hazard assessments and been registered with EHSO if necessary.
- Reporting any potentially hazardous conditions within the lab to EHSO.
- Ensuring that laboratory personnel report any accidents, incidents, or near misses to EHSO.

Lab Managers
Laboratory Managers are delegated by PIs to oversee the daily operations of a research

lab. They serve as the point of contact for Research Safety Building Liaisons and their responsibilities include (but are not limited to):

- Following all guidelines and prudent practices covered in the CHP.
- Ensuring that all laboratory personnel working in the lab understand and follow guidelines and prudent practices covered in the CHP.
- Ensuring that all individuals (self-included) have completed all required safety training, remain current with refresher training requirements, and maintain laboratory safety records.
- Ensuring that all personnel wear minimum PPE (lab coat, gloves, closed toe shoes, eye protection) & additional PPE as required, when working in the presence with hazardous chemicals.
- Working in a safe and efficient manner to avoid harm or injury to oneself or other personnel.
- Reporting any potentially hazardous conditions within the lab to the PI and/or EHSO.

Laboratory Staff, Students, Volunteers and Visitors
All individuals who participate in research activities and use hazardous chemicals have responsibilities that include (but are not limited to):

- Reading and following all guidelines and prudent practices covered in the CHP.
- Completing all required safety training and remaining current with refresher training requirements.
- Wearing minimum PPE (lab coat, gloves, closed toe shoes, eye protection) & additional PPE as required, when working in the presence of hazardous chemicals. Additional PPE may be required as determined by risk assessment.
- Working in a safe and efficient manner to avoid harm or injury to oneself or another individual.
- Reporting any potentially hazardous conditions within the lab to the Lab Manager, PI and/or EHSO.

1.6 Rights of Employees

Emory University employees have the right to be made aware of any hazardous materials they may be required to use during work activities, and to be provided with information and training on how to safely use these materials prior to working with them. Emory employees also have the right to work in an environment that is free from recognized hazards, and to be protected from those hazards while working.

1.7 Availability

The Emory University CHP is available on the EHSO website. (https://ehso.emory.edu/guidance/forms-documents.html).

1.8 Information and Training

All employees of Emory University must be provided with information and training that addresses the hazards they will encounter when working in a laboratory environment. This information must make them aware of what the hazards are, their risk of exposure to these hazards, how to protect themselves from the potential hazards, and the procedures to follow if they are exposed to the hazards. An overview of industrial toxicology is presented in Appendix A – Industrial Toxicology Overview. The information in this appendix clarifies the variety of effects that hazardous chemicals can manifest.

Information – employees must be informed of the chemicals they will be working with daily, and the hazards associated with these chemicals. The information must be accessible prior to beginning work (initial assignment) and whenever there are changes in job function that also change exposure conditions. This information includes (but is not limited to) the following:

- The OSHA Laboratory Standard and all its parts.
- How to locate the Emory University CHP.
- Where and how to find permissible exposure limits for both OSHA regulated and non-regulated materials.
- Signs and symptoms associated with exposure to these chemicals.
- How to find Safety Data Sheets (SDSs) for hazardous chemicals.
- Performing job hazard analyses to identify hazards and risks of planned experiments.

Training – must be received prior to beginning work (initial assignment) and whenever there are changes in job function that also change exposure conditions. Employees must also receive annual refresher training and continuing education training throughout each year. Training, in accordance with the OSHA Laboratory Standard, must include (but is not limited to) the following:

- The details of the CHP.
- Physical and health hazards of chemicals in the work area.
- Methods to detect the presence or release of a hazardous chemical in the work area.
- Protective control measures against hazards.
- Standard operating procedures (SOPs).
- Prudent practices for laboratory safety.
- Emergency procedures.
- PPE.
- To meet the requirements above, Emory University offers faculty, laboratory employees, non-Emory affiliates, and students Research Laboratory Safety training. This training is to be completed before work in the lab begins and refresher training is an annual requirement.
- Other subject matter-specific trainings are also offered, and are available in a variety of forms, including classroom modules, online modules, and video clips.
- Other forms of training that are required by the OSHA Laboratory Standard are laboratory-specific and should be provided by the PI or laboratory Supervisor/Manager of the lab. This training should include (but is not limited to) the following:

- Lab-specific SOPs.
- Chemical-specific training.
- Lab-specific methods of handling emergencies.
- Training on operation of equipment.
- Exposure prevention of recognized hazards.
- Any other training appropriate for lab specific work.

1.9 Recordkeeping Requirements

Training required in accordance with the OSHA Laboratory Standard must be documented and retained. Research Laboratory Safety training, which is an annual requirement, is offered online through the electronic platform SciShield. After completing the training module, the training date is tracked and retained by the system. Records for other required training courses offered through an entity other than EHSO must also be retained by filing (electronically or hard copy) a confirmation completion page or certificate of completion.

1.10 Program Review

In accordance with the OSHA Laboratory Standard, the CHP must be reviewed annually to evaluate the effectiveness of the plan. It should be updated as necessary to reflect any changes in the lab standard or changes in safety measures or processes.

2.0 Laboratory Practices

2.1 General Laboratory Safety

When working in a laboratory, it is important for the Faculty, Staff, and Students to use prudent laboratory practices to maintain a safe work environment. The items below are some basic guidelines to follow and should be considered the minimum requirements to maintain safety in the lab.

- Every laboratory using hazardous chemicals must have current/accurate laboratory door signage. Signage is obtained by submitting the Lab Signage Requirements Form to EHSO.
- Prior to working with any hazardous chemical for the first time, read the SDS to identify what the hazards are, and how to safely handle and store it.
- When working with hazardous chemicals, always use the available engineering controls when possible, to eliminate or minimize exposure (e.g., chemical fume hoods, sharps containers, etc.).
- Always wear the appropriate clothing and Personal Protective Equipment (PPE).
- Avoid wearing overly loose clothing. Long hair must be restrained.
- All laboratory refrigerators, freezers, and microwaves must be labeled with a “No Food/No Drink” label.
- After working with hazardous chemicals, wash hands thoroughly and dry completely. This must be done after removing PPE, prior to leaving the lab, and prior to consuming food, drinks, and applying cosmetics.
- Never work alone. Always ensure that at least one other person is in the work area; this person can assist you in the event of a laboratory exposure or injury.

- Always use hazardous chemicals and equipment for their intended purposes.
- Always be aware of the hazards around you. If someone in the lab is using hazardous chemicals, avoid startling or distracting them.
- Know where emergency equipment is located, including emergency showers, emergency eyewash stations, fire extinguishers, and fire alarm pull stations.
- In the event of an emergency or a hazardous chemical spill, know where to locate the *Just in Time* guide in your lab, which contains the appropriate emergency response procedures.
- Never pipette any materials by mouth.

2.2 Recognizing Hazards and Risks

The basics of risk analysis combine hazard recognition, hazard assessment, and identification of protective measures. Laboratory personnel must be able to recognize common hazards within the laboratory and be familiar with how these hazards are communicated based on the Globally Harmonized System (GHS) of hazard classification and Emory-specific hazard symbols. In addition to recognizing the hazards, assessing the risk of the hazards presented by chemicals used is vital to prevent accidents, injuries, and exposures. Examples of hazards to consider include:

Table 1.0 – Common Laboratory Hazards

Laboratory Hazard	Examples
Chemical Hazards	Strong Acids or Bases, Flammables
Physical Hazards	Strong Oxidizers, Pyrophorics, Air or Water Reactive, High Pressure or Low Pressure systems, Vacuum Systems, Compressed Gases
Electrical Hazards	Electrical Equipment
Cryogenic Hazards	Liquid Helium, Liquid Nitrogen, Dry Ice
Health Hazards	Toxic Substances, Carcinogens, Mutagens, Teratogens, Nanomaterials
Reaction Hazards	Energy Sources, Heat Sources, Scale-Up reactions, Catalyst effects

2.3 Unattended Operations

Plan to conduct experiments that involve hazardous chemicals during normal working hours. When unattended operations are necessary, follow these practices:

- Leave laboratory lights on during overnight experiments.
- Post information about the experiment nearby that includes the chemicals used, their hazards and the name and number of the contact person.
- Periodically check on the experiment, especially when heating and/or using water cooling equipment.

2.4 Food and Drink in Laboratory Areas

According to Emory University's Food and Drink Guidelines, it is prohibited to consume food and drinks, to smoke, or to apply cosmetic materials in any laboratory area. It is also prohibited to store food in refrigerators that are used to store chemicals, and to use microwave ovens that are used for research purposes to heat food. Based on risk assessment performed by EHSO, certain areas within a laboratory may be designated as appropriate to consume food and drinks. For more information, access the Emory University

Food and Drink Guidelines at https://ehso.emory.edu/guidance/forms-documents.html.

2.5 General Housekeeping

Cleanliness and order in the laboratory work environment are the result of good laboratory housekeeping practices. These practices support safety in the lab. The following is a list of good housekeeping practices for laboratories:

- Chemicals must always be stored in their appropriate locations, not on the floor or in cabinets under the sinks.
- Chemicals must be stored by compatibility to avoid unwanted chemical reactions.
- The floor, particularly high traffic areas, must be cleared of all trip hazards (boxes, electrical cords, loose paper, etc.) to prevent trips and falls.
- All spills must be contained, and the contaminated area should be decontaminated immediately according to the appropriate spill procedures (Just In Time guide).
- All materials used to decontaminate spills must be discarded into the appropriate waste stream [e.g., materials used to decontaminate chemical spills must be disposed of as chemical waste and given to EHSO].
- Doorways, exits, fire extinguishers, emergency eyewash stations, and emergency showers must never be obstructed.
- Call the Spill Response Team if there is a spill at 404-727-2888.

2.6 Use of Controls

Controls are provided in Emory University laboratories and are designed to protect users from hazards by physically separating the handler/user from the hazard. The following is a list of controls used at Emory University and guidance regarding how they should be used.

Chemical Fume Hoods (CFHs)

Chemical fume hoods can be found in most research labs, and should be used when pouring volatile chemicals, or for procedures that have the potential to produce chemical vapors, dusts, or mists, all of which are inhalation hazards. Chemical fume hoods provide protection to the employee only. There is no product protection; therefore, avoid working with biological agents. When using a chemical fume hood (CFH), employees must stand directly in front of the hood, with the sash positioned at 18 inches or less from the work surface. Chemical fume hoods are always ducted and provide protection by “pulling” air around the individual and carrying both the air and harmful vapors through a series of ducts where they are exhausted outside the building. Chemical fume hoods must also satisfy the following requirements:

- They must be tested for performance at least annually. Performance testing is provided at no cost.
- They must have a label that indicates the testing date, the due date for the next testing, and the signature or initials of the tester.
- They must operate at a flow rate between 80-120 linear feet per minute (lfm).
- They should not be used for storage of chemicals, waste, or other materials.
- The flow rate must not be affected by any materials or equipment inside.
- The sash must not be broken or cracked.

- If there is an audible alarm to alert malfunction, it must not be muted.

The following best practices should be followed for work conducted in a CFH:

- Before beginning work, check the flow rate monitor to ensure the CFH is working within optimum performance parameters (80-120 lfm).
- The sash height should be kept at or below 18" while working in the hood and closed when you are not working in the hood.
- Work at least 6" inside the hood from the plane of the sash to minimize the potential for fumes to escape. A strip of tape at the 6" limit is a useful visual reminder.
- Never work in the CFH if the monitor is in alarm mode.
- Keep the CFH work surface free of chemical spills, residue, and contamination to prevent unintended chemical reactions or exposures. See Appendix C for cleaning procedures.
- Reduce obstructions in the fume hood to improve its effectiveness by allowing adequate air flow across the working surface with minimum turbulence. Cluttered hoods can lead to spills and disrupt the ventilation. Minimize the number of objects stored in the hood – keep at least 50% of the working surface clear and remove all materials not required for the current task.
- If the CFH is equipped with a cup sink, chemical and waste containers on the work surface should be in secondary containment. Chemicals or waste should never be disposed of in the cup sink. Chemicals should also not be stored in a storage cabinet beneath the cup sink.
- Do not place power strips or surge protectors in the hood. Plug in all electrical equipment outside of the hood. Potential spark sources are not to be stored in close proximity to water sources or used in the hood when flammable liquids or gases are present.
- Route cords or tubing through the CFH transfer/access ports, if available, to allow the sash to close fully.
- Place containers and equipment toward the sides of the hood (allowing for a few inches of space for airflow between the item and the wall) to reduce obstruction of the exhaust slots.
- When possible, elevate equipment and containers (maintained in the CFH for long-term use) 2"-3" above the working surface using perforated or slotted shelving to minimize disruption to the airflow.

Biological Safety Cabinets (BSCs)

BSCs can be found in labs where biological agents are used for research. BSCs must be used when working with biological materials. Hazardous chemicals should not be used in BSCs unless specifically recommended by EHSO.

Gloveboxes

Gloveboxes are usually found in labs on campus that handle pyrophorics, water-reactive or otherwise air-sensitive chemicals/materials. These are enclosed units with several openings and are usually under a positive pressure of nitrogen. The user manipulates samples and equipment through arm-length gloves. When handling nanomaterials or particularly hazardous substances, the exhaust from these systems should be filtered or scrubbed before release. Contact the CHO for more information.

Emergency Showers
Emergency showers must be available in all areas where hazardous chemicals are used. The showers are to be used if there is a chemical exposure to the body. At Emory University, emergency showers are located either inside of the labs or in the hallways, and must meet the following requirements:

- They must be accessible within ten seconds of being exposed to a hazard.
- They must provide 20 gallons of water per minute for 15 minutes.
- They must be tested monthly (testing performed by Campus Services).
- When tested, the date and initials of the tester must be documented.
- They must never be obstructed from access.

Emergency Eye Wash Stations
Emergency eyewash stations must be available in all areas where chemicals are used. In accordance with ANSI standards, eyewash stations must be hands-free operated and of the double ocular design. Eyewash stations are to be used if there is a chemical exposure to the eyes or face. At Emory University, emergency eyewash stations can be located near most sinks inside of the labs or in the hallways. They must meet the following requirements:

- They must be accessible within ten seconds of being exposed to a hazard.
- They must provide 3 gallons of water per minute for 15 minutes.
- They must be tested monthly (testing performed by a designee from the lab).
- When tested, the date and initials of the tester must be documented.
- They must never be obstructed from access.

Sinks
Sinks for hand washing must be available in all laboratory and laboratory related areas. The following requirements must be met:

- The sink area must always be stocked with soap and paper towels.
- Sinks must be free of debris that could possibly lead to drain stoppage.
- Surfaces in and around the sink should be free of chemical residue.

Sharps Containers
Sharps containers must be available in laboratories and laboratory-related areas where sharps (e.g. - razor blades, syringes, scalpels, etc.) are used. The following requirements must be met:

- The containers must be hard-walled and tightly lidded (alternative disposal containers are not acceptable).
- The lid must be closed unless adding sharps to the container.
- The biohazard symbol must be displayed on the outside of the container.

For guidance on proper disposal of sharps, refer to the Sharps Guidelines, available at https://ehso.emory.edu/guidance/forms-documents.html.

Broken Glass Disposal Boxes
Broken glass disposal boxes must be made available in laboratories and laboratory-related areas if there is a need to dispose of clean, broken glassware (e.g. - beakers, flasks, graduated cylinders, etc.). The boxes can be purchased from a vendor. The box must be labeled as "Broken Glass Disposal," must contain a thick, plastic liner, and must be able to be closed and secured for disposal.

2.7 Hazard Assessment and Standard Operating Procedures

Hazard assessment is an important, ongoing process to help identify hazards, assess the risks, and incorporate controls to eliminate hazards and reduce risk of accident or injury. One method of hazard assessment, a standard operating procedure (SOP), is a step-by step written procedure that documents how to complete a specific task both safely and effectively.

An SOP can be developed for a variety of tasks, including how to complete a process, conduct a specific experiment, or use a specific hazardous chemical. The following should be included when writing SOPs:

- Administrative Information: PI name, lab contact, building, and room number, title of the procedure, the purpose of the procedure, and brief description of the process or experiment.
- Experimental Information: step-by-step explanation of the process or experiment.
- Safety Information: Control measures to protect against hazards (engineering controls, PPE), emergency procedures (spills, exposures).

Lab specific SOPs are required to be written particularly for processes that use hazardous chemicals. The procedures must be made available to all lab personnel for reference and training purposes. All laboratory personnel must be trained on applicable SOPs and must sign an agreement to follow them. SOPs in this CHP should be consulted when developing lab specific SOPs. A Chemical SOP Template is available on the EHSO website under Forms and Documents. See Appendix B - Hazard Assessment for more information.

2.8 Electronic Platform for Chemical Safety Management

EHSO uses an electronic software tool, SciShield that helps to build a profile of each laboratory for better research, safety, and compliance management. The electronic platform provides an integrated modular system which is used for biological, radiological, and chemical safety assessment and approvals at Emory University. For chemical safety assessment and approvals, each PI will be required to complete the following in the electronic platform:

- Lab Setup Wizard
- Hazardous Chemicals Registration

The electronic platform enables each lab to have a simple method for tracking inventory, reporting the use of highly hazardous chemicals, referred to as Particularly Hazardous Substances (PHSs), and the personnel that use them.

EHSO utilizes the electronic platform to collect information on chemical use, identify specific chemical hazards, provide safety guidance, and prevent accidents/exposures to PHSs. When chemicals are administered to animals, the following registration can be completed in the electronic platform by request of EHSO:

- Chemicals in Animals Form

When using PHSs or highly regulated chemicals, the following registration can be completed:

- Chemical Safety Form

For additional information on completing the Chemicals in Animals Form, refer to Guidelines for Use of Hazardous Chemicals in Animals Guidelines, available at https://ehso.emory.edu/guidance/forms-documents.html.

2.9 Processes and Procedures that Require Prior Approval

The following processes and procedures will require prior approval from EHSO unless otherwise noted:

- Use of formaldehyde, formalin, or paraformaldehyde.
- Volunteers or minors in the lab.
- Radioactive materials.
- Use of a new or tagged out of service chemical fume hood.
- Procedures that may require respiratory protection such as an N95.
- Biological materials – contact EHSO.
- Administering chemicals in animals – contact EHSO and the Institutional Animal Care and Use Committee (IACUC).
- DEA Controlled Substances and Dangerous Drugs – contact the Office of Research Integrity and Compliance (ORIC).

2.10 Use of Personal Protective Equipment

Personal protective equipment (PPE) must be worn by employees when working with hazardous chemicals, and when engineering controls do not provide adequate protection from hazards. Each PI/Lab Manager must complete a PPE Hazard Assessment that is reviewed with laboratory personnel. The PPE Hazard Assessment form is available at https://ehso.emory.edu/guidance/forms-documents.html.

The following requirements must be met regarding wearing PPE in the laboratory:

- Minimally, closed toe shoes, long pants/skirts, lab coats/gowns, ANSI (Z87.1) approved eye protection, and task appropriate gloves must be worn (for additional guidance, see Prudent Practices in the Laboratory).

- Where there is a potential for impact hazards safety glasses must be worn.
- Where there is potential for splashing or the production of aerosols, splash goggles must be worn.
- Always inspect PPE prior to donning it to ensure that there are no holes, breaks, or tears that will lead to an exposure.
- If PPE is disposable, use once and discard into the appropriate laboratory waste stream.
- Always wear the correct size and fit to avoid removal and/or damage while wearing.
- If PPE can be reused, it must be cleaned and stored appropriately after use.
- PPE must be removed prior to leaving the laboratory.
- PPE must **not be** worn in areas outside the laboratory (e.g., break rooms, bathrooms, eating facilities, etc.
- If respirators must be worn (e.g., N95 particulate masks, air purifying, self-contained breathing apparatus), the following is required:
- Training.
- Medical Clearance.
- Fit Testing.

2.11 Security

Laboratory areas contain hazardous chemicals, expensive equipment, and important research documentation; therefore, security measures should be implemented when possible. Potential security risks include, (but are not limited to) the following:

- Theft of computers, electronics, and other expensive equipment.
- Theft, misuse, and/or intentional release of hazardous chemicals.
- Demonstrations from activist groups.
- Inappropriate use or loss of sensitive/confidential information.
- Unauthorized laboratory experimentation.

To prevent security breaches in laboratory areas, it is important to secure all doors appropriately. This can be accomplished by enforcing key card entry, or by closing and locking all doors during periods of inactivity.

2.12 Transportation of Hazardous Chemicals

Department of Transportation (DOT) regulates the transportation of hazardous materials. Personnel involved in the transportation of these materials must be trained to ensure that the material is packaged safely.

There is an exception that covers many hazardous materials known as the “materials of trade” (MOT) exemption. Under the MOT exemption, there is a limit to what can be transported based on the quantity, hazard class, and packing group.

Under the MOT exemption, the material being transported must be used for the following purposes:

- To protect the health and safety of the vehicle operator or passengers (i.e., fire extinguishers, flares, or insect repellant).
- To support the operation or maintenance of the vehicle (i.e., fuel additives, spare batteries, gasoline).
- To support the principal business of a private motor carrier (i.e., landscapers, painters, or other businesses carrying supplies).

All MOT transports or shipments must comply with the hazard class and quantity limitations specified by DOT. Allowable hazard classes include:

- Flammable Liquids (Class 3).
- Corrosives (Class 8).
- Miscellaneous Hazardous Materials (Class 9).
- Toxic (Poison) (Class 6, Division 6.1).
- Oxidizers (Class 5, Division 5.1).

The allowable quantity limitations under the MOT exemption are as follows:

- 1lb or 1pint for Packing Group I Materials.
- 66lbs or 8 gallons of Packing Group II Materials.
- 440 lbs. aggregate gross weight of all MOTs in a motor vehicle.

MOTs must be:

- In the manufacturer's original packaging or a package of equal strength and integrity.
- Packaged in leak tight containers for liquid and sift proof containers for solids.
- Securely closed, secured against movement, and protected from damage.
- Marked with the proper shipping name or common name.

Explosives, radioactive material, and compressed gas cylinders are not permitted in private motor vehicles.

Before transporting hazardous chemicals on or off campus, contact EHSO, Environmental Programs (chemwaste@emory.edu) for assistance with transportation requirements.

2.13 Disposal Practices for Waste Materials

Proper disposal of chemical waste includes the following general steps (including but not limited to):

- Dispose of contaminated materials in the containers provided by EHSO.
- Ensure that each container has an EHSO waste container label.
- Enter the appropriate information on the label when waste is first added to the container.
- Ensure that all waste containers are closed unless adding waste.
- Dispose of chemical waste via the appropriate waste stream.

- Avoid mixing incompatible chemical waste materials.
- Never dispose of chemically contaminated materials in regular waste.

Further guidance for the disposal of chemical waste is provided in the EHS-201 Regulated Waste Guidelines, available at https://ehso.emory.edu/guidance/forms-documents.html.

3.0 Hazard Identification

Some chemicals have inherent properties that can produce hazards or adverse effects, and therefore have been defined by OSHA as hazardous.

Hazardous chemicals can be distinguished by four basic characteristics:

- Flammability.
- Corrosivity.
- Reactivity/Instability, and
- Toxicity.

Laboratory personnel must be able to identify hazardous chemicals and understand their properties. In addition, a current hazardous chemical inventory should be available in the laboratory to keep track of which hazardous chemicals are on hand and their quantities. Inventory information can be organized and maintained in EHSO's electronic platform.

Classifying the hazards of a mixture depends on the information available for each component and the mixture itself. Generally, if a mixture's components are hazardous, then the mixture is assumed to be hazardous. Mixtures diluted with solvents of equal or lower toxicity are assumed to have hazards of the original mixture. Mixtures that have components with a range of hazards are assumed to have all those known hazards.

3.1 Safety Data Sheets (SDSs)

One of the most critical prerequisites for lab personnel when working with hazardous chemicals in the laboratory is having the ability to recognize or identify them. It is every employee's right to know the hazards associated with their work and what can be done to protect themselves from those hazards. Hazard identification at Emory is made possible by three main methods: reading of SDSs, chemical labeling, and laboratory signage.

SDSs are documents that are made available by the manufacturer with every hazardous chemical. These documents provide specific information regarding the specific properties of the chemical and guidance for the storage, use, and handling of the chemical. SDSs also provide information on what PPE should be worn while using the chemical, and suggestions on what should be done in emergency situations involving the chemical.

In accordance with the OSHA Laboratory Standard, the following are required regarding SDSs:

- The employer must maintain any SDSs that are shipped with hazardous chemicals.
- All laboratory personnel must know how to access and/or locate SDSs in the laboratory work area.
- All laboratory personnel must read and understand the content of SDSs for each

hazardous chemical that is to be used in their work.

- SDSs are available at https://ehso.emory.edu/resources/systems.html. Labs can maintain hard copies of SDSs if the online version is otherwise not immediately available.

3.2 Laboratory Signage

At Emory University, the entrance to all laboratories and laboratory related work areas are posted with laboratory signage. Each sign lists the emergency contacts of the lab as well as the chemical hazards that are found inside the lab. If there are multiple occupants in the lab, the sign displays the total combined hazards from all occupants.

3.3 Chemical Labeling

Labeling is essential in the identification of all chemical substances, both hazardous and non-hazardous. Effective labeling prevents confusion when distinguishing between containers with chemical substances. In the laboratory, there are two types of chemical labeling that are mandatory: **labeling of incoming containers of chemicals** (whether purchased from a manufacturer or received from another entity/collaborator, which also includes chemicals produced for another user outside of the laboratory) and **labeling of laboratory working containers**. Laboratory containers include beakers, flasks, bottles, glass tubes, etc.

All incoming containers of chemicals must meet the following labeling requirements:

- Full chemical name and/or signal word, hazard statement, Globally Harmonized System (GHS) pictogram (immediate visual recognition), precautionary statements, and the manufacturer's contact information.
- Written in English.
- Be legible.
- The label must never be removed, altered, or obscured in any way.

All laboratory working containers that contain chemicals must be legibly labeled in English, and meet the following requirements:

- The container must have the full chemical name, preferably the name from the stock bottle (abbreviations, chemical formulas, and chemical structure drawings are not sufficient) e.g., ethanol.
- If the chemical is hazardous, the label must include the hazard(s). If the container is small, the primary hazard should receive precedence, e.g., Flammable.
- If there is more than one chemical in the container, the label must include the chemical name of each chemical, and of each hazard, as applicable and feasible.
- The label must only be removed when the container is empty.

Note: There is only one exception to the labeling requirements. Labeling is not required for a laboratory working container if the total volume of material in the container is used immediately in an experiment (during the work shift).

3.4 Globally Harmonized System (GHS) Pictograms

OSHA has aligned the Hazard Communication standard (HCS) with the Globally

Harmonized System (GHS), an international chemical classification system. The GHS is the system used for the classification of health, physical, and environmental hazards. GHS specifies the information that must be included on chemical labels and Safety Data Sheets (SDSs) to communicate hazard information.

To ensure a safe workplace, information about the identity and hazards of the chemicals must be available. The OSHA pictograms in the table below conform to GHS and are used worldwide. These pictograms are required to be on all stock bottles of hazardous chemicals.

Some hazard classes such as flammables, oxidizers, and carcinogens follow a GHS hierarchy, but the same pictogram is used to represent the hazard on chemical label. Each hazard class uses hazard statements and signal words to organize the hazard information from high hazard to low hazard.

Table 2.0 – GHS Pictograms

Pictogram	Distinct Hazard	What it Means	Hazard Classes
	Exploding Bomb	This chemical can react instantaneously releasing large amounts of gas and/or heat.	Explosives Self-Reactive Organic Peroxides
	Flame	This chemical and/or its vapor can ignite easily and could burst into flames.	Flammable Liquids Combustible Liquids Pyrophorics Self-Heating Flammable Gas Flammable Solids Emitters Self-Reactive Organic Peroxides
	Flame over Circle	This chemical is oxidizing. It can react with other materials causing them to ignite, burn, or explode.	Oxidizing Liquids Oxidizing Solids Oxidizing Gases
	Corrosion	This chemical can cause serious damage to skin and eyes. It can also destroy clothing, working surfaces, and metal.	Acids Bases Some organic solvents

Pictogram	Distinct Hazard	What it Means	Hazard Classes
	Health Hazard	Prolonged or chronic exposure to this chemical can cause health problems including but not limited to cancer, asthma, birth defects, infertility.	Carcinogens Mutagens Reproductive Toxins Respiratory Sensitizers Target Organ Toxins Aspiration Toxins
	Exclamation Mark	Exposure to this chemical may cause immediate health effects including but not limited to skin rash, contact dermatitis, respiratory irritation, eye irritation, and chronic or prolonged exposures can lead to possible allergy.	Irritants (eye and skin) Skin Sensitizers Respiratory Tract Irritants
	Gas Cylinder	If the container is ruptured, leaking, or heated, it can explode.	Compressed Gas or Gases under pressure
	Environment and Aquatic Toxicity	This chemical can cause damage to aquatic organisms this includes but is not limited to fish, crustaceans, and aquatic plants.	Compounds known to cause injury to aquatic organisms or bio accumulate in aquatic environments

3.5 Permissible Exposure Limits

OSHA regulates the use of some hazardous chemicals and assigns permissible exposure limits (PELs) for their use, as specified in 29 CFR 1910, subpart Z. These limits are set to protect individuals using the chemicals from overexposure, which has the potential to cause adverse effects. When regulated chemicals are used in the lab, the PELs must never be exceeded.

For any OSHA Health Standard, controls are implemented to prevent skin or eye contact and limit employee exposure to the specific PEL.

OSHA also uses action levels to indicate the concentration of a harmful or toxic substance/activity that requires an employer to start medical surveillance, exposure monitoring, or biological monitoring.

When an action level or PEL is unavailable, it is supplemented with relevant exposure limits from national consensus standards such as the Threshold Limit Value (TLV) of the American Conference of Governmental Industrial Hygienists (ACGIH) or the Recommended Exposure Limits (RELs) of the National Institute for Occupational Safety and Health (NIOSH).

For laboratory use of OSHA regulated substances, the PELs must never be exceeded. To limit employee exposures, EHSO has a process for identifying and capturing the use of OSHA regulated substances (found in Subpart Z) and hazardous chemicals on campus via EHSO's electronic platform.

Exposure assessments, exposure monitoring and medical surveillance programs are available to limit exposure to chemicals which present a health hazard. Exposure assessments and monitoring are conducted based on duration of use, frequency of use, and concentration. Some OSHA Health Standards require monitoring if it is believed that the PELs or action levels of these chemicals are being routinely exceeded. The results of initial monitoring will disclose if employee exposures are over the action level or PEL. In those instances, EHSO will perform additional monitoring or medical surveillance activities as required by the relevant OSHA health standard.

If using regulated chemicals in the lab, and there is a reasonable expectation that the PELs of these chemicals are being routinely exceeded, contact EHSO immediately, as a risk assessment must take place. Since each regulated chemical has unique requirements, the risk assessment may involve exposure monitoring, to be conducted in accordance with the applicable OSHA standard. If monitoring has been completed, the monitored employee will be notified within 15 days in writing.
Monitoring is discontinued when it is determined that exposure levels fall below the established PEL or action level.

Participation in the Respiratory Protection Program may be necessary to maintain employee exposure below PELs or action levels. The appropriate respiratory equipment will be provided upon completion of medical clearance, training, and respiratory fit testing. Fit testing and training are provided by EHSO. Medical clearance is obtained through Employee Health Services or Student Health Services.

To ensure employees and other interested parties are aware of the occupational exposure limits that OSHA uses to protect workers, the following link is a table with OSHA PELs and the comparable consensus standards from NIOSH, ACGIH, and California Occupational Health and Safety (CAL/OSHA): https://www.osha.gov/dsg/annotated-pels/index.html

4.0 Standard Operating Procedures for Hazardous Chemicals

Chemicals are used in most laboratories on Emory's campus. In addition to being informed about chemical hazards, it is also important that lab personnel are able put their knowledge into practice while performing their daily duties. When working with chemicals, all lab personnel must employ the following general practices:

- Store all chemicals according to compatibility groups (e.g. – acids must not be stored with bases).
- Do not mix chemicals that are not compatible with one another.
- Minimize the volume of chemicals used where possible (only use what is needed).
- If a less hazardous chemical can be used to achieve the same results as a highly hazardous chemical, use the less hazardous chemical.
- When pouring chemicals, use them inside a chemical fume hood as much as feasible.
- Always wear appropriate PPE.

Lab specific SOPs are required to be written particularly for processes that use hazardous chemicals. SOPs in this CHP should be consulted when developing lab specific SOPs. A Chemical SOP template is also available on the EHSO website under Forms and Documents.

4.1 Flammable and Combustible Materials

If misused, handled, or stored incorrectly, flammable materials can cause fires in the presence of oxygen and an ignition source. Refer to 1.4 Glossary of Terms for definitions of flammable materials in various states (e.g., flammable gases, flammable liquids, and flammable solids).

Examples: ethanol, diethyl ether, methane, and xylene.

Table 3.0 – Flammables

Flammables	
GHS Hazard Symbol	
Storage Requirements	Flammables must be stored in cabinets that help to protect the material from fire. In the event of a fire, the flammable liquids cabinet will contain and protect the material from fire. Labs may also utilize the flammable liquid storage areas under the Chemical Fume Hoods inside the laboratories. If the space under the chemical fume hood is inadequate, liquid containers must be stored in an NFPA approved flammables cabinet with the appropriate warning labels. If stored in places other than an NFPA approved flammables cabinet, the volume must not exceed 16 liters (approximately 4 gallons) within 100 square feet of lab space. If the materials must be refrigerated, ensure that flammable and volatile liquids are stored in a flammable materials refrigerator, or they must be stored in explosion proof refrigerators. Ensure that all lines and equipment associated with flammable gas systems are grounded and bonded. It is best practice to also ensure that flammable liquid transfer systems (e.g., dispensing flammable liquid from solvent drum) are grounded or bonded. Never store these materials inside of conventional refrigerators or freezers.
Work Practices	Read chemical's SDS. Follow written laboratory procedures. Flammables are incompatible with oxidizers and must be stored separately. Flammables and oxidizers can be physically separated by the use of secondary containment. Avoid ignition sources such as open flames, hot plates, sparks, etc.
PPE	Lab personnel should wear flame-resistant lab coats, safety glasses, and gloves. In addition, personnel must wear closed toed shoes and long pants.

Flammables	
Emergency Procedures	In the event of a fire, the lab must be aware of the location of the nearest fire extinguisher. In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

4.2 Compressed Gases

Compressed gases pose both chemical and physical hazards. Information on proper handling of compressed gases can be found in the Compressed Gas Cylinder Guidelines available at https://ehso.emory.edu/guidance/forms-documents.html.

4.3 Corrosives

Corrosive chemicals produce destruction of skin tissue, namely, visible necrosis through the epidermis and into the dermis. Corrosive effects not only occur on the skin but can also affect the eyes and respiratory tract. Corrosives can be acidic or basic in nature and can also destroy (or react with) plastics, metals, and other materials that they come in contact with. Strong dehydrating agents and strong oxidizing agents can also have corrosive effects on the skin and eyes.

Examples: sulfuric acid, hydrochloric acid, phosphorus pentoxide, concentrated hydrogen peroxide and sodium hydroxide.

Table 4.0 Corrosives

Corrosives	
GHS Hazard Symbol	
Storage Practices	Containers should be stored in corrosive cabinets. Containers must be stored in secondary containment. Secondary containment must be able to: ○ Contain the volume of material in the event of a spill ○ Resist corrosion of the material (e.g., polypropylene bins) Acids and bases must be stored separately from one another below eye level, and preferably inside of a corrosives cabinet. Secondary trays or containers must be used to separate incompatible acids within the corrosives cabinet.
Work Practices	Read chemical's SDS. Follow written laboratory procedures. When mixing concentrated acids with water, add the acid slowly to the water and mix slowly to avoid splattering and possible chemical reaction. Dispensing corrosive chemicals must be performed inside of a chemical fume hood while wearing safety splash goggles, lab coat, and gloves. Chemical fume hoods ventilate the work area and prevent vapors from causing irritation to the eyes or respiratory tract. The sash provides protection from splashes and splatters of liquids. When transporting stock bottles of corrosive liquids, protective carriers should be used. If transporting using a cart, then liquids should be placed in a secondary container. Corrosive waste must be kept separate from metals and flammable materials. Ensure PPE is worn when adding waste to the container. The container must be labeled with an EHSO Waste Label. The label must name all of the contents and must be completed at the time of initial waste collection. Once the waste container is about 90% full, it must be transferred to EHSO for disposal.

Corrosives	
PPE	For larger volumes, safety splash goggles, a face shield, a lab coat, and a rubber apron are appropriate forms of PPE. Appropriate protective gloves that are resistant to permeation or penetration from corrosive chemicals must be selected when there will be direct or prolonged contact with a chemical. Gloves with an extended cuff will ensure that the skin of the wrist and portions of the forearm are protected from exposure.
Emergency Procedures	In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

4.4 Oxidizers

Oxidizers are chemicals that readily yield oxygen or other oxidizing gases, or that readily react to promote or initiate combustion of combustible materials. The main hazard of oxidizers is that they accelerate the rate of combustion in fires. Oxidizing gases pose a unique hazard because they can become concentrated in a room or poorly ventilated space. Oxidizers can lower flash points and ignition temperatures of flammable gases and liquids. When working with oxidizers, it is important to remember that they must not be stored around fuels or any other flammable/combustible materials.

Examples: Bromine, Bromates, Nitrates, Nitrites, Chlorates, Chromates, Hydroperoxides, Hypochlorites, Inorganic Peroxides, Perchlorates, Periodates, Permanganate, and Persulfates.

Table 5.0 Oxidizers

Oxidizers	
GHS Hazard Symbol	
Storage Practices	Oxidizers must be physically separated from flammable and combustible materials as well as ignitions sources. Oxidizers must be physically separated from reducing agents such as formic acid, zinc, and alkaline metals.
Work Practices	Read chemical’s SDS. Follow written laboratory procedures. Special care should be taken when oxidizing compressed gases are used to ensure that gauges, piping systems, gas lines are free of contamination. Gases should be used inside of a chemical fume hood or well-ventilated space if possible. Combine oxidizers with other materials according to established protocols. Avoid using oxidizing chemicals outside of accepted temperature ranges. Collect waste from oxidizing materials into an inert container such as glass or plastic. Ensure that the waste container is labeled with the EHSO Chemical Waste Label.
PPE	Lab personnel should wear flame-resistant lab coats, safety glasses, and gloves. In addition, personnel must wear closed toed shoes and long pants.
Emergency Procedures	In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services () through the Self-Service portal (PeopleSoft).

4.5 Water-Reactive Chemicals

Water-reactive chemicals react violently with water to produce a gas that is flammable or poses a health hazard. Some materials also produce flammable hydrogen gas which can cause fires or explosions when in the presence of air. Store water-reactive chemicals away from water and moisture and ensure that they are kept dry.

Examples: lithium metal, sodium metal, magnesium powder, and zinc powder.

Table 6.0 Water Reactives

Water Reactives	
GHS Hazard Symbol	
Storage Practices	Avoid storing reactive chemicals near flammable material. Store according to the SDS. An inert gas filled desiccator or glove box are suitable storage locations.
Work Practices	Read chemical's SDS. Follow written laboratory procedures. Handling water reactive material is considered a high-risk activity. Lab personnel must receive adequate training and supervision before being allowed to work with water reactive chemicals. Lab personnel must demonstrate proficiency in proper lab technique before working without direct supervision. Ensure that water reactives are used in an inert atmosphere that excludes air or moisture. Glove boxes are an engineering control and containment device that can be used for this purpose. Transferring water reactive compounds from the parent container into a secondary container must be done using small volumes or an engineered system. A blast shield must be used if working inside or outside of the chemical fume hood. The sash position of the fume hood must be at the lowest position feasible. Do not return excess chemical to the original container. Small amounts of impurities can be introduced into the container that may cause a fire or explosion. Empty containers should be rinsed three times with an inert, dry, compatible solvent. The rinse solvent must be added and removed from the container in an inert atmosphere. The rinse solvent must be neutralized.

Water Reactives	
	Dispose of reagents as hazardous waste through EHSO. Do not mix with incompatible waste streams.
PPE	Gloves must be worn when working with water reactive chemicals. Disposable nitrile gloves provide adequate protection for handling small quantities. If prolonged or direct contact with a chemical is required, then labs should contact EHSO for advice on chemical resistant gloves. Safety goggles, flame-resistant lab coat, and gloves must be worn. In addition, synthetic clothing is strongly discouraged. Cotton or wool clothing is strongly recommended. Closed-toed shoes must be worn. Lab coats need to be buttoned and fit properly to cover as much skin as possible.
Emergency Procedures	In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

4.6 Pyrophorics

Pyrophoric chemicals spontaneously ignite in air due to rapid oxidation by the oxygen or moisture in the air. They should be stored in an inert environment, and away from flammable/combustible materials, and oxidizers.

Examples: tert-butyl lithium, silane, and white or yellow phosphorus.

Table 7.0 – Pyrophorics

Pyrophorics	
GHS Hazard Symbol	
Storage Practices	Pyrophoric materials must be stored in tightly closed containers under an inert atmosphere or liquid. All transfers and manipulations of them must also be carried out under an inert atmosphere or liquid.
Work Practices	Read chemical's SDS. Follow written laboratory procedures. Specific SOPs for experiments using these chemicals must be written and available to lab employees who will conduct the experiments. Employees must be trained on the SOPs. Individuals working with pyrophorics must never work alone. Perform activities in a glove box or a chemical fume hood. If working inside the fume hood, use a blast shield. Reactions need to be carried out using glass apparatuses infused with inert gas such as nitrogen or argon. Laboratory glassware should be warmed in an oven to remove any moisture prior to contact with air sensitive reagents. Transfer small quantities of air-sensitive reagents using oven dried syringes and needles. On-hand quantities must be minimized in laboratories, and the smallest amounts possible must be used in experiments. Ensure that air sensitive reagents are disposed of properly. Never leave waste containers open and exposed to the atmosphere. Unwanted or unused reagent must be hydrolyzed or neutralized prior to disposal. All materials including gloves, paper towels, and wipes that are contaminated must be treated as hazardous waste. Remove residue from needles, syringes, and other equipment before storing.

Pyrophorics	
PPE	Required PPE includes flame resistant lab coats, face shields in conjunction with safety glasses, and nitrile gloves.
Emergency Procedures	In the event of a fire, Class D fire extinguishers are needed for combustible metals. The standard fire extinguisher can be used for other reagents. In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

4.7 Peroxide Forming Chemicals

Peroxide forming chemicals (PFCs) form peroxides upon exposure to the oxygen in the air over time. Accumulated peroxides can explode upon exposure to heat, friction, or force/impact. The reaction can be initiated by light, heat, introduction of a contaminant, oxygen or the loss of an inhibitor. Some PFCs have inhibitors such as butylated hydroxytoluene (BHT) to slow the formation of peroxide crystals. Most peroxide crystals are sensitive to heat, shock, or friction. Accumulation of peroxide crystals can cause explosions.

Some examples of PFCs include (but are not limited to):

Can form explosive levels of peroxide within 3 months		
Butadiene	Isopropyl Ether	Tetrafluoroethylene
Can form explosive levels of peroxides within 12 months		
2-Butanol	2-Propanol	Cyclohexene
Can auto polymerize as a result of peroxide accumulation		
Acrylonitrile	Vinyl chloride	Vinyl Pyridine

Table 8.0 Organic Peroxides

Organic Peroxides	
GHS Hazard Symbol	
Storage Practices	Visually inspect containers for visual discoloration, crystal formation, or liquid stratification. If any of these conditions are observed, do not attempt to open or move the container. Store containers in a cool, dark area and avoid heat/ignition sources. Unopened containers are typically stable for up to 18 months when stored in cool, dark locations. Once a container reaches the expiration date, the chemical must be transferred to EHSO as hazardous waste. Always date the container upon receipt and upon opening. Opened containers should be disposed of through EHSO after 6 months.
Work Practices	Read chemical's SDS. Follow written laboratory procedures. Work with PFCs in a chemical fume hood. Maintain the sash height as low as feasible to provide physical barrier and prevent fumes from escaping. Carefully monitor processes involving PFCs (i.e., distillation) to ensure that process does not dry out and overheat. Always handle containers carefully, even if they are unopened. Never force open a cap that becomes stuck on a PFC. Do not attempt to move or open a container if there are visible crystals around the lid, inside the container, or if the container is deformed; opening the lid could cause an explosion. If the container tests positive for peroxides, then the chemical must be disposed through EHSO. Labs should purchase peroxide formers with inhibitors added by the manufacturer, when possible. Containers can be periodically tested with peroxide test strips. Contact EHSO (404) 727-5922 for more information about testing for peroxide formation.

Organic Peroxides	
	Chemical fume hoods or other exhaust ventilation must be used. Blast shields should also be available if the reaction will be vigorous.
PPE	Required PPE includes flame resistant lab coats, face shields in conjunction with safety glasses, and nitrile gloves.
Emergency Procedures	In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

4.8 Explosive Materials

OSHA defines an explosive as any chemical, mixture, or device, for which it's primary or common purpose is to function by explosion and with a substantially instantaneous release of gas and heat. There are other materials commonly used in laboratories that have the potential to explode when dry, or when exposed to shock or heat. These materials are not typically found in the laboratory setting; however, there are other materials commonly used in laboratories that have the potential to explode when dry or when exposed to heat or shock.

Examples: peroxide forming chemicals, chemicals whose name includes "azide" or "nitro," (dry) benzoyl peroxide, and (dry) picric acid. Explosive materials also include compounds containing functional groups azide, acetylide, diazo, nitroso, haloamine, peroxide, and ozonide.

Table 9.0 – Explosives

Explosives	
GHS Hazard Symbol	
Storage Practices	When storing, always date the containers when received and opened. Be aware of any potentially explosive compounds that appear to exhibit the following signs of characteristics: o Deterioration of the outside of the container. o Precipitate formation either in or outside the container. o Discoloration of the chemical.
Work Practices	Read chemical's SDS Follow written laboratory procedures Safety shielding must be used for any operation having the potential for explosion. Especially in the following circumstances: o When a reaction is attempted for the first time. o When a familiar reaction is carried out on a larger than usual scale (i.e., 5-10 times more material). Use the smallest quantities possible in experiments. The amount of explosives should be used in quantities of less than 1 gram. Work should always be done in a chemical fume hood (may be necessary to use a properly rated safety shield). Blast shields must be placed so that all personnel in the area are protected. Conduct experiments in a designated area. Signage should be used to indicate that explosives are in use. Ensure that potentially explosive material remains labeled at all times. Be sure to remove any excess equipment and other chemicals (particularly highly toxic and flammables) away from the immediate work area. Avoid using metal or wooden devices when transferring potentially explosive compounds (to reduce the chance of creating a spark). Solid waste should not be generated to minimize the potential for detonation. Limited amounts of organic waste may contain explosives. Ensure that all waste is collected in EHSO chemical waste containers. Containers must be stored in secondary containment. Explosive wastes must be stored separately from other waste.

Explosives	
PPE	Always wear a flame-retardant lab coat, safety glasses and full-face shield when performing any reactions that may lead to an explosion. Consider blast protective clothing depending on the amounts and stability of compounds used.
Emergency Procedures	In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

4.9 Cryogenic Materials

Cryogenic materials are liquefied gases that have a boiling point of less than - 130º F at an absolute pressure of 14.7 psi. Cryogens are extremely cold and direct exposure to the liquids or vapors causes frostbite to skin or can cause materials to become weakened and/or brittle. There are several other hazards associated with cryogens, which include but are not limited to:

- Asphyxiation – caused by rapid expansion of liquid to gas inside enclosed areas to create an oxygen deficient environment.
- Pressure build-up – caused by rapid expansion of liquid to gas inside of a vessel.
- Fire or explosion – caused when cryogenic liquids such as oxygen and hydrogen and flammable gases combine in air to create an oxygen rich environment. In the presence of flammable materials, the potential for fire/explosion becomes greater.

Examples: inert Gases (i.e., Nitrogen, Helium, Neon), Flammable Gases (i.e., Hydrogen, Methane), and Oxygen.

Table 10.0 – Cryogenic Materials

Cryogenic	
Hazard Symbol (Emory Specific)	
Storage Practices	Do not store containers where they may come into contact with moisture. Store all cryogenic liquid containers upright in well-ventilated areas. Handle them carefully, and avoid dropping, rolling or tipping them on their sides. Containers must be able to withstand extreme cold temperatures without becoming brittle or weakened. Cylinders containing cryogens must be equipped with pressure release valves. Store cylinders and use liquids in a well-ventilated area.
Work Practices	Read the chemical's SDS. Follow written laboratory procedures. Ensure that ice does not form in the neck of flasks. Dewar flasks are not pressure vessels so if the opening is blocked pressure can slowly build up. Eventually, the pressure may cause a violent rupture. If the neck of the Dewar flask is blocked by ice or "frozen" air, follow the manufacturer's instruction for removing it. Ice can also cause pressure relief valves to malfunction or become blocked. Keep Dewar flasks covered with a loose-fitting cap. This method prevents air or moisture from entering the container yet allows pressure to escape. Use only the stopper or plug supplied with the container. When transferring from one container to another, always pour slowly to prevent splashing or boiling. Never overfill vessels or containers with cryogenic liquids to avoid rupturing (rapid expansion of gas). Always start filling slowly to allow the vaporization to chill the receiving container. After the vaporization and liquid boiling has decreased, fill the container at the normal rate. Never fill containers higher than the indicated level.
PPE	When handling, wear PPE that protects against splashing and extreme cold temperatures (cryogenic gloves, splash goggles, face shield, long sleeves, and lab coat).

Cryogenic	
	Use tongs or proper gloves to handle objects that are in contact with cryogenic liquids.
Emergency Procedures	If contact does occur, immediately flush the area with large quantities of warm (not hot) water. If the skin is blistered or the eyes have been exposed, obtain medical attention immediately. Locate emergency eyewash stations and safety showers wherever there may be accidental exposures to cryogens. In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

4.10 Light Sensitive Materials

Light sensitive materials are chemicals that undergo changes or degradation or may react when exposed to light. Some reactions could result in the production of hazardous byproducts or building of pressure inside the container. Store these materials in a cool, dry place, away from exposure to light.

4.11 Non-Ionizing Radiation

Lasers

Laser devices and laser systems are types of equipment that emit intense laser light by stimulated emission. These high-energy devices can be divided into one of several categories from Class 1 to Class 4, with Class 1 lasers being the least hazardous, and Class 4 being the most hazardous. Of concern are the lasers that are classified as Class 3B and Class 4, as they have the potential to cause severe injury to the eyes and skin, and in the most extreme cases, can cause fires and explosions. Class 3B and Class 4 lasers are used on Emory's campus in various forms of research. For more guidance on the safe use of Class 3B and Class 4 lasers, access the Laser Safety Program Manual, available at *https://ehso.emory.edu/guidance/forms-documents.html*.

Ultraviolet Radiation

Ultraviolet radiation comes from various sources, and it can be hazardous to both the eyes and skin if exposure is not minimized. Most individuals are exposed to UV radiation, primarily from direct sunlight. However, in laboratory settings, there are other sources of UV radiation that are far more concentrated, which makes exposure more hazardous. Therefore, it is very important to use control measures to limit exposure. For more guidance on the safe use of UV radiation, access the Guidelines for Safe Use of UV Radiation, available at https://ehso.emory.edu/guidance/forms-documents.html.

4.12 Ionizing Radiation

Ionizing radiation has sufficient energy to ionize atoms and the potential to cause damage to living tissue. Forms of ionizing radiation include alpha particles, beta particles, gamma rays, x-rays, and neutrons. Ionizing radiation is used in research laboratories in the form of radioactive isotopes. Examples: phosphorus-32, iodine-125, sulfur-35, and tritium.

4.13 Use of Radioactive Isotopes

The use of radioactive isotopes at Emory is regulated by the Nuclear Regulatory Commission (NRC), and through Emory's broad scope Radioactive Materials License, which is issued by the Georgia Department of Natural Resources (GADNR). All users of radioactive materials users must be authorized through Emory's Radiation Control Council (RCC). The Radiation Safety group of EHSO provides training and guidance to all radioactive materials users and conducts periodic inspections of authorized areas. For more guidance on the use of radioactive isotopes, access the Radiation Safety Manual available at https://ehso.emory.edu/guidance/forms-documents.html.

4.14 Particularly Hazardous Substance

Some chemicals used in laboratories present much greater hazards than others, and therefore, special provisions must be made for their use and disposal. The OSHA Laboratory Standard considers carcinogens, reproductive toxins, and substances with a high degree of acute toxicity as Particularly Hazardous Substances (PHSs).

OSHA defines PHSs as chemicals that are known to have immediate or long-term toxic health effects. The OSHA Lab Standard (29 CFR 1910.1450) defines PHSs as chemicals that are either: Carcinogens, Reproductive Toxins, Mutagens, Acute Toxins, or Specific Organ Toxins.

In addition, the Lab Standard requires that special provisions be made for the use of these substances.

Laboratory personnel must be specifically trained on the potential hazards associated with PHSs. The training should include a description of the hazards that the chemicals may present and the operations with exposure potential. Staff must be aware of emergency response, proper decontamination procedures, the location of designated areas where these chemicals are used, and proper waste disposal procedures.

The following Provisions must be made for the use of PHSs:

- Establishment of a designated area.
- Use of containment devices (chemical fume hoods or glove boxes).
- Procedures for safe removal of contaminated waste.
- Decontamination procedures.
- Standard operating procedures (SOPs).

Establishing a Designated Area
When establishing a designated area for use only with a PHS, it may be appropriate to designate an entire room or a particular area within a lab. In doing so, the area should be clearly marked to communicate which materials can be used there. It is also important to inform all lab personnel of the designated area(s), its restrictions, and any special PPE requirements for the area. One way of communicating this information is by posting warning signs inside and outside the area.

Use of Containment Devices
Working with PHSs may also require the use of engineering controls and containment devices such as chemical fume hoods or glove boxes. These containment devices provide additional protection to lab personnel. Depending on the substance being used, it may be appropriate to limit the use of the fume hood or glove box to only that particular substance. Closed systems, like syringes or cannulas can also be used to handle these types of chemicals. This also needs to be communicated to all lab personnel and reinforced by posting signs in the area.

Procedures for Safe Removal of Contaminated Waste
Disposal of waste materials that are contaminated with PHSs may require unique procedures to ensure personnel safety and proper disposal. These special procedures need to be emphasized in the SOPs for the use of the material. Also, additional training should be administered to all laboratory personnel who use the materials. For additional guidance on waste disposal, access the EHS-201 Regulated Waste Guidelines, available at https://ehso.emory.edu/guidance/forms-documents.html.

Decontamination Procedures
When working with PHSs, it is necessary to decontaminate the work surfaces in the area after work is completed. Decontamination of these areas may require unique procedures or the use of particular cleaning agents. There must be procedures for decontamination of the equipment or tools that are used. Labs can clean instruments and glassware using a mild detergent. Work surfaces should be wiped down with a mild detergent after any spills and at the end of each workday.

Refer to the SDSs or other reliable reference materials to determine if special decontamination procedures are required. Any such requirements need to be emphasized in the SOPs for the use of the material. Also, additional training should be administered to all laboratory personnel who use the materials.

When assessing risk, personnel should be able to estimate the severity of an experiment or activity using knowledge of hazards present. The risk of an activity can be minimized by using the Hierarchy of Controls. EHSO utilizes the following hazard controls to reduce employee exposure to laboratory hazards chemicals:

HIGHEST LEVEL of PROTECTION		MOST RELIABLE
	LEVEL 1	
	Elimination of the hazard	
	LEVEL 2	
	Substitute the hazard with something safer	
	Isolate the hazard from work area	
	Utilize Engineering Controls	
	LEVEL 3	
	Utilize Administrative Controls (Training and SOPs)	
	Utilize Personal Protective Equipment (PPE)	
LOWEST LEVEL of PROTECTION		**LEAST RELIABLE**

Carcinogens
As defined by the OSHA Laboratory Standard, a carcinogen, or select carcinogen, is any substance that causes cancer, is suspected to cause cancer, and meets one of the following criteria:

- It is regulated by OSHA as a carcinogen.
- It is listed under the category "known to be carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP).
- It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC).
- 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:
- 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/m3.
- After repeated skin application of less than 300 (mg/kg of body weight) per week.
- After oral dosages of less than 50 mg/kg of body weight per day
- The health effects of carcinogens are evident only after a long latency period. An individual’s risk of developing cancer varies based on personal characteristics.
- Monitoring in certain laboratory areas may be required based on the amount and frequency.
- Laboratory workers’ potential for exposure is determined by the types of carcinogens used, frequency/type research procedures, and amounts/concentrations used.
- There is no safe level of exposure to carcinogenic compounds. The lab must ensure that exposure is reduced as much as possible.

- To evaluate exposure potential, consider the physical state of the chemical being used and the possible routes of exposure. Additionally, consider the quantity of material and the experimental procedure being conducted.

Table 11.0 – Carcinogens

Carcinogen	
GHS Hazard Symbol	
Storage Practices	Designated areas (e.g., an entire laboratory, an area of a laboratory, or a device such as a fume-cupboard) should be identified where carcinogens are used or are to be used. Doors into areas where carcinogenic chemicals are used should be marked to identify the nature of the hazard.
Work Practices	Read chemical's SDS. Follow written laboratory procedures. Utilize engineering controls such as chemical fume hoods, glove boxes, or isolation boxes for procedures involving carcinogens. Respiratory protection may be necessary depending on the experimental procedure. Designated areas can be a chemical fume hood, specific bench top, or another location where carcinogens are handled or stored. Work surfaces should be cleaned with a mild detergent following an experiment. Disposable bench paper can also be used to ensure work surfaces remain free from contamination. Wash hands and exposed portions of the forearm with soap and warm water following glove removal.
PPE	Lab coat, safety glasses, and gloves are considered minimum PPE for working with carcinogens. Glove selection depends on the physical state of the compound. Labs can review Appendix D for guidance on glove selection or the PPE Assessment Form available on the EHSO website.
Emergency Procedures	In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing.

Carcinogen	
	In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

Reproductive Toxins

Reproductive toxins cause adverse effects on the health of reproductive organs, endocrine system, or gametes (eggs or sperms). Exposures can result in effects that may include menstrual dysfunction, impaired male and female infertility, or the inability to maintain a pregnancy. Women and men of childbearing age must adhere to the recommended administrative, engineering, and personal protective equipment hazard controls to reduce the potential for exposure.

Occupational health consultations and assessments are available for individuals who are expecting a child or have plans to conceive. Individuals may contact EHSO regarding Occupational Health consults to receive safety information about reproductive hazards or developmental hazards posed by potential exposures at any time. Individuals are not required to declare an actual, suspected, or planned pregnancy.
There are three main types of reproductive toxins: mutagens, embryo toxins, and teratogens.

The OSHA Laboratory Standard defines “mutagen” as a chemical that causes permanent changes in the genetic structure or amount of genetic material in cells. Since mutagens can increase the frequency of mutations within cells, mutagens are typically also carcinogens. “Teratogens” are chemical substances that have adverse or lethal effects on fetuses. Embryo toxins are chemicals that are toxic to embryos. Embryo toxins are agents that may kill, deform, retard the growth, or adversely affect the development of an unborn child. Teratogens may cause a birth defect in the child or cause termination of pregnancy.

Table 12.0 - Reproductive Toxin

Reproductive Toxin	
GHS Hazard Symbol	
Storage Practices	Ensure that secondary containers or working containers are labeled with the chemical name and associated hazards. Handle in a designated area. Signs can be posted to indicate where reproductive toxins are handled.
Work Practices	Read chemical's SDS. Follow all written laboratory procedures. Wash hands following glove removal or after touching work surfaces. Ensure that personnel perform all chemical manipulations in a fume hood. The fume hood should be used with the sash in the proper operating position.
PPE	Use proper PPE to prevent exposure. Lab coat, gloves, and safety glasses must be worn to prevent contact with skin, eyes, and mucous membranes.
Emergency Procedures	In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

Acutely Toxic Chemicals

Chemicals that are acutely toxic have the potential to cause adverse effects after a single exposure. These adverse effects can be local, systemic, or both. Acutely toxic chemicals are known to be hazardous in small doses.

Acutely toxic chemicals are classified by the LD 50 or LC 50 values. Adverse health effects can occur after a single exposure, multiple exposures, or doses within a 24-hour period. GHS descriptions of acutely toxic compounds include the following statements on chemical labels and SDSs:

- Fatal if swallowed.

- Fatal if in contact with skin.
- Fatal if inhaled.

Table 13.0 – Acute Toxins

Acute Toxins	
GHS Hazard Symbol	
Storage Practices	Designated area(s) are required for use and storage of Acute Toxins. Such areas must be clearly marked with signs that identify the chemical hazard and include an appropriate warning.
Work Practices	Read chemical's SDS. Follow all written laboratory procedures. Use the smallest amount of chemical that is needed for the experiment. Use engineering controls and containment devices, such as a chemical fume hood for weighing chemicals, creating solutions from a powder, or heating solutions. All open chemical handling should be done inside the chemical fume hood. If a chemical fume hood or other containment device is unavailable, then contact EHSO for review of ventilation needs. Decontamination procedures will vary depending on the material. All surfaces should be wiped with the appropriate cleaning agent. Dispose of any waste through EHSO as hazardous waste.
PPE	Lab coats, safety glasses, and gloves are required. Chemical resistant gloves may be needed depending on the physical state of the compound. Immediately after working, remove gloves and wash hands and exposed portions of the forearm with warm water and soap. Long pants, and close-toed shoes must be worn.
Emergency Procedures	In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing.

Acute Toxins	
	In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

4.15 Hydrofluoric Acid

Hydrofluoric acid (HF) is especially hazardous to handle. It is a highly corrosive liquid that has the ability to cause deep tissue damage and systemic toxicity. The vapor from concentrated solutions is also dangerous. HF users must be familiar with the appropriate first aid response in case of exposure.

HF is very toxic because the acid readily penetrates skin causing severe burns. HF exposure is also associated with hypocalcemia (low calcium levels), hyperkalemia (high potassium levels), hypomagnesemia (low magnesium levels), and sudden death. Concentrated HF burns can be fatal depending on how much of the body's surface area is exposed.

HF contact with eyes can cause burns and destruction of the cornea.
Inhalation of HF vapors may cause spasms in the respiratory tract, coughing, chest tightness, and acute edema.

Table 14.0 – Hydrofluoric Acid

Hydrofluoric Acid (Corrosive and Health Hazard)	
GHS Hazard Symbol	 
Storage Practices	Never store HF in glass containers. Use containers made of polyethylene or Teflon. Ensure all containers are clearly labeled. Keep vials, flasks, and containers securely closed to prevent exposure to HF vapors.
Work Practices	Read chemical's SDS. When working, remember to follow the SOP for the process in which HF is used.

Hydrofluoric Acid (Corrosive and Health Hazard)	
	Obtain a Calgonate first aid kit and become familiar with the first aid procedures. The first aid kit must contain 2.5% calcium gluconate gel or Zephiran solution. Ensure that there are enough tubes of the gel and solution based on the volume of HF typically used. Review expiration dates and replace the tubes before they expire. Both must be available to treat skin or eye exposures. Always handle HF inside of a chemical fume hood. The fume hood should be marked as a "designated area." A sign stating "Danger: Hydrofluoric Acid Used in this Area" is sufficient. When transporting, place HF into a chemically compatible container and then don a fresh pair of gloves. Place the container inside of a carrying container or inside a secondary container. Avoid touching door handles and other objects with gloved hands. Use the buddy system to facilitate navigating common areas. Dispose of HF waste following the EHSO hazardous waste procedures. Ensure that the chemical waste container is chemically compatible with HF.
PPE	When using HF, wear a lab coat and an acid resistant apron, close-toed shoes, long pants, safety goggles, and chemical resistant gloves with extended cuffs. Nitrile gloves with extended cuffs are acceptable for dilute concentrations (double gloving is strongly recommended). Concentrated HF requires chemical resistant gloves such as neoprene gloves or Butyl rubber gloves.
Emergency Procedures	In the event of exposure, apply immediate first aid. Flush the area with water for 15 minutes and apply the Calcium gluconate gel (2.5%) to the affected site or solution to the affected eye area. Dial 9-1-1 for EMS assistance and be able to provide information regarding the exposure. Do not allow the affected individual to go home or return to work without medical examination. In the event of a spill (a spill that can be comfortably addressed by research personnel) involving HF, contact the EHSO Spill Team at 404-727-2888. Ensure that others in the work area are notified of the spill. Block the area by closing the lab doors to prevent exposure to the vapors. In the event of a **major** spill, contact the EHSO Spill Team at 404-727-2888. Alert nearby coworkers and evacuate the laboratory to a safe distance.

Hydrofluoric Acid (Corrosive and Health Hazard)	
	If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. All incidents must be reported via PeopleSoft. In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

4.16 Perchloric Acid

Perchloric Acid is a very strong mineral acid and a strong oxidizing agent. When concentrated, it can become unstable. It can also become shock sensitive upon drying. If mixed with flammable or combustible material, it may ignite. Exposure to concentrated solution can result in skin burns. Repeated dermal exposure to dilute concentrations can result in dermatitis due to sensitization. Exposure to the acid's vapor can cause irritation to the eyes and respiratory tract, chest pains, and nasal congestion.

Table 15.0 – Perchloric Acid

Perchloric Acid (Corrosive and Reactive)	
GHS Hazard Symbols	 
Storage Practices	Perchloric acid is incompatible with acetic acid, hydrochloric acid, flammable and combustible materials, and organic compounds. Inspect containers of perchloric acid monthly for discoloration. Ensure that bottles are dated upon receipt and dated once they are opened. Dispose of perchloric acid one year from the date of opening. Best practice is to dispose of chemical when a small amount is still remaining in the container. This will prevent the residue from drying and becoming extremely shock sensitive. Store the smallest amount of perchloric acid.

Perchloric Acid (Corrosive and Reactive)	
Work Practices	Read chemical's SDS. Develop and implement SOPs for laboratory staff to use when preparing/using perchloric acid. Handle perchloric acid in a designated area. Ensure that work surfaces are decontaminated following use with 10% sodium carbonate solution. Work requiring heating of perchloric acid in concentrations above 72% must be conducted in a specially designed perchloric acid hood equipped with a wash down system. Work requiring heating of perchloric acid in concentrations below 72% can be conducted in a standard chemical fume hood. Dispose of perchloric acid waste following the usual hazardous waste procedures.
PPE	Use nitrile gloves with extended cuffs when working with perchloric acid. Double gloving is strongly recommended. Safety goggles, lab coat, acid-resistant apron, long pants, and close-toed shoes are required.
Emergency Procedures	In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

4.17 Nanomaterials

Nanomaterials are structures that have at least one dimension that is between 1 and 100 nanometers. Nanoparticles typically have all three dimensions on the nanoscale. Nanoparticles can be dry, suspended in solution (as a nanocolloid), embedded in a matrix (as a nanocomposite) or suspended in gas (as a nanoaerosol).

There are many unknowns regarding the health risks and health effects following exposure to nanoparticles. There are no national or international consensus standards on measuring an individual's exposure to nanoparticles in the workplace.

Certain characteristics of nanoparticles can influence their effects in biological systems.

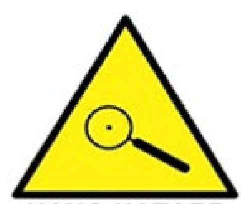
Some of these characteristics include:

- Charge.
- Chemical reactivity.
- Degree of agglomeration.
- Shape.
- Size.
- Solubility.
- Surface area.
- Surface composition.

Before working with nanomaterials, a hazard assessment should be performed by safety personnel in conjunction with research personnel. Assessments help to identify appropriate work procedures, controls, and necessary PPE to ensure worker safety.

- The most common route of exposure is inhalation.
- Ingestion is another route of exposure through unintentional hand-to-mouth transfer.
- Nanomaterials may enter the body through the skin, but the health effects are unknown.
- Labs can submit Chemicals in Animals Forms through EHSO's electronic platform for protocols involving the use of nanoparticles in animals.
- For more information, access the Guidelines for Working with Nanomaterials at http://www.ehso.emory.edu/documents.

Table 16.0 – Nanomaterials

Nanomaterials (Health Hazard)	
GHS Hazard Symbol and Emory Specific Symbol	 
Storage Practices	Use in designated areas such as a chemical fume hood or biological safety cabinet. Nanomaterial storage containers should have a designation that the material is "nanoscale" or a "nanomaterial."
Work Practices	Read chemical's SDS. Follow written laboratory procedures.

Nanomaterials (Health Hazard)	
	Chemical fume hoods are the recommended containment device for all tasks with potential for aerosolizing nanomaterials in liquid or powder form. Containment devices with HEPA filters are also effective to remove nanoparticles from the environment. Equipment that is too large to be enclosed in a fume hood can be set up such that specially designed local exhaust ventilation can capture contaminants. Place inside sealed containers for transport to other locations. If nanomaterial product from a reactor is bound or adhered to a substrate, the substrate may be removed and put in a transport container. After the conclusion of procedures involving nanomaterial, avoid dry sweeping or using pressurized air to clean the area. Wet wiping methods or a HEPA filtered hand-held vacuum cleaner should be used to clean. Respiratory protection is recommended if a potential for aerosol exposure exists. Before wearing a respirator for use with nanoparticle research, the lab must contact EHSO to be included in the Respiratory Protection Program. Dispose of nanomaterial waste using EHSO hazardous waste disposal procedures.
PPE	Safety glasses, lab coats, gloves, long pants and close-toed shoes are required. Two pairs of gloves can be worn if extensive skin contact is anticipated. If contamination of clothing is a concern, use disposable lab coats and dispose of through hazardous waste pickup.
Emergency Procedures	In the event of a minor spill (5mg of solid material or 5ml of solution), the nanomaterials should be wet wiped with a cloth/paper towel dampened with soapy water. Affected surfaces should be wiped two or three times to ensure appropriate cleaning. Dispose of the spill debris as hazardous waste. In general, any skin or eye exposure must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact the Spill Team for assistance with spill cleanup at (404) 727-2888. Dial 9-1-1 (from a cellphone or campus phone) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire.

Nanomaterials (Health Hazard)	
	Report any accident, injury, or illness to supervisor and submit notification of the incident to the Occupational Health Services (OHS) through the Self-Service portal (PeopleSoft).

5.0 Lab Decommissioning and Equipment Decontamination

5.1 Lab Decommissioning

Prior to a change of occupancy or use, a laboratory must be decommissioned to ensure that it is safe for re-occupancy or repurposing (such as converting a lab into an office). This process entails:

- Removal of hazardous waste.
- Removal of samples.
- Surface decontamination.
- Equipment decontamination and tagging using the Equipment Hazard Tag.

To aid in this process, EHSO developed laboratory decommissioning guidelines available at https://ehso.emory.edu/guidance/forms-documents.html. This process is envisioned as a collaboration between the laboratory, department administration and EHSO. Contact your EHSO Research Safety Building Liaison for more information.

5.2 Equipment Decommissioning

Laboratory equipment that contains, or is exposed to, hazardous material must be decontaminated prior to the following events or actions:

- Redistribution.
- Disposal through Emory Surplus.
- Relocation (within Emory's Campus or to an off-campus location).
- Repairs or Maintenance with an outside vendor.

To aid in this process, EHSO created an Equipment Hazard Tag, which must be completed and attached to equipment prior to these events or actions. This form is available at https://ehso.emory.edu/guidance/forms-documents.html.

In some cases, it may be necessary to utilize a service to perform equipment decontamination. Contact your EHSO Research Safety Building Liaison for more information.

6.0 Medical Consultation and Medical Examinations

There are two types of exposures that are most often used when referring to hazards: Acute and chronic

- Acute health effects are due to short-term exposures and happen in short period of time.
- Chronic health effects are due to long-term exposure and happen over a longer period of time.

- Chemicals enter the body through Inhalation, Skin or Eye contact, or Ingestion. Inhalation exposure can occur from breathing chemical gases, mists, or dusts in the air.
- Skin or eye contact can occur if vapors from chemicals contact the eyes or chemicals get on the skin or in the eyes. Chemicals can damage the skin or be absorbed through the skin into the bloodstream.
- Ingestion can occur when chemicals have spilled or settled onto food, beverages, beards, or hands.
- Injection can occur through physical penetration of the skin barrier by a contaminated sharp object, such as a needle.
- The following table provides an overview of the symptoms that may be caused by chemicals. There is also an appendix within this document (Appendix A – Industrial Toxicology Overview) that provides more detailed information regarding chemical toxicology:

Table 17.0 – Overview of Symptoms Caused by Chemicals

Affected Body Part	Symptoms	Common Causes	GHS Hazard Class
Head	Dizziness, headache	Organic solvents, Corrosive vapors	Flammables Corrosives
Eyes	Red, watery, irritated, grainy feeling	Vapors from acids, Various dusts and particulate mater	Corrosives Irritants
Nose and Throat	Sneezing, coughing, sore throat, shortness of breath	Vapors from solvents and acids	Corrosives Irritants
Chest and Lungs	Wheezing, coughing, shortness of breath, lung cancer	Solvent vapors Metal fumes Various dusts and particulate matter	Corrosives Irritants
Stomach	Nausea, vomiting, diarrhea	Long term lead exposure Solvent vapors	Target Organ Toxins
Skin	Redness, dryness, rash, itching, burns	Solvents, Detergents, Acids/Bases	Irritants, Sensitizers, Corrosives
Nervous System	Loss of balance, Loss of coordination, tremors, sleeplessness	Long term solvent exposure, long term lead exposure	Target Organ Toxins
Reproductive System	For men: Low sperm count; damage to sperm For women: Irregularities to menstruation; miscarriage; damage to egg, embryo, or fetus	Organic Solvents Lead	Mutagens Reproductive Toxins

Consultations and/or examinations will be authorized under the following conditions:

- When an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in a laboratory.
- When a spill, leak, explosion, or other emergency causes exposure to a hazardous chemical.

- Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA-regulated substance for which there are exposure monitoring and medical surveillance requirements.

The following information should be provided to the healthcare provider by the employee:

- The identity of the hazardous chemical(s) to which exposure may have occurred accompanied by an SDS.
- 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 the employee is experiencing, if any.

For examination or consultations required under this plan, Emory University receives a written opinion from the examining physician, which shall include the following:

- Any recommendation for further medical follow-up.
- The results of the medical examination and any associated tests.
- Medical conditions which may be revealed during the examination which may place the employee at increased risk because of exposure to a hazardous chemical found in the workplace; and
- A statement that the physician has informed the employee of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

The written opinion shall not reveal specific findings or diagnoses unrelated to occupational exposure. Copies of any reports and laboratory examination results made available to the University shall also be made available to the employee and the employee's private physician upon request.

7.0 Emergency Procedures

7.1 Exposures and Injuries

Emory University employees who work with hazardous chemicals may seek medical attention in the event of an exposure or injury. The following steps should be followed accordingly:

- Always administer first aid immediately (i.e., use emergency eye wash station, emergency shower, etc.).
- Report the incident to the immediate supervisor.
- Seek medical attention at Occupational Health Services (or EUH ER after 4 p.m.).
- Exposures are reported in PeopleSoft (https://hrprod.emory.edu/psp/hrprod/?cmd=login)
  Emory HR website > Self-Service > Workplace Health> HOME portal OHS: 7:30 am- 4pm 404-686-8587; After Hours, Weekends, Holidays: NP On-Call: 404-686-5500 PIC# 50464.
- For Emory Primate Center (EPC) Accident/Injury, report to EPC Environmental Health and Safety Office.

3rd floor Main Center room # 3147 or 2nd floor room # 2109 Office: 404-727-8012; Cell: 404-275-0963.

- Additional information can be found at the Emory University Accident/Injury Reporting webpage.

Note: As a follow up, EHSO will conduct an accident investigation to obtain information regarding the incident. The accident investigation is a tool to assist the research community in developing methods for prevention of accident reoccurrence.

7.2 Spills

In the event of a spill, it is critical to remember the following:

- Chemical spills should be mitigated by laboratory personnel only if the personnel have been trained to do so.
- Chemical spills that cannot be safely mitigated by laboratory personnel are considered major spills and should immediately be reported to EHSO (404-727-2888) or Emory Police (911 from any campus phone or 404-727-6111).
- For Emergencies at Oxford College, contact Campus Police at 770-784-8377.
- In the event of a major spill, notify all lab personnel, and evacuate the lab.

The Office of Critical Event Preparedness and Response (CEPAR) provides information regarding how to properly handle emergencies. For more information, access the Just in Time Guide to Campus Emergencies, or visit emergency.emory.edu.

Note: The *Just in Time Guide* is available on the CEPAR website.

8.0 References

- NFPA 30: Flammable and Combustible Liquids Code, National Fire Protection Association, Quincy, Massachusetts, most current version
- NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals, National Fire Protection Association, Quincy, Massachusetts, most current version
- NFPA 55: Compressed Gases and Cryogenic Fluids Code, National Fire Protection Association, Quincy, Massachusetts, most current version
- NFPA 400: Hazardous Materials Code, National Fire Protection Association, Quincy, Massachusetts, most current version
- Prudent Practices in the Laboratory: Handling and Disposal of Chemicals, National Academy Press, Washington D.C., 2011.
- OSHA Laboratory Standard – 29 CFR 1910.1450 - Occupational Exposure to Hazardous Chemicals in Laboratories

9.0 List of Associated Documents

- EHS-201, Regulated Waste Guidelines
- EHS-300, Hazard Communication Program
- EHS-310, Personal Protective Equipment (PPE) Guidelines

- EHS-323, Compressed Gas Cylinder Guidelines
- EHS-408, Equipment Hazard Tag Guidance
- EHS-410, Guidelines for the Consumption and Storage of Food and Beverages in Laboratory Areas
- EHS-411, Guidelines for the Safe Use of Sharps
- EHS-412, Guidelines for Use of Hazardous Chemicals in Animals
- EHS-418, Laboratory Moves, Relocations and Decommissioning Guidelines
- EHS-419, Laser Safety Program
- EHS-459, Guidelines for Working with Nanomaterials
- Chemical SOP Template
- Equipment Hazard Tag
- Incident Reporting Guide
- “Just in Time” Emergency Guide
- Personal Protective Equipment (PPE) Assessment Form
- RAD-030, Radiation Safety Manual
- Ultraviolet (UV) Radiation Facts

Appendix A: Industrial Toxicology Review

Chemical Toxicology
Toxicology is the study of the nature and action of chemical poisons. Toxicity is the ability of a chemical molecule or compound to produce injury once it reaches a susceptible site in or on the body. Toxicity hazard is the probability that injury will occur considering the manner in which the substance is used.

Dose-Response Relationship
The potential toxicity (harmful action) inherent in a substance is exhibited only when that substance comes in contact with a biological system. A chemical normally thought of as "harmless" may evoke a toxic response if added to a biological system in sufficient amount. The toxic potency of a chemical is thus defined by the response that is produced in a biological system.

Routes of Entry into the Body
There are four main routes by which hazardous chemicals enter the body:

- **Inhalation**: Introduction to system through the respiratory tract. Most important in terms of severity.
- **Absorption**: Skin absorption or absorption through mucous membranes.
- **Ingestion**: Introduction to system through the digestive tract. Can occur through eating or smoking with contaminated hands or in contaminated work areas.
- **Injection**: Introduction of toxin into bloodstream; can occur by accidental needle stick or puncture of skin with a sharp object.

Exposure Limits as Related to Routes of Entry
Most exposure standards are based on the inhalation route of exposure. They are normally expressed in terms of parts per million (ppm) or milligrams per cubic meter (mg/m) concentration in air.

The Occupational Safety and Health Administration (OSHA) has established Permissible Exposure Limits (PELs) and the American Conference of Governmental Industrial Hygienists (ACGIH) has established Threshold Limit Values (TLV's) for employee exposure limits. In many instances, the PEL and TLV are represented as the same number. In the instances where one is lower than the other, it is a prudent safety practice to maintain exposures at the lowest level achievable.

If a significant route of exposure for a substance is through skin contact, the TLV or PEL will have a "skin" notation. Examples are pesticides, carbon tetrachloride, cyanides, ethylene diamine, and thallium.

Types of Effects
Acute poisoning is characterized by rapid absorption of the substance when the exposure is sudden and severe. Normally, a single large exposure is involved. Examples are carbon monoxide or cyanide poisoning.

Chronic poisoning is characterized by prolonged or repeated exposures of a duration measured in days, months or years. Symptoms may not be immediately apparent. Examples include lead or mercury poisoning, or pesticide exposure.

Local refers to the site of action of an agent where the action takes place at the point or area of contact. The site may be skin, mucous membranes, the respiratory tract, gastrointestinal system, eyes, etc. Absorption does not necessarily occur. Examples are strong acids or alkalis.

Systemic refers to a site of action other than the point of contact and presupposes absorption has taken place. For example, an inhaled material may act on the liver. For example, inhaled benzene affects the bone marrow.

Cumulative poisons are characterized by materials that tend to build up in the body as a result of numerous chronic exposures. The effects are not seen until a critical body burden is reached. Examples are heavy metals.

Synergistic effects occur when two or more hazardous materials present at the same time have a resulting action greater than the effect predicted based on the individual substances. For example, workers exposed to benzene may show a direct toxicity in hematopoietic tissue and therefore be more susceptible to oxygen-displacing agents such as carbon monoxide.

Other Factors Affecting Toxicity

- **Rate of entry and route of exposure** - how fast the toxic dose is delivered and by what means.
- **Age** - can affect the capacity to repair damaged tissue.
- **Previous exposure** - can lead to tolerance, increased sensitivity, or make no difference.
- **State of health, medications, physical condition, and** lifestyle - can affect the toxic response. Pre-existing disease can result in increased sensitivity.
- **Environmental factors** - temperature and pressure, for example, can affect exposure.
- **Host factors** - genetic predisposition and the sex of the exposed individual.

Physical Class Effects on Toxicity

When considering the toxicity of gases and vapors, the **solubility of the substance** is a key factor. Highly soluble materials like ammonia irritate the upper respiratory tract. On the other hand, relatively insoluble materials like nitrogen dioxide penetrate deep into the lung. Fat soluble materials, like pesticides, tend to have longer residence times in the body.

An **aerosol** is composed of solid or liquid particles of microscopic size dispersed in a gaseous medium. The toxic potential of an aerosol is only partially described by its concentration in milligrams per cubic meter (mg/m^3). For a proper assessment of the toxic hazard, the size of the aerosol's particles is important. Particles above 1 micrometer tend to deposit in the upper respiratory tract. Particles less than 1 micrometer in diameter enter the lung. Very small particles (< 0.2 µm) are generally not deposited.

Physiological Classifications of Toxic Materials

See Glossary of Terms for definitions of the following classifications.

- Irritants.

- Corrosives.
- Asphyxiants.
- Teratogenic.
- Mutagenic.

Other specific classifications include:

- A **primary irritant** exerts no systemic toxic action because the products formed on the tissue of the respiratory tract are non-toxic or because the irritant action is far in excess of any systemic toxic action. Example: hydrogen chloride.
- A **secondary irritant's** effect on mucous membranes is over-shadowed by a systemic effect resulting from absorption. Examples include hydrogen sulfide and aromatic hydrocarbons.
- Exposure to a secondary irritant can result in pulmonary edema, hemorrhage, and tissue necrosis.

Primary anesthetics have a depressant effect upon the central nervous system, particularly the brain. Examples include halogenated hydrocarbons and alcohols.

Target Organ Effects

The following is a target organ categorization of effects which may occur from exposure to hazardous chemicals, including examples of signs and symptoms and chemicals which have been found to cause such effects.

Category (Organ)	Signs & Symptoms	Example Chemicals
Hepatotoxins (liver)	jaundice, liver enlargement	carbon tetrachloride, nitrosamines, chloroform, toluene, perchloroethylene, cresol, dimethylsulfate
Neurotoxins (nervous system)	narcosis, behavioral changes, decreased muscle coordination	mercury, carbon disulfide, benzene, carbon, tetrachloride, lead, mercury, nitrobenzene
Hematopoietic (blood system)	cyanosis, loss of consciousness	carbon monoxide, cyanides, nitrobenzene, aniline, arsenic, benzene, toluene
Pulmonary (lung)	cough, tightness in chest, shortness of breath	silica asbestos, nitrogen dioxide, ozone, hydrogen, sulfide chromium, nickel, alcohol
Reproductive Mutagens & Teratogens	birth defects, sterility	lead, dibromo dichloropropane
Dermal Irritants & Sensitizers (skin)	defatting of skin, rashes, irritation	ketones, chlorinated compounds, alcohols, nickel, phenol, trichloroethylene
Nephrotoxins (kidney)	edema, proteinuria	halogenated hydrocarbons, uranium, chloroform, mercury, dimethyl sulfate

Category (Organ)	Signs & Symptoms	Example Chemicals
Ocular toxins (eyes)	conjunctivitis, corneal damage	organic solvents, acids, cresol, quinone, hydroquinone, benzyl chloride, butyl alcohol, bases

Appendix B: Hazard Assessment

Hazard Assessment Tool

OSHA requires that SOPs be included in the CHP, these SOPs focus on the major hazard classifications of chemicals. An SOP is a method of hazard assessment. At Emory University, individual research laboratories need to develop effective SOPs to work safely with hazardous chemicals. The American Chemical Society (ACS) created a tool to help “identify hazards, assess risk, and select the appropriate control measures to eliminate a hazard or minimize risk…” The ACS Hazard Assessment Tool can be used to facilitate this process, and a variety of methods are available.

Link to Tool ACS Hazard Assessment Tool – accessed on 04/01/2024.

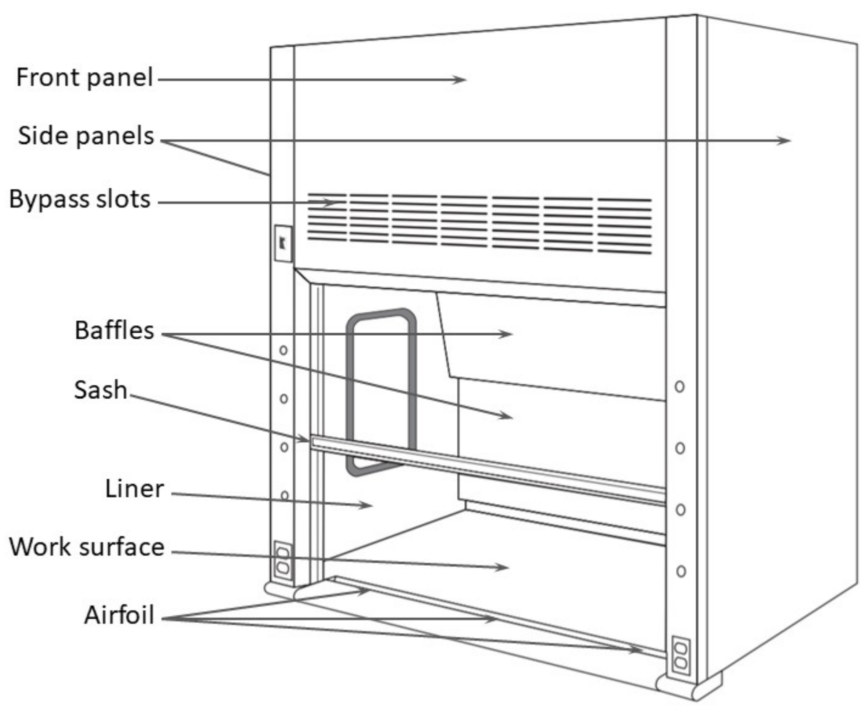
Appendix C: Chemical Fume Hood Cleaning Procedures

Chemical fume hoods (CFHs) must be cleaned regularly in order to function properly. Dust and chemical residue can impede proper airflow.

To clean your CFH:

1) Ensure that your hood is on and functioning normally, then remove all items from the hood.
2) Begin cleaning by dusting any bypass slots located on the front panel (Figure 1), then thoroughly clean the slots using warm water containing a small amount of dishwashing soap. Rinse the slots by wiping with a damp paper towel.
3) Follow the same procedure to clean the airfoil. *Ensure that the interior side of the airfoil, which may have small air holes, is entirely clean and unobstructed.*
4) Clean the remaining portion of the front panel, as well as both side panels and the sash.
5) Finish by cleaning the interior of the hood including the back baffles, liner on each side, and the work surface.

Figure 1. Chemical fume hood (CFH) surfaces that require regular cleaning.



Appendix D: Glove Guide

Guidance on Glove Selection

It is important to choose the right type of glove for the chemical and task. Consult the relevant Safety Data Sheet (SDS) which may recommend a particular glove material. Gloves should be checked for physical damage before each use to ensure they are not torn, punctured, or made ineffective in any way. Gloves that are discolored or stiff may also indicate deficiencies caused by excessive use or degradation from chemical exposure.

Glove	Chemical	Recommended	Disadvantages
Polyvinyl Chloride (PVC)	Medium general resistance	Acids, bases, salts, alcohols, amines, peroxides, petroleum hydrocarbons	Poor for most organics, aromatics, aldehydes, and ketones
Nitrile	Some organics	Organics, oils, greases, aliphatic chemicals, xylene, perchloroethylene, trichloroethane, toluene, some acids and bases, some biohazardous materials	Material not good with many ketones, benzene, methylene chloride, and trichloroethane
Neoprene	Medium general resistance	Acids, alcohols, oils, solvents, esters, greases, and animal fats	Not good with many chlorinated solvents, ethers, ketones, and aromatics
Viton	Organic solvents	Aromatics, chlorinated solvents, aliphatics, and alcohols	Poor physical properties, not good with some ketones, esters, and amines
Butyl	Polar organics	Gas or water vapors, ketones, esters, and highly corrosive acids	Not good with hydrocarbons or halogenated solvents
Polyvinyl Alcohol (PVA)	Organics	Strong solvents, including aromatics, aliphatics, and chlorinated solvents	Not good with alcohols, acids, bases
Silver Shield	High general resistance	Hazmat	Poor fit, stiff, and easily punctured