FIU | Operations and Safety

Environmental Health & Safety

# Chemical Hygiene Plan

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# Chemical Hygiene Plan

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# 1.0 BACKGROUND

## 1.1 REGULATORY STANDARDS

Florida International University (FIU) is committed to providing a safe and healthy workplace, and to meeting its obligations under the Occupational Safety and Health Administration (OSHA), "Occupational Exposures to Hazardous Chemicals in the Laboratory" (29 CFR 1910.1450). Included in OSHA's standard is the requirement that all employers develop and implement a Chemical Hygiene Plan which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace. The following is FIU's chemical hygiene plan in conformance with these requirements.

This Chemical Hygiene Plan applies to all employees and students engaged in laboratory use of hazardous substances, where there is the potential for employee exposure to hazardous materials. It does not apply to those working outside the laboratory setting. This plan was developed by FIU Environmental Health & Safety (EH&S). Individuals working with radioactive materials should refer to the FIU Radiation Safety Manual. Those working with biological agents should refer to the FIU Biosafety Manual. Program manuals, such as the Biosafety Manual and Radiation Safety Manual, can be found under their respective programs in the Safety Programs section of the EH&S website.

The standard implemented by OSHA with these specific objectives is known as Occupational Exposure to Hazardous Chemicals in Laboratories: 29 CFR 1910.1450. The issuing of this "performance oriented" standard did not diminish the need for continued compliance with pre-existing standards such as the Hazard Communication Standard: 29 CFR 1910.1200, also known as the Employee-Right-to-Know Standard; the Bloodborne Pathogens Exposure Control Standard: 29 CFR 1910.1030; or The General Duty Clause, each of which works in concert with the Occupational Exposure to Hazardous Chemicals in Laboratories Standard to provide for the protection of personnel from unhealthful laboratory exposures.

NOTE: The "General Duty Clause" extends beyond compliance with current and specific requirements and is intended to assure that due consideration is given to the identification and abatement of potential hazards, which may not be specifically covered by a specific standard.

## 1.2 FLORIDA INTERNATIONAL UNIVERSITY LABORATORY SAFETY STANDARD OPERATING PROCEDURES

- Laboratory activities carried out at FIU shall be planned and executed with appropriate consideration for the safety and wellbeing of the University community.
- Each individual working with, or who may be potentially exposed to, chemical, thermal, radiological, biological, electrical, mechanical or any recognized or recognizable hazard in the setting of a teaching or research laboratory environment, shall possess or receive sufficient information and training that will enable them to understand the relative significance of the potential hazards of the materials to which they are exposed and to work safely.
- Students and employees; including but not limited to researchers, professors, study participants, graduate and teaching assistants, and visiting scholars; who may be directly involved or associated with, or who occupy laboratory locations where teaching and research activities involving any recognized or recognizable health or safety hazard, shall be informed and periodically advised about the following:

- Likely sources of exposure.
- Adverse health effects associated with exposure.
- Laboratory practices and engineering controls implemented to limit exposure.
- Recommended environmental and medical monitoring procedures applicable to operations in that laboratory.
- Individual responsibilities to follow proper laboratory practices.

NOTE: Building maintenance/service personnel shall be similarly advised, to the extent required to assure their protection, while performing maintenance and building related services in teaching and research laboratories.

Principal investigators seeking to conduct research activities involving, but not limited to controlled substances, human subjects, biomedical or biological agents, scientific/research diving & boating, radioactive materials, radiation-producing machines, lasers, nanomaterials, hazardous chemicals or explosive materials, shall obtain approval from the appropriate committee and/or provide notification to EH&S, prior to initiating any aspect of the activity.

Specific committees from which prior approval is required are listed below:

- FIU-Institutional Animal Care and Use Committee
- FIU-Institutional Biosafety Committee
- FIU-Nanotechnology Safety Committee – COMING SOON
- FIU-Radiation Control Committee
- FIU-Institutional Review Board
- FIU-Diving Control Board
- FIU-Boating Safety Committee
- FIU-Lab Safety Committee

## 1.3 PLAN DEVELOPMENT, MAINTENANCE, AND REVISION

This document was reviewed by the FIU Laboratory Safety Committee and the Chemical Safety Committee in March 2021. All feedback relative to current procedures and regulations were incorporated. The Department of Environmental Health & Safety will maintain and revise this document based on the following criteria as described in the **Standard Operating Procedure for Plan Development, Maintenance, and Revision – Plan Revision Section**:

- Changes in laws, regulations, and policies that impact laboratory safety at FIU
- Lessons learned following real-world incidents that require improvement of the laboratory safety and chemical hygiene programs
- Changes in availability of resources that impact the laboratory safety and chemical hygiene programs

# 2.0 INTRODUCTION

## 2.1 PURPOSE

The Florida International University Chemical Hygiene Plan is intended to serve as the safety guidance document applicable to all laboratory operations at the University. The policy statements, recommendations and guidelines included are by no means all-inclusive or universally applicable to all laboratory activities, conditions, practices, or exposures.

The Plan has been prepared in accordance with specific guidelines from the OSHA Standard on Occupational Exposure to Hazardous Chemicals in Laboratories, other applicable regulatory and consensus standards, best practices from universities and research facilities through-out the country, recommendations from consultants, and empirical knowledge regarding laboratory practices observed here at FIU. Further, in consideration of the ultimate responsibility for teaching and research which rests with the instructor and/or principal investigator, it is expected that the safety policy statements and recommendations included in this Plan will be complemented by departmental, laboratory and program specific safety procedures applicable to various laboratory activities.

## 2.2 SCOPE

The FIU Chemical Hygiene Plan applies to all laboratory operations at Florida International University.

NOTE: "A laboratory is defined as a facility where operations are normally carried out by one person, where many different procedures involving many different substances are performed, and where the end result is not production." For the definition of the scope in this Plan, the use of the word laboratory may extend to performing arts production shops, art studio operations, etc. More specifically, laboratories include all locations where:

- Chemical operations are carried out on a laboratory scale, as opposed to operations in which the objective is to produce "commercial" quantities of materials.
- Activities are designed to be easily and safely operated by one person.
- Multiple chemicals or processes are used.
- Procedures involved are not part of a manufacturing process and do not simulate a production process.
- Standard laboratory procedures and equipment are commonly used to minimize potential exposure.

NOTE: The "letter of the law" as dictated by OSHA* addresses employee safety only, however prudence dictates that all safety standards governing employee protection must be extended to apply to anyone working or studying in laboratories and who may be, reasonably or foreseeably, exposed to the hazards of laboratory operations.

*Worker safety provisions are administered by the Florida Department of Labor and Employment Security - Division of Safety, for the State's public sector employees. These provisions are consistent with federal OSHA.

The FIU Chemical Hygiene Plan addresses the following:

- Standard operating procedures to be followed when laboratory work involves the use of hazardous chemicals.

- Criteria to be applied in the identification of the appropriate control measures (engineering controls, administrative controls, personal protective equipment, and hygiene practices) intended to prevent and mitigate personnel exposures to hazardous substances.
- Measures to be taken to ensure proper performance of laboratory safety equipment such as fume hoods, fire extinguishers, eyewash stations, etc.
- Training requirements and resources.
- Criteria to be used to evaluate the hazards associated with laboratory procedures or activities.
- Guidelines relevant to employee exposure monitoring and medical consultations, such as: signs and symptoms of exposure to hazardous chemicals, when routine monitoring reveals an exposure above the Action Level or Permissible Exposure Limit (PEL); or when a spill, leak or other occurrence creates the likelihood of hazardous exposures.
- Assignment of responsibility for implementation of the Chemical Hygiene Plan.
- Administrative procedures that may apply in order to provide for the protection of laboratory personnel.
- Others.

## 2.3 PROGRAM ADMINISTRATION RESPONSIBILITY AND ACCOUNTABILITY

The Director of Environmental Health and Safety (EH&S) serves as the University laboratory safety program administrator. The Director shall manage the ongoing health and safety program that provides for University wide compliance with the requirements for laboratory safety, and shall administer resources as assigned in order to meet this objective. Further, the Director of EH&S shall recommend to department heads, Office of Research and Economic Development, and the Provost those policies and procedures to be implemented in order to provide for the safe conduct of work in teaching and research laboratories.

*The Office of Research and Economic Development:*

- Institutes procedures for approving high risk academic and research activities.
- Periodically reviews the status of compliance with policies for the safe conduct of research activities University-wide.
- Provides notification to EH&S on specific activities requiring approval, monitoring, licensure, permitting or surveillance.

*Laboratory Safety Compliance Team:*

The Laboratory Safety Team reports directly to the Director of Environmental Health & Safety. The Laboratory Safety Team shall assist department heads, principal investigators, and laboratory managers in achieving compliance with laboratory safety standards and the requirements of the Manual by doing the following:

- Assisting principal investigators in the selection of best laboratory safety practices, personal protective equipment, and engineering controls.
- Conducting laboratory safety inspections, at the frequency prescribed by ‘the degree of hazard’ of each laboratory.
- Investigating all reported accidents that result in personnel or environmental exposure to hazardous materials and recommending corrective action to reduce the potential for recurrence.
- Assuring the adequacy of clean-up and decontamination procedures in situations where accidents have resulted in contamination of laboratory areas.

- Facilitating and scheduling appropriate training and dissemination of topical information in order to promote safe laboratory practices.
- Monitoring laboratory personnel for potential exposure to hazardous substances.
- Providing guidance on administrative and procedural controls for the safe management of regulated substances.
- Facilitating safe storage, handling, and ultimate disposal of hazardous wastes generated by maintaining the Manual current to address changes in regulations, technology, etc.

*Laboratory Manager/Principal Investigator/Instructor:*

The principal investigator, instructor, or laboratory manager shall serve as the supervisor of the laboratory and shall be responsible and accountable for the following:

- Ensuring that laboratory personnel and students are advised of and follow prudent safety practices; that protective equipment is available and in working order; and that the specific precautions applicable to the type of work being conducted have been provided assuring that emergency response procedures for the area(s) under their control are maintained current and appropriate for the type of occurrences to be expected in such locations.
- Conducting periodic laboratory safety and housekeeping inspections in order to maintain the laboratory in a safe working condition.
- Assuring access control procedures have been developed and are complied with for the laboratory or work area under their control.
- Maintaining laboratory chemical inventory current.
- Maintaining a basic understanding of the current legal requirements applicable to the use of regulated/hazardous substances in the laboratory.
- Identifying and assuring the availability of appropriate types of personal protective equipment.
- Assuring that laboratory conditions and equipment are appropriate for the type of work planned.
- Identifying and reporting maintenance and repair requirements to the Facilities Management/Maintenance Department.
- Providing timely notification to EH&S of process, procedural or facility related changes within their area of operation which are likely to change the hazard rating assigned to that location.
- Identifying those substances and equipment, such as explosive materials or lasers, used in their laboratories which may pose a high risk of injury and/or property damage and implementing procedures to control exposures.
- Complying with appropriate approval procedures, when required, for conducting high risk research activities.
- Arranging for immediate medical attention and reporting of any incident that results in:
    - Injury.
    - Exposure to hazards at or above established thresholds.
- Assisting representatives of EH&S in investigating occurrences that result in hazardous exposures, injuries and/or property damage.
- Notifying EH&S of problems related to the general operation and implementation of laboratory safety practices and engineering controls.

*Employees & Students:*

Each individual is responsible for planning and conducting laboratory activities in accordance with instructions received from instructors, laboratory managers, and principal investigators, and in accordance with appropriate laboratory safety guidelines.

Students and laboratory workers shall comply with the following minimum guidelines:

- Knowing and complying with the safety guidelines, regulations and procedures required for tasks assigned.
- Reporting unsafe conditions to the principal investigator, immediate supervisor, or EH&S.
- Reporting to the principal investigator or immediate supervisor facts pertaining to any accident resulting in hazardous exposures, injury and/or property damage.
- Following instructions given.

*Contractors:*

Contractors performing work on FIU premises are responsible for conducting their activities in accordance with established EH&S procedures prescribed by their organization's health and safety plan, or as otherwise instructed by the FIU Facilities Management project managers.

NOTE: EH&S, the principal investigator, and the laboratory manager may make specific recommendations to the contractor **through** the Facilities Management project manager regarding work to be carried out by contractors in university laboratories.

*Visitors:*

Visitors to laboratories on FIU campuses are required to abide by the appropriate safety recommendations included in this Manual; however, it is the specific responsibility of staff and laboratory personnel to advise visitors of potential exposures and to assure they are appropriately protected prior to accessing locations where such hazardous exposures are likely.

## 2.4 GENERAL LABORATORY SAFETY CONCEPTS

*Emergency Response:*

Each laboratory shall be equipped with supplies and maintain documented procedures required for appropriate and timely response to spills or unintended releases of hazardous material, employee exposure to hazardous substances, and "shut down" procedures for campus declared State of Emergency. Emergency response equipment and procedures shall be easily accessible.

NOTE: FIU Emergency Operations Plan and Individual Department COOP Plan identifies the conditions and procedures applicable to a university/campus State of Emergency.

*Access Controls:*

Unauthorized access to laboratory work areas shall be strictly controlled, however the use of padlocks and personally installed locks is not permitted. For purposes of emergency response, all doors shall be equipped **only** with locks installed by the Facilities Management Department. **Doors should not be left or propped open if no one is present in the lab area.** All laboratories shall be accessible by the University Police Department, Office of Research and Economic Development, and Environmental Health & Safety. **Door vision panels, except for laser labs, shall remain clear and unobstructed to allow for a clear view into the laboratory.**

*Labeling:*

All containers used for storage of any material other than controlled substances shall be properly labeled using the Globally Harmonized System (GHS) requirements at all times.

*Signage:*

Entrance doors to laboratories, in which regulated hazardous materials are used, shall bear appropriate hazard warning or safety signs identifying the nature of the hazard within. For security reasons, the door shall not be marked with controlled substances hazard warning.

The EH&S Emergency Signage Program is a mandatory initiative that ensures FIU is compliant with the GHS, NFPA, and Hazard Communication regulatory requirements. The signage displays a primary and alternate contact for the space, special hazard pictograms, GHS pictograms, PPE pictograms, and important emergency numbers. To get started on your lab signage, access the Qualtrics Survey.

*Smoking:*

Smoking is prohibited on campus, as FIU is a smoke and tobacco. See **FIU-113 Smoke, Vape-Free and Tobacco-Free Campus policy.**

*Food:*

Food storage, preparation and/or consumption is prohibited in laboratories, stock rooms or any other location where laboratory type chemicals or hazardous substances are stored, handled, or used for research, educational, or any other purpose.

> NOTE: Glassware or any other apparatus used in laboratories shall not be used for storage, preparation and/or consumption of food. Likewise, refrigerators used for the storage of laboratory supplies shall not be used to store foods unless such foods have been specifically identified for research purposes.

*Cosmetics:*

Neither the application of cosmetics, nor the insertion of contact lenses, should be carried out in laboratories, storage rooms or any other facilities where chemicals or hazardous substances are stored, handled, or used for research, educational, or any other purpose.

*Universal Precautions:*

Universal precautions shall be practiced in each laboratory within which the potential exists for biological contamination or exposures. Please

*Use of Equipment and Glassware:*

Do not use damaged glassware. Use equipment only for its intended purpose. Laboratory equipment and glassware shall be handled with care in order to avoid breakage and potential injury. In cases where “explosion” or “implosion” may occur, use extra care with evacuated glass apparatus. Consider the use of shielding or wrapping to contain the release of chemicals and fragments. Broken glassware shall be disposed of with care in appropriately labeled and designated containers.

> NOTE: Laboratories using glassware should have special containers, clearly labeled, for the disposal of broken glassware. Broken glassware containers can be obtained from any lab safety supply vendor. Labs are responsible for proper containment and disposal of broken glass containers.

*Personal Hygiene Practices:*

Wash areas of exposed skin promptly and thoroughly whenever contact with chemicals or hazardous substances is suspected. Remove clothing or personal protective equipment (PPE) if contamination is

suspected or apparent. Decontaminate work clothing or PPE in accordance with an established schedule and procedure. At the end of all work procedures, wash hands thoroughly with soap and water.

NOTE: Remove or change gloves before leaving the laboratory or answering phones. Leaving the laboratory while wearing contaminated PPE may contaminate non-lab locations. In the event that gloves are absolutely needed, use the One Glove Rule.

*Personnel Apparel:*

Do not wear loose fitting clothes or jewelry, which may become caught in moving mechanical parts, or clothing that may inadvertently dip into containers of chemicals and other materials. Wear clothing that provides maximum skin coverage. Do not wear light weave fabrics since rapid chemical penetration can occur. Sandals and various types of perforated or open-toe shoes are **PROHIBITED** in the lab area because of the limited protection they provide in case of a spill. No one should be permitted to enter or continue work in any laboratory while bare footed.

*Use of Personal Protection Equipment (PPE):*

Typical PPE required for laboratory operations include - goggles, glasses and face shields; gloves and aprons; respirators and boots. Always refer to the Safety Data Sheet (SDS) for required PPE **PRIOR TO** working with any chemical.

Eye protection must be worn by all persons, including visitors, in locations where chemicals or hazardous substances are stored, handled, or used, and the potential for eye injury exists. Eye protection must be approved [ANSI Z.87.1] for the type of exposure anticipated. Special eyewear is required for work with lasers.

Wear appropriate gloves when the potential for contact with toxic materials exists. The style of glove and the type of material from which the glove is made should be selected based on type of chemicals or substances handled, quantities to be used, potential for contact, permeation of the chemical through the glove and degradation of the material. Please contact EH&S for assistance in the selection of suitable type gloves or other PPE. Refer to the EH&S Gloves Guide for a list of different types of gloves and the protection provided.

Discard disposable gloves after every use. Do not save and reuse. Reusable gloves must be washed with soap and water before removal. Gloves should be inspected for tears and pinholes before each use. New gloves should also be inspected before initial use. Inspect gloves during use and replace immediately if rips observed. Under no circumstances should a student or employee leave a chemical use area while wearing contaminated gloves. Remove and/or replace gloves prior to leaving the work area. Gloves should be removed when picking up a telephone or using equipment others may touch barehanded.

All laboratory apparel should be selected with appropriate consideration to the possibility of chemical or hazardous substances contact.

*Practical Jokes:*

Practical jokes or any other behavior, which may distract or potentially cause physical harm to others, should be avoided. Running, jumping, or rushing around should be avoided in laboratories or where chemicals or hazardous substances are being handled or stored.

*Skin Contact:*

Skin contact with chemicals or hazardous substances shall be avoided under all circumstances. In case of

skin contact, wash with plenty of soap and water. If redness or itching develops, consult a physician immediately.

*Eye Contact:*

Protection for the face and eyes shall be provided where the potential for hazardous exposure exists. Wear approved safety eyewear when the potential for eye injury exists. In case of eye contact with chemicals, flush eyes with plenty of water for a minimum of 15 minutes. Consult physician if necessary.

*Housekeeping:*

The work area shall be maintained uncluttered. Chemicals, hazardous substances, and equipment shall be labeled. Glassware and other apparatus should be cleaned at the end of each work session and stored properly. Corridors and passageways shall be maintained free of tripping hazards. Inappropriate storage of materials in hallways, exit routes, or in any such manner that emergency equipment may be obstructed, or emergency evacuation hampered, is strictly prohibited. Contact FIU Surplus Property at 7-2799 to surplus items that are no longer needed. **NOTE:** Property Control will not accept any items that have not been sanitized by the user and approved by EH&S.

*Unattended Operations:*

A thorough hazard analysis shall be conducted for any experiment or project which is planned to operate unattended. Hazard analysis of unattended operations, which reveals an above average degree of risk, should be avoided. When such operations are required, the following minimum precautions shall be considered: leave lights on; place an appropriate information at the door that includes the name(s) and phone number(s) of personnel, including alternates, to be contacted in an emergency; activity being performed, provide for secondary containment of toxic substances in the event of failure; consider the use of monitoring alarms, and leave view panel unblocked with a clear view into the lab from outside.

*Children:*

Prudent laboratory safety practices prohibit the presence of children and infants in areas that have a potential for exposure to radioactive materials, toxic or hazardous chemicals, and infectious agents. University policy prohibits the presence of minors in research laboratories unless approved by Human Resources, ORED, and EH&S. Please refer to the Minors in the Laboratory Policy for more information.

*Vacuum and Pressure Operations:*

Planning for proper and safe procedures for the operation of vacuum and pressure equipment, including but not limited to explosion shields and facemasks is required. The pressure differential created when laboratory apparatus is used at pressures above or below standard atmospheric pressure creates several potential hazards. The hazards most typically associated with high-pressure systems arise largely from failures caused by leaks, pulsation, vibration, and over exposure. Do not indiscriminately rely on pressure gauges. Pressure gauges should be checked and recalibrated on a regular basis.

The hazards most typically associated with an evacuated system in which the higher pressure is on the outside, rather than on the inside, arise from implosions rather than explosions. The resulting hazards include flying glass, spattered chemicals, and possibly fire.

> NOTE: Water, solvents, or corrosive gases should not be allowed to be drawn into a building vacuum system. When the potential for such a problem exists, a water aspirator is recommended to be used as the vacuum source.

Mechanical vacuum pumps should be protected by using cold traps, and their exhausts should be vented to an exhaust hood or to a safe location outside of the building.

# 3.0 HEALTH AND SAFETY TRAINING REQUIREMENTS

The most important element of the FIU Chemical Hygiene Plan is awareness. Individuals who are knowledgeable and properly trained are better able to identify and minimize hazards and unhealthful exposures for themselves and their peers. Each laboratory worker is accountable to assure that he or she has sufficient information to proceed with the tasks assigned. Further, 29 CFR 1910.1450 and 29 CFR 1910.1200 specifically mandate the following:

- Safety training at the time of initial assignment.
- Safety training prior to assignment involving new exposure situations (i.e., new chemical use & handling, equipment, or technology).

NOTE: Training program outlines shall, at minimum, include the following:

- General laboratory safety rules.
- Emergency response procedures; laboratory and building evacuation procedures; response to medical emergencies and emergency notification procedures.
- Methods to detect the presence (above acceptable levels) or release of hazardous substances in the work area.
- Physical and health hazards of materials, equipment or technology being used.
- Measures to protect the individuals from unhealthful exposure.
- Details of the University's, the department's, or the laboratory's written Hazard Communication Program.
- Details of the University's, department's, or the laboratory's written Laboratory Safety Program.
- The requirements of specific safety standards for operations in the laboratory, such as radioactive materials, lasers, infectious agents, etc.

**All laboratory safety training provided to students or laboratory personnel shall be documented and maintained on record at each lab location for a minimum of three years.**

Training records shall include the name and title/qualification of the trainer, the date and time of the training, an outline of the content of the training provided, and an attendance register with the names and (student) identification numbers/social security numbers of attendees.

Resources available from EH&S include fully interactive online safety training courses that meet applicable regulatory requirements. Please refer to the following:

- EH&S Training Webpage
- Required Laboratory Safety Training Matrix

**ALL** laboratory personnel, at a minimum, are required to take the following trainings:

1) Laboratory Hazard Awareness (refresher every 2 years)
2) Hazard Communication (HAZCOM) (refresher every 2 years)
3) Fire Safety (refresher every 2 years)

Additional resources available from EH&S includes classroom safety training courses which are available to University faculty, staff, or students. For questions, please email ehstrain@fiu.edu.

## 3.1 EMPLOYEE RIGHT-TO-KNOW STANDARD

University laboratories are loaded with chemicals with properties that can cause illnesses, injury and even death to those who may be exposed to them in quantities in excess of safe threshold. In an attempt to protect employees (and all affected persons) who may be exposed to these chemicals in the workplace, the Hazard Communication Standard (adopted by the State of Florida under the authority of Chapter 442, Florida Statutes, as the Florida Right-to-Know standard) was promulgated.

The Right-to-Know Standard requires a full evaluation of all chemicals in the workplace, especially laboratories, for possible physical or health hazards, and that any such hazards are identified and communicated to employees or those who could reasonably be expected to be exposed.

The areas specifically covered in the Standard include:

1. Determining the hazards of chemicals
2. Providing Material Safety Data Sheets
3. Assuring proper and appropriate labeling practices
4. Hazard controls
5. Employee Training
6. Maintaining a written Hazard Communication Program

The FIU Laboratory Safety Program requires the application of each of these six requirements to all hazardous materials or agents (chemical, biological, radiological, etc.) acquired, used, stored, or held for disposal at any University operated laboratory. For area-specific hazard communication plans, you can utilize this EH&S template.

**Each department is strongly encouraged to develop an area-specific written Hazard Communication Program**.

Safety Data Sheets (SDS) are available for chemicals only therefore, the manufacturers' specifications, regulatory or consensus standards, safety guidelines and publications, or similar such fact sheets shall be made available for other materials used in laboratories.

Safety Data Sheets (SDS) Sections as per ANSI:

| | |
|---|---|
| Section 1 | Chemical Product & Company Information |
| Section 2 | Composition/Information on Ingredients |
| Section 3 | Hazards Identification |
| Section 4 | First Aid Measures |
| Section 5 | Fire Fighting Measures |
| Section 6 | Accidental Release Measures |
| Section 7 | Handling and Storage |
| Section 8 | Exposure Controls/Personal Protection |
| Section 9 | Physical and Chemical Properties |
| Section 10 | Stability and Reactivity |
| Section 11 | Toxicological Information |
| Section 12 | Ecological Information |
| Section 13 | Disposal Considerations |
| Section 14 | Transport Information |
| Section 15 | Regulatory Information |
| Section 16 | Other Information |

Each laboratory must maintain a current chemical inventory and update it at least once a year via the EHS

Chemical Inventory Tracking System. Additionally, Safety Data Sheets must be maintained as required.

NOTE: Several web sites make safety data sheets available to browsers and may be accessed from the laboratory via the internet, however the laboratory manager or principal investigator, may choose to maintain hard copies of Safety Data Sheets in the laboratory.

*Signs, Placards and Labels:*

Laboratories shall display, in readily visible locations, signs that provide information to visitors, building service and maintenance personnel, and general building occupants regarding the hazards in the laboratory.

Each department must ensure that all employees can read and understand the Globally Harmonized System of Classification and Labelling of Chemicals (GHS), the standardized 16-section safety data sheets (SDS), and the elements of container labels.

Where informational signs or placards are posted, and such information is relevant to the health, safety and wellbeing of building services personnel, Environmental Health & Safety strongly recommends that such signs should be in English **AND** Spanish. Symbols should carry a sub-text for clarification. Color-coding for signage shall be as "recommended" by 29 CFR 1910.145(f). These recommendations are as follows:

| | |
|---|---|
| "DANGER" | Red, or predominantly red, with lettering or symbols in a contrasting color. |
| "CAUTION" | Yellow, or predominantly yellow, with lettering or symbols in a contrasting color. |
| "WARNING" | Orange, or predominantly orange, with lettering or symbols in a contrasting color. |
| "BIOLOGICAL HAZARD" | Fluorescent orange or orange-red, or predominantly so, with lettering or symbols in a contrasting color. |

Labels from the manufacturer must have product identifier; signal word (Danger, Warning); hazard statement; precautionary statements; supplementary information; and a pictogram (see graph below).

GHS Symbols:


General hazard signs, Radiological signs, and Biohazard signs may be obtained from EH&S.

NOTE: EH&S strongly recommends that signs are posted at eye level on the outer side of the main entrance to the laboratory. If there is more than one entrance to the laboratory similar signs must be posted on the outside of each door. Safety signs shall not be used to block view panels.

*Labels:*

A label is any written, printed, or graphic material displayed on, or affixed to containers. Labels, or other forms of hazard warnings, such as tags or placards, provide immediate warning of potential danger. Each container of chemical in which the contents are expected to remain for more than a single use shall be clearly labeled. Damaged labels shall be replaced, as necessary. All labels must follow the GHS requirements. Hazard Communication Standard Labels can be found at OSHA's HAZCOM Webpage.

The OSHA's Hazard Communication Standard has established minimum labeling requirements for most chemical containers in the workplace. All chemical containers shall be labeled according to these requirements, which are as follows:

**Labels must contain the following:**

- Common and scientific name of the chemical.
    - NOTE: Chemical formulas and structural formulas alone are not acceptable, except for labeling the container in which small quantity of a compound synthesized in the laboratory is stored.
- Physical and health hazards.
- Appropriate handling precautions.

Existing labels on new containers of chemicals or containers in storage shall not be removed or defaced. Containers shall display original labels from manufacturer/distributor. These labels shall bear the name and address of the manufacturer.

Employees and students should not work with any chemical from an unlabeled container. However, portable containers intended for immediate use, by the employee or student who performed the transfer, do not (necessarily) need to be labeled.

> NOTE: This labeling requirement does not apply to students assigned unknown chemicals for analysis. However, hazard information should be provided with all unlabeled chemicals distributed for analysis in student laboratories. Any portions remaining after the class or the experiment has concluded shall be labeled or appropriately discarded (in accordance with regulations). Unlabeled chemical containers shall not be left unattended at the conclusion of classes or experiments.

All containers of carcinogens, reproductive hazards or acutely toxic reagents shall be properly labeled with the health hazard of the reagent. Most new reagent containers will usually have the chemical hazards clearly displayed on the label. However, particular care is required to assure thorough and proper labeling of these substances when transferred to other containers.

The SDS usually provides additional information beyond that which is provided on the manufacturers'/distributors' label. Laboratory personnel are required to become familiar with information on labels and SDSs. Each lab must have a copy of the SDS for each chemical used in their lab. This copy can be a hard copy or a digital one. As long as it is easily accessible to all lab staff.

> NOTE: New chemicals shall not be ordered, used, or stored unless proper prior consideration has been given to associated health and safety hazards and the appropriate exposure control procedures.

For more information, please see OSHA Regulations (Standards - 29 CFR) Hazard Communication. Standard Number: 1910.1200

# 4.0 PERSONAL PROTECTION

The use of personal protective equipment (ppe) does not substitute for good engineering and administrative controls, or good work practices. Personal protective equipment shall be considered as a last resort, to be used in conjunction with other controls that ensure the safety and health of employees and students. Always consult the SDS (section 8 – personal protection) to determine the proper protective equipment for each material to be used.

NOTE: All costs associated with outfitting employees with personal protective devices required for their work shall be paid by the employing department. Individual University departments shall establish procedures regarding acquisition of personal protective equipment for students.

Examples of engineering and administrative control practices which may serve to reduce the need or dependence on personal protective equipment are the following:

- Substitution of a less hazardous substance.
- Substitution of a less hazardous equipment or process.
- Isolation of the operator or the process.
- Use of local and/or general ventilation.
- Laboratory worker education and training.
- Limiting length of work period.

NOTE: The use of personal protective equipment is required whenever the determination has been made that the implementation of engineering and/or administrative controls is neither possible nor adequate to protect the individuals from injury and/or illness.

## 4.1 EYE PROTECTION

Prevention of eye injuries requires that all persons who may be potentially exposed to hazards to the eye wear protective eyewear. This includes employees, students, visitors, researchers, contractors, building service personnel, inspectors and any others passing through an area identified as an eye hazard area.

NOTE: The appropriate type of eye protection shall be provided for employees and students who are exposed to hazards. These hazards include but are not limited to flying particles, molten metal, acids or caustic liquids, gases or vapors, bio-aerosols, or potentially injurious light radiation.

Standard eye protection includes:

*Safety Glasses:*

They are designed to be resistant against flying particles, water, or chemicals from striking the eyes. The lenses of safety glasses are impact resistant and the frames are stronger than regular glasses.

They may be fitted with side shields, cups, or tinted lenses to offer additional protection. Safety glasses are required to meet the standards of the American National Standards Institute (ANSI).

NOTE: Safety glasses are also available in prescription form for those persons who need corrective lenses. Individuals who wear contact lenses are also required to wear appropriate eye and face protection devices.

*Safety Goggles:*

Goggles are impact resistant and are available in tinted lenses. They provide a secure shield around the entire eye area in order to protect against hazards coming from many directions.

*Face Shields:*

Face shields are not intended to serve as the primary protective eye wear; however, they are frequently used in conjunction with eye protectors to provide additional degrees of protection. Full-face shields are often used when the potential exists for exposure to chemicals, heat, or glare hazards.

NOTE: Other eye and face protection equipment may be necessary for specific circumstances

not mentioned here.

*Eyewear Use & Selection Guidelines:*

When selecting protective eyewear, consider the following:

- Side protectors shall be used when there is a hazard from flying objects.
- Goggles and face shields shall be used when there is a hazard from chemical splash.
- Eyewear shall be suitable for the hazard (e.g., for the type of laser radiation).
- Face shields shall only be worn over primary eye protection (safety glasses or goggles).
- Individuals who wear require corrective lenses shall either incorporate the prescription into the design of protective eye wear or assure that eye protector fit properly over their prescription lenses.
- Eye protective devices shall bear the manufacturer's marking to assure they are approved for type usage.

NOTE: Equipment fitted with appropriate filter lenses shall be used to protect against light radiation. Tinted and shaded lenses are not filter lenses unless they are marked and identified as such.

## 4.2 RESPIRATORY PROTECTION

Respirators are used to prevent inhalation of air contaminants such as dusts, fumes, mists, vapors, and gases that may be hazardous. Positive pressure respirators can also supply breathable air in oxygen-deficient atmospheres.

Standard respiratory protective equipment include:

- Particle-removing air purifying respirators.
- Gas and vapor removing air-purifying respirators.
- Supplied-air respirators.

*Air Purifying Respirators:*

Mechanical filter respirators are used for particulate matter. Chemical cartridge respirators are used for gaseous contaminants. A special subcategory of air purifying respirators is the Powered Air Purifying (PAPR) type. PAPRs are positive pressure devices that use a blower to force contaminated air through a filter or cartridge. PAPRs are powered by portable rechargeable battery packs. The respirator selected must be appropriate for the chemical and physical state of the contaminant for which protection is required.

*Supplied Air Respirators:*

Supplied air respirators provide uncontaminated air from a source independent of the surrounding atmosphere, via an air-line. Air supplied respirators can be fed from air tanks carried by the user or from a piped air-line specially dedicated for this purpose.

The appropriate type respirators shall be provided for all employees when contaminant exposures can reasonably be expected to exceed or have been shown to exceed established thresholds.

NOTE: Respirators are the option of last resort. Engineering and administrative control must be evaluated and exhausted before reliance is placed upon respirators.

The principal investigator or laboratory manager of any location where employees and/or students are required to use respiratory protection shall assure full compliance with the requirements of the Respiratory Protection Standard, as prescribed in 29 CFR 1910.134. The basic components of the program are:

- Established guidelines for respiratory selection.
- Description of the medical evaluation program (fitness to wear respirator).
- Fit testing protocols.
- Procedures for proper use of respirators.
- Procedures for proper maintenance of respirators.
- Hazard communication training for wearers.
- Program evaluation and update.

NOTE: Employees or students may voluntarily choose (in the absence of a recognized hazard) to wear a respirator for protection from any substance which may be particularly bothersome to them or about which they hold an individual concern. All students and employees shall be afforded this option; however the employing department is not required to assume costs for purchasing the device, but shall maintain responsibilities for "minimal training" assurance of medical fitness to wear respirators, establishment of a program to assure proper storage, cleaning, maintenance and repair of the devices.

**IMPORTANT:** Respirator use requires enrollment in the FIU Respirator Program and completion of a fit test. For more information, visit the EH&S Respirator Safety Webpage, or contact EH&S at 305-348-2621.

## 4.3 SKIN PROTECTION

Attire for work in laboratories should be selected with the intent to provide protection that covers areas of the skin that may be exposed to hazardous substances. Gloves, laboratory coats and proper attire provide skin protection.

*Gloves:*

Skin contact is a potential route of exposure to toxic materials. Most injuries to the hands and arms have been shown to arise from one of the following: chemical exposure, abrasions, cutting, and heat. Various types of gloves are available that can protect workers from each of these hazards or any combination thereof.

Gloves should be selected based on the hazard and should be replaced periodically, depending on frequency of use, the permeability rating and or the manufacturer's recommendations.

In addition to the typical hazards of the chemical and research laboratories, gloves should also be worn whenever it is necessary to handle rough sharp-edged objects, and very hot or very cold materials. The type of gloves applicable to protection from these exposures includes leather, welder's gloves, aluminum-backed gloves, and other types of insulated glove materials.

Careful attention should also be given to protecting the hands when working with tools and machinery. Power tools and machinery must have guards installed or incorporated into their design that prevent the hands from contacting the point of operation, power train, or other moving parts. The following rules shall apply to the use of machinery and power tools:

- Ensure that guards are always in place and used.

- Always lock-out machines or tools and disconnect the power before making repairs.
- Tag-out any machine without a guard, where a guard was a part of the original design, as inoperative and discard or replace.
- Do not wear gloves around moving machinery, such as drill presses, mills, lathes, and grinders.
- Shut down equipment when not in use, to prevent inadvertent use by others. If equipment is not fully operational and represent a hazard when turn on the equipment must be lockout/tagout.
- Follow Lockout/tagout procedures when applicable; for more information on the LOTO (lockout/tagout) process, see OSHA 1910.147. You can also visit the EH&S LOTO Webpage.

The following is a guide to the most common types of protective work gloves and the types of hazards they can guard against:

| | |
|---|---|
| Disposable Gloves | Disposable gloves, usually made of lightweight plastic, protect against mild irritants. |
| Fabric Gloves | Made of cotton or fabric blends are generally used to improve grip when handling slippery objects. They also help insulate hands from mild heat or cold. |
| Leather Gloves | These gloves are used to guard against injuries from sparks or scraping against rough surfaces. They are also used combination with an insulated liner when working with electricity. |
| Metal Mesh Gloves | These gloves are used to protect hands from accidental cuts and scratches. They are used most commonly by persons working with cutting tools or other sharp instruments. |
| Aluminized Gloves | These gloves are made of aluminized fabric are designed to insulate hands from intense heat. These gloves are most commonly used by persons working with molten materials. |
| Chemical Resistance | These gloves may be made of rubber, neoprene, polyvinyl alcohol, or vinyl. The gloves protect hands from corrosives, oils, and solvents. |

Refer to the EH&S Gloves Guide, which provides a guide for the selection of different types of gloves and the chemicals for which they provide protection against. When selecting chemical resistance gloves, be sure to consult the manufacturer's recommendations, especially if the gloved hand will be immersed in the chemical.

*Laboratory Coats:*

The laboratory coat can be used to protect street clothing against biological or chemical spills as well as to provide additional body protection. The specific hazard(s) and the degree of protection required must be known before selecting coats for laboratory personnel. Disposable laboratory coats need to be used and disposed of properly during all direct laboratory animal handling work.

NOTE: To prevent the spread of contamination from laboratory coats and contaminated gloves, these items shall be removed, and hands properly washed before leaving the laboratory.

*Clothing:*

Long sleeve shirts are recommended. Shorts or other type clothing which leave skin exposed to chemical contact shall not be worn. Sandals or any type of shoe that partially expose the feet are **STRICTLY PROHIBITED** in the laboratories. Any clothing item that becomes contaminated with chemicals must be decontaminated before reuse or must be disposed as recommended on the chemical's material safety data sheet. If clothing becomes contaminated with more than one chemical, the item must be handled and disposed according to the instructions applicable to the most hazardous chemical.

NOTE: Gloves overtly contaminated should be rinsed and then carefully removed after use.

*Manufacturer's Recommendations:*

In all cases the use of personal protective equipment shall be consistent with manufacturer's recommendations, industry practice, proper hygiene, and specific task safety considerations.

# 5.0 MEDICAL EVALUATION AND CONSULTATION

Evidence of employee exposure is a clear signal calling for examination, identification, and possible revision of the laboratory practices that may have contributed to the exposure.

It is the responsibility of each principal investigator and/or instructor to identify, in the planning stages of each research undertaking or experiment, the need to **implement or request** medical monitoring for any and all laboratory workers whose work will involve regular and frequent handling of toxicologically significant quantities of material known or suspected to be acutely or chronically toxic.

NOTE: Environmental Health & Safety recommends baseline medical evaluations for all persons who will be working with particularly hazardous substances, prior to the commencement of any such project or experiment.

Guidelines specific to medical monitoring stipulate that the following information shall be placed in each employee or student file, as such may be relevant:

(a) reports of accidents that have resulted in the following exposures:
    (i) inoculation of hazardous substances through cutaneous (skin) penetration,
    (ii) ingestion of hazardous substances,
    (iii) inhalation of hazardous substances, and
    (iv) any incident resulting in overt exposure of the employee or student to hazardous substances.
(b) results of any surveillance procedures employed; and
(c) results of environmental measurements of hazardous substances that may have been made within the employee's or student's work environment.

## 5.1 MEDICAL MONITORING

Each principal investigator and/or instructor shall consider the following in making the determination to implement or request medical monitoring for employees or students who will be involved in the research undertaking or experiment:

- The identity of the hazardous chemicals to which the employee or student may have been exposed.

- The potential health effect of the chemical to be used.
- An evaluation of the conditions under which the exposure may occur.
- A description of the signs and symptoms of exposure that the employee or student may exhibit.

Medical evaluation of laboratory workers is available as a component of the FIU Medical Surveillance Program. Medical examinations and consultations are performed by a licensed and qualified physician or under a physician's direct supervision at such frequencies as determined to be necessary.

For additional information regarding the FIU Medical Surveillance Program, please contact Environmental Health & Safety at 305-348-2621, or you can visit the EH&S Occupation Health and Safety Webpage.

## 5.2 MEDICAL SURVEILLANCE

Employees and students who work with hazardous chemicals are required to be provided with the opportunity to contact/consult with a licensed and qualified physician:

- Whenever an employee or student develops signs or symptoms associated with a chemical to which the employee may have been exposed.
- When a routine monitoring of the work area reveals an exposure above approved personal exposure limits.
- When an event takes place in the work area such as a spill or leak, explosion, or other occurrences where in there is a likelihood of an acute exposure to a hazardous agent.
- When OSHA mandates this, based on the materials being used.
- When EH&S determines that an individual assessment should be made with respect to specific hazardous substances or specific experiments.

## 5.3 RECORD KEEPING

The results of any laboratory tests, biological monitoring, physical examinations, and diagnosis shall be kept on record by the attending medical practitioner.

A written medical opinion to the administrator of the medical surveillance program shall include only the following:

- Any recommendation for further medical follow-up including periodic biological testing.
- A description of the results of the examination and any associated tests.
- Any medical condition that is revealed during the examination that may place the employee at increased risk, if exposed to a hazardous substance in the workplace.
- A statement that the employee has been informed by the physician of the results of the examination and any medical condition which may require further evaluation or treatment.

NOTE: Departments which choose to administer their own medical monitoring/surveillance programs are required to comply with all the requirements of the relevant laws.

Specific diagnosis unrelated to occupational exposure shall not be revealed to anyone except the employee. All records related to employee medical status shall be maintained confidential in accordance to HIPAA requirements.

## 5.4 FIRST AID

The following guidelines must be followed when using first aid kits and applying first aid to employees or

students:

- Assure First Aid Kits are visible, accessible, and appropriately stocked.
- Do not dispense or administer any medication, including common pain relievers to another person.
- Do not put any ointments or creams on wounds or burns. Use ice, a cold pack or cold water.
- Consult the SDS for first aid information.
- Student (or employees) requiring first aid may seek treatment at FIU Student Health Services.
- FIU Police Officers are trained and certified in the administration of first aid. Notify University Police of all emergencies.
- Request First Aid training from EH&S or other resources. To schedule training or for more information, contact the Safety Training Coordinator at 305-348-1421 or ehstrain@fiu.edu.

# 6.0 HOUSEKEEPING AND MAINTENANCE

Good housekeeping in laboratories is essential to reduce risks of accidents and injuries and to protect the integrity of experiments. Routine housekeeping should be relied upon to assure work areas free of sources of nuisance hazards which can subsequently mushroom into significant hazards, if left unattended.

## 6.1 HOUSEKEEPING GUIDELINES

Laboratory personnel are responsible for cleaning laboratory benches, equipment and any area that may require specialized technical knowledge. Additional housekeeping concerns include:

- Access to emergency equipment, safety showers, eyewash fountains and exits must never be blocked.
- All aisles, hallways, and stairs (egress paths) must be kept clear of obstruction and chemical storage, as required by fire codes enforced by the State Fire Marshall's Office.
- Attention must be paid to electrical safety, especially as it relates to the use of extension cords, proper grounding of equipment, overloading of electrical circuits and electrical hazards related to wet work.
- Original labels on containers must be protected so that the identity of the contents and the hazards are known.
- Containers into which chemicals have been transferred, from an original container, must be labeled according to Section 3.1 of this Chemical Hygiene Plan.
- All chemicals must be replaced in their assigned storage area prior to leaving the area at the end of each workday/schedule.
- All working areas and floors must be cleaned regularly, kept dry and free of tripping hazards.
- **DO NOT** use laboratory floors and bench tops for storage of equipment and materials.
- Secure all gas cylinders properly.
- Never use fume hoods for storage of chemicals or other materials.
- Maintain laboratories free of excess, unused, or old chemicals by periodically requesting a hazardous waste pick-up. Please refer to the Hazardous Waste Management Plan for details on managing all types of waste.

## 6.2 MAINTENANCE

Maintaining laboratory facilities in a safe and operable condition requires all laboratory personnel to become and remain proactive rather than reactive. Most equipment and devices used in teaching and research facilities are required, by the manufacturer, to be serviced, calibrated, or cleaned at specified intervals. Failure to follow these guidelines invariably results in failure of the equipment and "emergency situations".

The Facilities Management Department is responsible for completion of work orders for repairs and correction of facilities maintenance concerns arising in laboratories, however you must initiate the process by reporting unsafe conditions.

NOTE: Principal investigators and laboratory personnel may place work orders by calling 305-348-4600 (MMC) and 305-919-5565 (BBC), via email at workmgmt@fiu.edu, or online at https://myfacilities.fiu.edu/.

## 6.3 LABORATORY INSPECTIONS

Laboratory safety inspections are conducted by Environmental Health & Safety at all University campuses to help assure a safe environment is maintained for employees and students.

Each laboratory is inspected routinely, by Environmental Health & Safety personnel, according to the frequency established under the Laboratory Safety Risk Assessment Program. The Laboratory Safety Program evaluates laboratories on a case-by-case basis in order to determine an appropriate inspection frequency based on the degree of hazard and the compliance history of each location.

Inspection items include general housekeeping, proper ventilation, compressed gases storage, Right- to-Know compliance procedures, hazardous waste management practices, chemical storage, proper use of signage, access to means of egress, electrical and radiation safety.

In addition, each lab space is required to complete the annual Lab Self Audit (LSA). The Lab Self-Audit (LSA) is a mandatory self-inspection program for FIU's laboratory community intended to cultivate a proactive approach to safety and regulatory compliance in all laboratory working environments. Conducted annually through an online survey, this program supports the lab community by:

- Promoting individual accountability for safety and regulatory compliance
- Encouraging a proactive approach to environmental health and safety issues
- Facilitating a better understanding of regulatory compliance
- Reducing lab-related incidents/injuries/violations/fines through encouraging effective communication and training

The LSA audit is designed to identify safety and compliance concerns and implementing corrective actions. Submissions are reviewed by EH&S to verify whether safety equipment, standards, and practices are in place as required by governing regulatory agencies and institutional policies. The LSA is used in conjunction with the EH&S inspections to identify compliance concerns/deficiencies and allows EH&S to assist in implementing corrective actions by educating the lab users on best laboratory practices and procedures.

### 6.3.1 SAFETY VIOLATIONS

Safety violations found during routine inspections are recorded and reported to the Laboratory Manager or Principal Investigator for corrective action. The amount of time designated for corrective actions is based on the following criteria. **NOTE:** Extensions may be provided on a case-by-case basis for corrective actions that are outside of the control of the user (fume hood repair, facility renovation) OR if the user is currently working with EH&S to resolve the violation:

- *Critical* - imminent danger to health, safety or environment; immediate stoppage of activities until the violation is corrected and approved by EH&S/ORED
- *Serious* - serious hazard to health, safety or environment if left uncorrected; up to 48 hours to correct the violation.
- *Moderate* - no immediate risk to health, safety or environment, but is a compliance issue (training records, SDS, labeling); up to 2 weeks to correct the violation.
- *Minor*- no immediate risk to health, safety or environment (general signage, housekeeping); up to 30 days to correct the violation.

Failure to resolve the violation in the allotted amount of time OR to provide updates to EH&S will result in escalation and possible closure of the lab space.

## 6.4 LABORATORY CLOSEOUT PROCEDURE

Principal Investigators or laboratory supervisors are responsible for "Cradle to Grave" management of all hazardous materials in their laboratories, therefore it's important that they follow appropriate laboratory closeout procedures prior to separation from the University, relocation to a new lab, or disposal of specialized laboratory equipment.

*Vacating Procedure:*

The following procedure should be completed before the responsible individual leaves the university or transfers to a different location on campus. Refer to the Laboratory Relocation Procedures on the EH&S Chemical Safety Webpage for additional forms and information:

- Assure that all containers of chemicals are labeled with the name of the chemical.
- All containers must be securely closed. All laboratory glassware must be emptied and cleaned.
- Equipment and chemical inventory must be updated.
- Hazardous chemical wastes must be collected and labeled for disposal. Please contact Environmental Health & Safety for pick-up **at least two weeks prior to** vacating the laboratory to assure proper coordination prior deadline.
- Check refrigerators, freezers, ovens, fume hoods, storage cabinets and bench tops for hazardous materials, biohazardous materials and cultures and thoroughly clean these locations.
- Assure all electrical equipment is turned off and the cords unplugged from their outlet.
- Chemicals that may still be used must be removed, redistributed through EH&S, or specifically transferred to another principal investigator or laboratory manager. Contact EH&S at 305-348-6849 for more information.
- Gas cylinders must have the regulator removed and the cap secured in place. Return cylinders to the supplier, or transfer as described above.
- Submit the signed Laboratory Closeout Activity Checklist form to EH&S at least two weeks prior to the scheduled laboratory shutdown date.

*Vacating Inspection:*

Upon receipt of the Laboratory Closeout Activity Checklist, Environmental Health & Safety will schedule an inspection with the current principal investigator or laboratory manager to evaluate vacating conditions and will issue a clearance report based on the findings.

# 7.0 LABORATORY SAFETY EQUIPMENT

Several pieces of equipment play an important part in the protection of students and employees in the research and teaching laboratory.

## 7.1 SAFETY SHOWERS

It is the responsibility of each laboratory worker and student to identify and familiarize themselves with the location of, and the route to the safety shower in their work area. Every employee and student should learn the location of safety showers so that it can be found with eyes closed, if necessary.

Showers are capable of providing a thorough drenching. They are equipped with a quick-opening valve to provide continuous water flow.

NOTE: The quick-opening valve requires manual closing to stop the flow of water.

Safety showers are provided in areas where chemicals are handled and where the potential for an exposure to hazardous materials may require immediate first aid treatment.

Safety showers are inspected and tested annually by Environmental Health & Safety personnel. They are checked for valve operability, water flow, accessibility, and housekeeping in the surrounding area. Inspection dates are recorded on the safety shower inspection tag attached to each safety shower.

More frequent tests, by laboratory personnel, are recommended to ensure that the valve is operable and to remove any debris in the system.

NOTE: Testing requires special equipment or the willingness to be drenched.

## 7.2 EYEWASH STATIONS

It is the responsibility of each laboratory worker and student to identify and learn the location of and the route to the eyewash station in their work area so that they will be able to use these in an emergency. Every employee and student should learn the location of eye wash stations so that it can be found with eyes closed, if necessary.

Eyewash fountains are required if substances in use present corrosive hazards to the eye, or in research or instructional laboratories where unknown hazards may be encountered. Eyewash fountains should provide a soft stream or spray of aerated water for an extended period, at least 15 minutes.

Eyewash fountains are tested annually by Environmental Health & Safety personnel. Eyewash fountains are checked in conjunction with safety showers at dual installation locations. Eyewash stations are checked for valve operability, water flow, flow alignment, accessibility and general surrounding area housekeeping.

Environmental Health & Safety recommends weekly routine tests to be performed by laboratory personnel in order to assure operability and to remove debris.

## 7.3 LABORATORY FUME HOODS

Work that involves hazardous materials which are toxic, odoriferous, volatile, or harmful shall be conducted within a laboratory hood. The primary purpose of the laboratory hood is to keep toxic or irritating vapors and fumes away from the breathing zone of the researcher and out of the general laboratory circulation.

*Operating Guidelines:*

A laboratory fume hood is a ventilated enclosure in which gases, vapors, and fumes are contained and evacuated. Ductwork connects the hood to a fan that pulls contaminants out of the enclosure. Caution should be used to ensure that continuous air flow is maintained in a direction away from the user. Refer to the EH&S Fume Hoods Guidelines to help ensure safe use of a fume hood.

*Fume Hood Inspection Program:*

Fume hoods shall provide an average face velocity of 100 +/- 20 linear feet per minute to provide the necessary protection to users. Higher face velocities have been shown to cause turbulence that may push the contaminants back into the user's breathing zone. Lower face velocities may not adequately remove harmful contaminants.

FIU Facilities Management established a Laboratory Fume Hood Inspection Program to evaluate the performance of the laboratory fume hoods on a periodic basis and to initiate the necessary work required to correct deficiencies and malfunctions discovered during the inspections. The Program covers all University campuses.

The inspections involve the use of properly calibrated anemometer and smoke tube tests as well as checking of light switches, gauges, general physical condition, and housekeeping within the hood. Fume hoods are inspected at annually.

Any issues with laboratory fume hoods should be reported to Facilities Management via phone (7-4600), email workmgmt@fiu.edu, or online https://myfacilities.fiu.edu/. If a fume hood is not working properly, cease the use of the fume hood and contact Facilities Management immediately.

## 7.4 FIRE EXTINGUISHERS

Fire extinguishers are distributed as per code requirements and although fire extinguishers are accessible from a reasonable travel distance, not all laboratories contain a fire extinguisher inside the laboratory. At the request of laboratory managers or principal investigators additional fire extinguisher can be made available. As a general rule, laboratories are provided with ABC fire extinguishers unless specific laboratory conditions require another type. Fire extinguishers are strategically located in laboratory hallways and other locations throughout the University, in accordance with National Fire Protection Association (NFPA) guidelines.

NFPA Fire extinguisher inspection guidelines dictate monthly inspections. However, EH&S Standard Operating Procedures discourage staff access to research and teaching laboratories where principal investigators and laboratory managers may not be present at the time of inspection, as such the monthly inspection frequency is not always strictly maintained.

## 7.5 FIRE ALARMS

Fire alarms, pull stations, horn and strobes are located in hallways and other locations throughout the

University. Do not block access to, or visibility of fire alarm pull stations. All occupants shall be advised when and how to activate alarms.

### 7.6 EMERGENCY TELEPHONES

All teaching and research laboratories shall be provided with telephones or similar type communication devices for emergency use. Laboratories are required to maintain an emergency contact list posted by the exit door. This list shall include telephone numbers of principal investigator, laboratory manager, University Police, Environmental Health & Safety, and any other contacts determined to be useful in case of an emergency. If a lab space is missing an emergency phone or if the phone is not working properly, please contact the Department of Emergency Management at dem@fiu.edu.

## 8.0 ENVIRONMENTAL MONITORING

### 8.1 AIR QUALITY

Air is, in essence, invisible. Contrary to the popular saying of "what you can't see can't hurt you", contaminated air can hurt you. Therefore, the quality of air in the laboratory environment, and its potential to affect human health must be a concern to which laboratory personnel, and those who occupy spaces in proximity to research and teaching laboratories, apply great vigilance. Reliance on the sense of smell in order to determine the presence of a contaminant is not acceptable and reckless.

### 8.2 AIR CONTAMINANTS

Many factors are responsible for the effects of chemicals on our human body, however the most important factor that determines the safeness or harmfulness of any substance is the dose (amount) the body absorbs. The amount of a chemical absorbed is function of the duration of exposure to the chemical, the concentration of the chemical, and how often exposure takes place.

The effect of a chemical on the body may produce either acute or chronic toxicity. Acute toxicity results in conditions that are readily apparent. Chronic toxicity usually does not produce effects until exposure has continued for some time. A single chemical may produce both acute and toxic effects.

Environmental Health & Safety recommends periodic air sampling for all laboratories that use chemicals which present inhalation hazards (see label or SDS). More specifically the Occupational Health & Safety Administration admonishes that exposure to any substance listed in Tables Z-1, Z-2 and Z-3 (Refer to *Appendices K, L, and M*) of 29 CFR part 1910 subpart Z shall be limited in accordance with the following:

- Table Z-1

    1) Substances with limits proceeded by "C" – Ceiling values.

        Exposure to any substance in Table Z-1, the exposure limit of which is preceded by a "C", shall at no time exceed the exposure limit given for that substance. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute time weighted average exposure which shall not be exceeded at any time during the working day.

    2) Other substances – 8-hour Time Weighted Averages.

        Exposure to any substance in Table Z-1, the exposure limit of which is not preceded by a

"C", shall not exceed the 8-hour time weighted average given for that substance in any 8-hour work shift of a 40-hour work week.

- Table Z-2

  1) 8-hour Time Weighted Averages.

     Exposure to any substance listed in Table Z-2, in any 8-hour work shift of a 40-hour workweek, shall not exceed the 8-hour time weighted average limit given for that substance in Table Z-2.

  2) Acceptable ceiling concentrations.

     Exposure to a substance listed in Table Z-2 shall not exceed at any time during an 8-hour shift the acceptable ceiling concentration limit given for the substance in the table, except for a time period, and up to a concentration not exceeding the maximum duration and concentration allowed in the column under "acceptable maximum peak above the acceptable ceiling concentration for an 8- hour shift".

- Table Z-3

  Exposure to any substance listed in Table Z-3, in any 8-hour work shift of a 40-hour workweek, shall not exceed the 8-hour time weighted average limit given for that substance in the table.

- Computation formulae

  The computation formula, which shall apply to employee exposure to more than one substance, for which 8-hour time weighted averages are listed in subpart Z of 29 CFR part 1910, to determine whether an employee is exposed over the regulatory limit, is as follows:

  $E = (C_aT_a + C_bT_b + \ldots C_nT_n) / 8$

  Where:

  E is the equivalent exposure for the working shift.

  C is the concentration during any period of time T where the concentration remains constant.

  T is the duration in hours of the exposure at the concentration C.

  The value of E shall not exceed the 8-hour time weighted average specified in subpart Z of 29 CFR part 1910 for the substance involved.

  In case of a mixture of air contaminants the equivalent exposure shall be computed as follows:

  $E_m = (C_1/L_1 + C_2/L_2 + \ldots C_n/L_n)$

  Where:

  $E_m$ is the equivalent exposure for this mixture.

  C is the concentration of a particular contaminant.

  L is the exposure limit for that for that substance specified in subpart Z of 29 CFR part 1910.

The value of $E_m$ shall not exceed unity (1).

# 9.0 SAFETY CONSIDERATIONS FOR HAZARDOUS MATERIALS

## 9.1 SECURITY IN LABS WITH SPECIAL HAZARD MATERIALS

Florida International University's institutional ability to use Special Hazard Materials is contingent upon the compliance with all applicable laws, rules, regulations, terms, and conditions relating in any way to the purchase, handling, use, storage, transfer, and disposal of these materials.

All users of special hazard materials (radioactive materials, laser devices, controlled substance, select agents, infectious materials, carcinogenic materials, explosive materials) must be familiar with FIU "Security in Laboratories with Special Hazards" Policy (FIU Policy #125.405), handle these materials in a safe manner, and must take the necessary steps to assure responsibility, accountability, and physical safeguards.

For more information, please visit the EH&S website at https://ehs.fiu.edu.

## 9.2 PURCHASING

Good hazardous material management and acceptable safety practices begin with the decision to purchase/acquire hazardous materials. An understanding regarding the hazards of various materials is essential in order to make the most judicious decision regarding the need for, use of, handling, storage, and ultimate disposal of hazardous materials purchased/obtained for academic and research purpose.

The following guidelines are recommended:

1) Evaluate the need for the particular material and determine if a less hazardous substitute is available.
2) Determine the minimum quantity required to satisfy your specific demand.
3) Determine the specific safety procedure and design elements required to assure protection of personnel and property (e.g., storage cabinets, respiratory protection, control ventilation).
4) Check to determine if unused quantities can be returned to the manufacturer.
5) Determine if environmental or air monitoring is required for the substance.
6) Determine if the required personal protective equipment necessary to safely handle the material is available and in good condition. If the personal protective equipment is not available, make sure it is ordered and the delivery date is prior to the arrival of the chemical.
7) Order materials in the smallest quantity necessary for the laboratory needs. Excess amounts of a chemical invariably must be disposed of as waste; this imposes an unnecessary expense on the University and contributes to overall degradation of the environment.
8) Request Safety Data Sheets (SDS) and safety specifications for all materials ordered.
9) Prepare the area for the arrival of the material. Check to determine if the exterior of the container is in good condition. Make sure the package is not damaged. Open the package carefully and determine if the container is labeled and undamaged.
10) Conduct a "dry run" for particularly hazardous materials.

## 9.3 CHEMICAL STORAGE

Information from the SDS and the container labels shall be evaluated and reviewed with lab workers and

others affected in order to determine appropriate storage. Proper storage of chemicals is not complicated but does require some thinking.

**IMPORTANT:** Chemicals shall not be stored alphabetically since incompatibles may be placed close to each other simply because the first letter of their names may follow each other in the alphabet.

The following general guidelines will help with the proper storage of chemicals:

- Ensure containers are in good condition, capped and properly labeled. **DO NOT** store unlabeled chemical containers.
- Store incompatible chemicals separately. Segregate chemicals according to hazard class. Refer to Appendix S, *Chemical Incompatibility*.
- Store Flammables in a Certified Flammable Cabinet.
- Ensure storage areas are dry, adequately ventilated and properly illuminated.
- Store highly reactive or corrosive liquids on spill trays.
- Storage within 18 inches from fire sprinkler heads in not allowed by fire code regulations.
- Do not store chemicals on the floor, in hallways or next to fire exits.
- Whenever chemicals are transferred from one container to another observe manufacturer's recommendation for storage and labeling condition. (Note the type of container – glass, plastic, light occluding, etc.).
- Store gas cylinders away from heat sources. Make sure cylinders are not leaking and label is in good readable condition. Check cylinders for stamped hydrostatic test date (testing should have been done within the past 5 years). Cylinders must be stored securely strapped in an upright position.
- See Section 9.8 for storage requirements for biological agents. Refer to Appendix M, *Chemical Compatibility Storage Guidelines*.

## 9.4 DISTRIBUTION

From the point of arrival to the final delivery location, there are several key factors to observe:

- Observe all warnings on the package.
- Open the package carefully and determine if the chemical is properly labeled.
- Review documentation on the safe handling and storage of the chemical.
- Do not transport open chemical containers. Lids must be tightly secured before moving the chemical.
- Carts for transporting chemicals and hazardous substances must provide for spill containment. Carts should have wheels large enough to negotiate uneven surfaces.
- Transport **only** compatible chemicals together.
- Hand deliveries must be in shock-resistant carrying containers and buckets which serve as secondary containment.
- Transport chemicals on freight-only elevators whenever these are available if not, avoid transporting materials during periods of high traffic or building activity.
- Transport gas cylinders using the appropriate hand truck **and** strap the cylinder down. Leave the valve cover cap on until the cylinder is located in its area of intended use. Make sure cylinders are properly chained when waiting to be used and when being used.
- Never leave carts with chemicals unattended in hallways or walkways.
- Never stack boxed chemicals beyond two levels on a delivery art.
- Ensure you maintain a stable posture and clear visibility over and around carts during

transportation.

## 9.5 WASTE MANAGEMENT

The following guidelines shall apply to the management of hazardous waste at Florida International University. However, these guidelines do not apply to radioactive waste, which must be managed in accordance with the FIU Radiation Safety Manual. For more detailed information regarding the management and disposal of hazardous waste, please visit the EH&S Hazardous Waste Webpage.

*Chemical Waste Management Guidelines:*

The responsibility for chemical waste identification, labeling, and packaging rests with the principal investigator or laboratory manager. The principal investigator and the laboratory manager shall follow all the procedures as provided in the Hazardous Waste Management Program and shall provide proper training to personnel under their supervision. Hazardous waste training is available online through FIU Develop. For detailed information of available courses, please visit the EH&S Training Webpage.

NOTE: Under no circumstance shall chemical waste be left in corridors or general access areas to await pick up.

*Disposal:*

Chemical waste picked up from the generating laboratories is transported by EH&S personnel to the Hazardous Waste Storage Facility. Chemicals are kept at this facility until removed by a permitted hazardous waste disposal firm contracted by FIU/EH&S. Please refer to the EH&S Hazardous Waste Management Plan for additional details and how to request waste pick-ups.

Biohazardous waste and radioactive waste disposal services are handled separately:

- Biohazardous Waste Management Guidelines
  - See FIU Biomedical Waste Plan; or
  - Contact the Biosafety Officer at 305-348-0489 or 305-348-2621.
- Radioactive Waste Management Guidelines
  - See FIU Radiation Safety Manual; or
  - Contact the Radiation Safety Officer at 305-348-6625 or 305-348-2621.

## 9.6 HAZARDOUS CHEMICALS

Some chemicals because of their specific characteristics require special care and special considerations. A brief overview of substances included in this category is provided below:

*Corrosive Materials:*

Biological corrosives attack human tissue and cause irritation, chemical burns, and in severe cases, tissue destruction. In case of skin or eye contact, prompt treatment with a physiologically correct buffered saline solution is important. After thorough washing, with a buffered saline solution or at an eye wash station, if indication of tissue damage exists, obtain medical attention as soon as possible.

Nose, throat, and lung injury may be caused by inhaling corrosive gases, vapors, or aerosols. The irritant nature of most airborne corrosives usually provide warning of exposure but **cannot and must not be depended on** as the means to determine exposure. Any indications of unhealthy respiratory exposures to corrosive substance must be brought to the attention of a qualified health professional.

Except for egregious ignorance or carelessness, ingestion of corrosives is less likely to occur in a laboratory; but if it does, seek immediate medical attention. Compliance with the requirement to abstain from storing or consuming foods in laboratories should help to prevent accidental consumption.

Refer to Appendix E, *Common Laboratory Corrosives*, for a list of corrosive substances commonly used in the laboratory.

*Oxidizer Materials:*

Oxidizers are compounds (solid, liquid, and gas) that produce oxygen or are electron acceptors. Oxidizers can react vigorously at ambient temperatures when they come into contact with organic materials or reducing agents.

In addition to their corrosive properties, powerful oxidizing agents such as perchloric and chromic acids (sometimes used as cleaning solution), present fire and explosion hazards on contact with organic compounds and other oxidizable substances. Strong oxidizing agents should be stored in glass or other inert containers (preferably unbreakable). Corks and rubber stoppers should **NOT** be used. When heating reaction vessels containing significant quantities of these reagents, fiberglass mantles or sand baths rather than oil baths, should be used. Refer to Appendix F, *Common Laboratory Oxidizers*, for a list of oxidizing substances commonly used in the laboratory.

*Air and Moisture Sensitive Materials:*

Many chemical compounds deteriorate when exposed to air. This exposure may only cause degradation in quality; however a few moisture-sensitive compounds are extremely reactive with oxygen from the air.

Another group of compounds which react with atmospheric moisture result in the release of toxic or flammable gases or vapors or the generation of enough heat to cause fires and explosions. Examples from this category include potassium and sodium metals. Many metal hydrides react on contact with water to produce hydrogen, and these reactions produce sufficient heat to ignite the hydrogen with explosive violence. Certain polymerization catalysts, such as aluminum alkyls, react and burn violently on contact with water.

*Pyrophoric Materials:*

Pyrophorics are a special sub-group of air sensitive compounds. These substances are so reactive that they undergo air oxidation and spontaneously ignite in air. **They do not require an external ignition source**. All such chemicals must be stored in tightly closed containers and, when being transferred, should be kept under an inert atmosphere or liquid. Among these substances are alkali metals; calcium and magnesium; metal alkyls and aryls; metal carbonyls; powders of aluminum, cobalt iron and manganese; metal hydrides; boranes and arsines; and white phosphorous. Failure to store and handle these chemicals properly can lead to fires and severe injury.

*Peroxide-Forming Materials:*

Some organic compounds are susceptible to atmospheric oxidation. These compounds invariably contain an autoxidizable hydrogen atom that is activated by adjacent structural features and/or the presence of actinic radiation (sensitivity to ultraviolet radiation). With this combination, these substances react slowly under ambient conditions with atmospheric molecular oxygen, initially to form a peroxide. However, once formed, peroxides are thermally unstable and may also be shock sensitive.

The general precautions applicable to these compounds are all aimed at preventing peroxide formation and include storage in opaque containers under a nitrogen atmosphere. The exceptions are

some monomers that contain inhibitors that need some amount of air in order to effectively retard the rate of peroxide formation. Refer to the Appendix G, *Peroxidizable Chemicals*, for a list of peroxidizable compounds and to Appendix H, *Peroxide Detection and Removal*.

NOTE: Inorganic peroxides should also be handled with care and respect for their hazard potential. Barium, sodium and potassium peroxides when mixed with combustible materials form explosives that ignite easily.

*Explosive and Shock-Sensitive Compounds:*

Shock-sensitive and/or explosive compounds present obvious safety concerns **even for laboratory-scale quantities**. The first step in safe operations with such substances is respect and recognition of the potential for personal injury and property damage. The empirical molecular formulas of individual compounds are instructive about their stability. For example, an unusually high proportion of nitrogen and N-N bonds in the compound indicates instability (hydrogen azide, 97.6% N, and hydrazine, 87.4% N, are both explosively unstable but ammonia, 82.2% N is not).

The concept of oxygen balance is also an important indicator. The oxygen balance of a compound is defined as the difference between the oxygen content of a compound and that which is required to fully oxidize all the other elements present. If there is a deficiency of oxygen, the balance is negative. If there is a surplus, the balance is positive. Compounds with a positive balance are often mixed with fuels to produce powerful explosives; therefore, such compounds must be stringently segregated from any combustible materials.

In addition to oxygen balance, the energy of activation of the decomposition reaction is also of significant importance in determining the margin between potential and actual hazard of explosive decomposition. Refer to Appendix I, *Shock Sensitive and Explosive Chemicals,* for a list of explosive and shock sensitive compounds.

NOTE: Explosives are classified as Class A, B, and C by the US Department of Transportation. Determine the explosive potential of any material you may have on order or in storage.

*Flammable Materials:*

General prudent practices applicable to the use of flammable materials include minimizing the amount of materials used in the laboratory; storing chemicals properly, keeping appropriate fire extinguishing equipment readily visible, available, and accessible; physically separating flammable materials from sources of ignition; properly grounding static sources of ignition, and using the least hazardous alternative available.

Specific precautions for the safe handling of flammable materials include the following:

- Handle flammable substances only in areas free of ignition sources.
- Never heat flammable substances with an open flame.
- Ventilate by diluting the vapors until they are no longer flammable.
- Keep containers of flammable substances tightly closed at all times when not in use.
- Use only refrigeration equipment certified for storage of flammable materials.
- Use the smallest quantities of flammable substances possible.
- Store Flammables in a Certified Flammable Cabinet when not in use.

While all flammable substances should be handled carefully, the extreme flammability of some materials require extreme caution. Refer to Appendix R, *Flammable and Combustible Materials*.

## 9.7 RADIOACTIVE MATERIALS AND LASERS

*Radioactive Materials:*

The FIU Radiation Safety Program Manual is available from the Radiation Safety Office (305-348-0489). Additional radiation safety information can be found at the EH&S Radiation Safety Webpage. This document provides specific purchasing, handling, storage, and disposal procedures for radioactive materials. **NO ONE** is authorized to use radioactive materials until they are authorized users of radioactive materials or work under the supervision of an authorized user. To become authorized users they must submit a proposal to the Radiation Safety Officer describing the isotope and the maximum radioactivity of the isotope to be authorized, location of the lab and layout of radioactive areas, training and experience with radioactive materials for approval by the FIU Radiation Control Committee.

*Lasers:*

Lasers produce non-ionizing radiation capable of causing eye injury. Lasers operating outside of the visible light region (ultraviolet or infrared) are especially hazardous. Laser protective eyewear shall be made available and shall be worn by all personnel within the Nominal Hazard Zone (NHZ) of Class 3 B and Class 4 lasers. All laser protective eyewear shall be clearly labeled with the optical density and the wavelength for which protection is afforded. Refer to Appendix L, *Laser Classification*, and the FIU Laser Safety Manual.

All purchases of Class 3B and Class 4 lasers must be authorized by the Laser Safety Officer (LSO). All Class 3B and Class 4 lasers (including embedded Class 3B and Class 4 lasers which may be given lower classification) must be registered with the Bureau of Radiation Control within 30 days of their receipt. Contact the LSO (348-0489) for any registration and safety issues.

## 9.8 BIOLOGICAL AND INFECTIOUS MATERIALS

*Bloodborne Pathogens:*

Bloodborne pathogens are pathogenic microorganisms that are present in blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV). Each laboratory or location with potential exposures to blood and body fluids is required to maintain an exposure control plan specific for their operations. Please reference the FIU Bloodborne Pathogens Exposure Control Plan for more detailed information. General biological safety information is also available on the EH&S Biological Safety Webpage. The purpose of the Plan is to protect employees from exposure to bloodborne pathogens and to outline the procedures that provide for appropriate prophylaxis, response, treatment and counseling.

*Biosafety Levels:*

Four biosafety levels (BSLs) are described in the FIU Biosafety Manual. These consist of combinations of laboratory practices and techniques, safety equipment, and laboratory facilities. Each combination is specifically appropriate to the operations performed, the documented or suspected routes of transmission of the infectious agents, and for the laboratory function or activity to be carried out. These considerations must be included in the evaluation carried out by the researcher prior to initiating any research activity involving these type materials. For more information about Biosafety Levels, please contact the Biosafety Office at 305-348-0489.

**IMPORTANT:** Research involving Biosafety Level 3 or 4 agents is **STRICTLY PROHIBITED** on FIU

campuses and satellite locations.

*Toxins:*

The laboratory facilities, equipment, and procedures appropriate for work with toxins of biological origin must reflect the intrinsic level of hazard posed by a particular toxin as well as the potential risks inherent in the operations performed. All toxins must be considered to pose a hazard in an aerosol form. However, most toxins exert their effects only after parenteral exposure or ingestion, and a few toxins present a dermal hazard. In general, toxins of biological origin are not intrinsically volatile. Thus, the laboratory safety precautions appropriate for handling these materials closely parallel those for handling infectious organisms.

For more information about the requirements for the laboratory use of toxins of biological origin including the general techniques applicable to etiologic agents **AND** the specific techniques applicable to toxins, please refer to the FIU Biosafety Manual.

*Select Agents and Toxins (SATs):*

SATs are any biological agent or toxin that could pose a threat to University Police, animal or plant health, or animal or plant products.

- Public Health Security and Bioterrorism Preparedness Response Act of 2002
- Agricultural Bioterrorism Protection Act of 2002

SATs are regulated by the Department of Human and Health Services (DHHS) and the United States Department of Agriculture (USDA).

- 42 CFR Part 73, 7 CFR Part 331, and 9 CFR Part 121

Unless exempted, any entity that possesses, uses, or transfers SATs are required to:

- Register with the Centers for Disease Control and Prevention (CDC) or the Animal and Plant Health Inspection Services (APHIS) **AND** FIU EH&S.
- Handle materials safely and secure against theft, loss, or release.
- Report any theft, loss, or release to the CDC or APHIS **AND** FIU EH&S.
- Failure to comply may result in criminal and civil penalties.

For more information about the FIU SAT Program, please contact the EH&S Biosafety Office at 305-348-0489 or refer to the FIU Select Agent Guidelines.

For more information about the OSHA Regulations, see Bloodborne Pathogens. – 29 CFR 1910.1030

## 9.9 OTHER HAZARDOUS MATERIALS

*Carcinogens:*

There are numerous chemicals classified as carcinogenic. It is the responsibility of the principal investigator to assure proper use and control of carcinogens and to designate appropriate areas for the storage and use of these chemicals. Special consideration should be given to protective equipment and handling practices including posting signs and restricting access to the areas where these chemicals are stored and handled.

Refer to Appendix J, *Carcinogens*, for a list of carcinogenic chemicals current as of the publication of this

manual. Always refer to the SDS for current information. Information regarding the potential carcinogenicity may be obtained from the SDS for the chemical under consideration.

*Reproductive Hazards:*

A very limited number of chemicals are currently suspected as being human mutagens or teratogens, in that exposures may result in DNA changes some of which are likely to affect the developing fetus. The risk may be related to the level of exposure. Infrequent low-level exposures are clearly less of a risk than frequent exposures to higher concentration in poorly ventilated areas. The risk is also greater during early stages of pregnancy.

In the typical working environment exposure by inhalation is the most common route. Working in a fume hood or in some other properly ventilated enclosure prevents exposure by inhalation. Skin absorption and ingestion are rarely significant routes of exposure, provided safe work practices are observed. Refer to Appendix K, *Reproductive Hazards*, for a list of these chemicals.

# 10.0 EMERGENCY RESPONSE PROCEDURES

## 10.1 SPILLS

Hazardous materials carry a designation known as a Reportable Quantity (RQ).

The RQ serves as the threshold above which spills, leaks and releases of hazardous materials must be reported to local, state, and federal agencies. Therefore, in order to assure University wide compliance with this requirement, all spills, leaks, and inadvertent releases of hazardous materials, in which there was actual or potential hazardous personal or environmental exposures, shall be reported to Environmental Health & Safety within 24 hours of occurrence.

*Prevention:*

The first and best spill control method is spill prevention. Using the proper equipment and storage and handling techniques can usually prevent spills and inadvertent releases.

Specific suggestions for preventing spills and inadvertent releases are:

- Provide a physical arrangement that permits easy manipulations and material transfers.
- Leak-test the system before introducing flammable or toxics.
- Make practice runs with inert or non-hazardous materials as a final check.
- Use secondary containment.

A thorough hazard evaluation including potential spill assessment should be conducted prior to starting new experiment or project.

*Preparation:*

Laboratory managers, principal investigators, and other laboratory personnel shall assure they are knowledgeable regarding the locations and use of all the following:

- Main electrical circuit shut off for specialized equipment.
- Main gas shut-off.
- Fire Extinguishers.
- Spill control materials.

- Personal protective equipment.
- Emergency response contact list.
- Written emergency response procedures for that location.

*Containment:*

Provide for containment of spills as a backup to the steps described above. Trays or catch-pans under apparatus where leaks or spills may occur greatly simplify the clean-up problem. Containers should be large enough to contain the maximum possible spill.

Appropriate emergency response equipment shall be kept available for the safe and proper response to spills. Recommended materials for containing spills include:

- Smothering and damming materials.
- Neutralizing agents.
- Absorbents.
- Scoops, spades, brooms.
- Paper towels.
- Labels or markers.
- Plastic buckets and thick plastic bags.
- Proper PPE.

Each laboratory shall maintain, in stock, spill control material specific to the type materials used at each location. Commercially available spill kits are available for specific categories of hazardous materials.

NOTE: Local, State and Federal regulations mandate that all employees who will be required to wear PPE receive appropriate training.

NOTE: Local, State, and Federal regulations mandate that all employees who will be required to serve as first responders receive appropriate training.

*Control and Clean-up:*

Small chemical spills should be promptly cleaned up when appropriate expertise, protective apparel, equipment, and proper disposal resources are available to safely accomplish the task. If the hazards of a chemical are unknown do not proceed until this determination has been made.

If the spill can be contained using the contents of the laboratory spill kit, take the following action:

1) Provide care for anyone who may have been injured. This includes calling FIU Police/Emergency at 305-348-5911, or 7-5911 from an FIU phone, if the injury requires medical attention.
2) Secure the area and prevent unauthorized entry.
3) Determine the hazards associated with the material spilled.
4) Protect yourself properly using the type gloves, goggles, respirators, and any other protective equipment specified in the SDS.
5) Pour the absorbent around the perimeter of the spill to prevent the spill from spreading.
6) Use the plastic scoop and brush to work the absorbent into the spilled material, working from the perimeter toward the center.
7) Add more absorbent as needed to contain the spill.
8) Use the scoop and brush to collect the contaminated absorbent and place it into an appropriate waste container.
9) Assure the container is compatible with the spilled material.

10) Place any other contaminated items such as glass, gloves, etc. in the separate waste container. Also secure this container.
11) Seal and label both containers.
12) Contact EH&S for proper disposal of the any hazardous waste.
13) Wash down the area, if necessary, with appropriate neutralizing agent.
14) Complete internal incident report and record-keeping requirements.
15) Restock inventory of spilled material.
16) Conduct incident evaluation and initiate changes, where required, in order to prevent recurrence.

If it is determined that the amount and/or hazardous nature of a spill is beyond the ability of laboratory personnel to respond safely, take the following action:

1) **Vacate the area immediately and close doors behind you!**
2) Notify personnel in adjacent areas of any potential hazard.
3) Contact University Police, 305-348-5911 or 7-5911 from FIU phone, and advise the operator of the following:
    a. A chemical spill has taken place and what type of chemical(s) was spilled.
    b. Estimate the amount spilled.
    c. Identify exact location (campus, building, room number) of the spill.
    d. Provide the number from which you are calling.
    e. Provide your name and position.
4) Notify Environmental Health & Safety, 305-348-2621.
5) Stand by to assist response crews as needed.

## 10.2 INJURIES & ILLNESSES

For minor cuts, burns, etc. follow first-aid procedures. If necessary, follow up with a visit to your doctor or the FIU Health Clinic.

NOTE: If a serious injury or illness occurs, immediately notify the University Police Department, 305-348-5911 or 7-5911 from an FIU phone. Give your name, describe the nature and severity of the medical problem, and the location of the victim.

Furthermore, apply the following guidelines as appropriate:

1) Keep the victim still and as comfortable – **DO NOT MOVE THEM** unless the hazard presented by remaining in a specific position of location outweighs the potential hazards of moving or attempting to move them.
    a. Example 1: You **should not** move a victim when it appears they fell and injured a limb, neck, head, or spine, and there is no apparent threat in the area.
    b. Example 2: You **should** move an individual who has become unconscious in a room on fire, in which it is clear that the fire is spreading rapidly and could very likely kill the victim.
2) If possible, find out what the victim feels/thinks is wrong.
3) Look for an Emergency Medical ID.
4) Apply first aid, if trained and necessary.
5) Attempt to comfort the victim until help arrives.

If you are a witness to an injury or illness, your willingness to provide information to responding

emergency crew is extremely important.

## 10.3 FIRE SAFETY & EMERGENCY EVACUATION PROCEDURES

If the response action calls for the initiation of the building fire alarm, everyone must immediately stop what they are doing, carry out their specified departmental responsibilities, and evacuate the building as quickly and as calmly as possible.

In the event of any fire, do the following:

- Move away from the source of the fire or smoke quickly.
- Activate building fire alarm by locating nearest pull station and pulling the alarm.
- Exit the building. If possible, close doors behind you as you exit the space where the fire/smoke is taking place.
- Go as far away from the building as possible. If your department/lab has a designated meeting area for emergencies, meet there.
- After safely exiting the building, call the University Police Department, 305-348-5911, and give a clear and accurate description of the location of the fire or smoke.

NOTE: If you elect to fight a fire, do not do so alone, and ensure it is a **MINOR** fire only. Get help and never allow the fire to block your path of exit from the area or the building. **At no point in time must your personal safety be put in jeopardy in order to control a fire**. Always activate the fire alarm to alert occupants of the building to exit.

A minor fire is considered to typically have the following characteristics:

- Releases small quantities of toxic fumes.
- Involves a limited quantity of materials.
- Presents no potential for explosion.
- Is restricted or contained to/in a small area.

**Your top priority, and what is expected from FIU, is that you exit the space/building immediately during a fire emergency. Preservation of your life is the most important matter!** If you choose to fight a minor fire, however, do so only under the following conditions:

- Fire alarm has already been activated.
- The fire is contained to a small area.
- There is minimal smoke.
- You are able to breathe without coughing.
- Visibility in the space is good and all doors, exits, and walkways can be seen clearly.

If these conditions have been met, proceed to fight the fire by doing the following:

- Locate nearest fire extinguisher and grab it.
- Stand approximately 6 – 10 feet away from the fire.
- Activate the extinguisher.
- Remember the acronym – **P.A.S.S.** – to use the extinguisher.
  - **P**ull the pin.
  - **A**im extinguisher nozzle at the **base** of the flames.
  - **S**queeze handle while holding the extinguisher upright.
  - **S**weep the extinguisher nozzle from side to side, covering the base of the fire with the extinguishing agent.

- As you use the extinguisher AND as the fire gets smaller, slowly move closer to the fire to allow the extinguishing agent to become more effective.

**Leave the area IMMEDIATELY if any of the following occurs:**

- Your path of escape is threatened.
- The extinguishing agent runs out.
- The extinguisher proves to be inoperable or ineffective.
- You are no longer able to safely fight the fire.
- The fire or smoke is increasing in intensity.

A major fire is considered to typically have the following characteristics:

- Releases large quantities of toxic fumes.
- Involves a large quantity of materials.
- Presents a potential for explosion.
- It is spreading and increasing in size.
- Diminishes visibility in the space quickly.
- Creates a panic situation among occupants.

To safety and effectively respond to a major fire, do the following:

- Alert occupants in the space.
- Leave the space immediately and close the door behind you.
- Activate building fire alarm by pulling the fire alarm at the nearest pull station.
- Exit the building immediately.
- Go as far away from the building as possible. If your department/laboratory has a designated meeting zone, please meet there to account for all your team members.
- Contact the University Police Department by calling 305-348-5911 (MMC) or 305-919-5911 (BBC).

NOTE: Many fire alarm pull stations/boxes have a clear plastic cover to discourage pranksters and vandals. When the plastic cover is lifted, a local “horn-like” sound is emitted. This is not the sound of the fire alarm. The handle of the red pull station must be grasped and pulled for the fire alarm to be activated. The alarm is characterized by a loud and continuous sound of horns ringing throughout the building, accompanied with flashing lights.

*ALL FIRES, REGARDLESS OF SIZE, MUST BE REPORTED TO THE UNIVERSITY POLICE DEPARTMENT.*

*NOTIFY ENVIRONMENTAL HEALTH & SAFETY AS SOON AS POSSIBLE AFTER THE OCCURRENCE.*

## 10.4 UNIVERSITY BUILDING EVACUATION PROCEDURES

The continuous ringing of the fire alarm is the evacuation signal for all types of emergencies. All building occupants must respond to the sound of the alarm by immediately initiating evacuation procedures, as follows:

1) Complete internal departmental or class evacuation procedures.
2) Follow EXIT signs to the nearest safe exit. Do not use the elevators.
   NOTE: Evacuation plans for persons with disabilities must be made part of each department’s documented emergency evacuation procedures.
3) Walk down the stairs. Do not run!
4) As you approach the landing of each floor allow evacuees from that level to enter the stairwell.

5) If evacuation becomes difficult because of smoke, flames, or blockage, re-enter the building, but first, assure that the floor on which you re-enter is safe. Continue evacuation via the nearest safe stairwell.
6) Once you have exited the building proceed to your designated Evacuation Assembly Area. Do not re-enter the building unless authorized by a University Police Officer, fire department personnel, or until a recognized University authority broadcasts the "All Clear" directive.

For detailed information pertaining to fire emergencies, extinguisher use, and other fire related guidelines at FIU, please visit the EH&S Fire Safety Webpage.

# 11.0 RECORDKEEPING REQUIREMENTS

## 11.1 ACCIDENTS

All accidents/occurrences resulting in significant property damage and/or injury to any person must be immediately reported to the University Police department. Timely notification shall be provided to Environmental Health & Safety. The office of Human Resources shall be notified for all injuries involving University employees. Laboratory managers shall assure that witness statements are taken and made available to Environmental Health & Safety, as appropriate.

Each laboratory shall be appropriately equipped with first aid supplies, spill kits, and fire extinguishers. First aid and CPR training is available for all laboratory personnel through Environmental Health & Safety.

## 11.2 CHEMICAL INVENTORY

Nothing is more important to laboratory safety than the identification of potentially hazardous materials used at that location. The maintenance of a chemical inventory is the heart of this process. It is the responsibility of each laboratory manager and principal investigator to assure the following:

- Compile a list of each chemical present at the laboratory.
- Maintain inventory current by adding each purchase and deleting used or disposed materials.

Chemical inventory procedures include periodic inspection of storage conditions and containers to check for:

- Shelf life.
- Inappropriate storage.
- Damaged labels.
- Damaged containers.

Inventories shall be maintained and immediately accessible to EH&S Safety Officers, EH&S Fire Prevention Officer, State Fire Marshall, and emergency response personnel as appropriate.

NOTE: Chemical inventories are now maintained electronically via the EHS Chemical Inventory Tracking System. To add an inventory item(s) or lab space to the database or for more information, please contact the Lab Safety Office at 305-348-6849 or visit the EHS Chemical Inventory Tracking System website to access your inventory.

# 12.0 APPENDICES

# *APPENDIX A: GLOVE GUIDE*

## Glove Guide

Glove Type and Chemical Use:

*Limited Service VG=Very Good G=Good F=Fair P=Poor (not recommended)

| Chemical | Neoprene | Natural Latex or Rubber | Butyl | Nitrile |
|---|---|---|---|---|
| *Acetaldehyde | VG | G | VG | G |
| Acetic Acid | VG | VG | VG | VG |
| *Acetone | G | VG | VG | P |
| Ammonium hydroxide | VG | VG | VG | VG |
| *Amyl acetate | F | P | F | P |
| Aniline | G | F | F | P |
| *Benzaldehyde | F | F | G | G |
| *Benzene | F | F | F | P |
| Butyl acetate | G | F | F | P |
| Butyl alcohol | VG | VG | VG | VG |
| Carbon disulfide | F | F | F | F |
| *Carbon tetrachloride | F | P | P | G |
| Castor oil | F | P | F | VG |
| *Chlorobenzene | F | P | F | P |
| *Chloroform | G | P | P | F |
| Chloronaphthalene | F | P | F | F |
| Chromic acid (50%) | F | P | F | F |
| Citric acid (10%) | VG | VG | VG | VG |
| Cyclohexanol | G | F | G | VG |
| *Dibutyl phthalate | G | P | G | G |
| Diesel fuel | G | P | P | VG |
| Diisobutyl ketone | P | F | G | P |
| Dimethylformamide | F | F | G | G |
| Dioctyl phthalate | G | P | F | VG |
| Dioxane | VG | G | G | G |
| Epoxy resins, dry | VG | VG | VG | VG |
| *Ethyl acetate | G | F | G | F |
| Ethyl alcohol | VG | VG | VG | VG |
| Ethyl ether | VG | G | VG | G |
| *Ethylene dichloride | F | P | F | P |
| Ethylene glycol | VG | VG | VG | VG |
| Formaldehyde | VG | VG | VG | VG |

| Chemical | Neoprene | Natural Latex or Rubber | Butyl | Nitrile |
|---|---|---|---|---|
| Formic acid | VG | VG | VG | VG |
| *Furfural | G | G | G | G |
| Gasoline, leaded | G | P | F | VG |
| Gasoline, unleaded | G | P | F | VG |
| Glycerine | VG | VG | VG | VG |
| Hexane | F | P | P | G |
| Hydrochloric acid | VG | G | G | G |
| Hydrofluoric acid (48%) | VG | G | G | G |
| Hydrogen peroxide (30%) | G | G | G | G |
| Hydroquinone | G | G | G | F |
| Isooctane | F | P | P | VG |
| Isopropyl alcohol | VG | VG | VG | VG |
| Kerosene | VG | F | F | VG |
| Ketones | G | VG | VG | P |
| Lacquer thinners | G | F | F | P |
| Lactic acid (85%) | VG | VG | VG | VG |
| Lauric acid (36%) | VG | F | VG | VG |
| Lineoleic acid | VG | P | F | G |
| Linseed oil | VG | P | F | VG |
| Maleic acid | VG | VG | VG | VG |
| Methyl alcohol | VG | VG | VG | VG |
| Methylamine | F | F | G | G |
| Methyl bromide | G | F | G | F |
| *Methyl chloride | P | P | P | P |
| *Methyl ethyl ketone | G | G | VG | P |
| *Methyl isobutyl ketone | F | F | VG | P |
| Methyl methacrylate | G | G | VG | F |
| Monoethanolamine | VG | G | VG | VG |
| Morpholine | VG | VG | VG | VG |
| Naphthalene | G | F | F | G |
| Naphthas, aromatic | G | P | P | G |
| *Nitric acid | G | F | F | F |
| Nitromethane (95.5%) | F | P | F | F |
| Nitropropane (95.5%) | F | P | F | F |
| Octyl alcohol | VG | VG | VG | VG |
| Oleic acid | VG | F | G | VG |

| Chemical | Neoprene | Natural Latex or Rubber | Butyl | Nitrile |
|---|---|---|---|---|
| Oxalic acid | VG | VG | VG | VG |
| Palmitic acid | VG | VG | VG | VG |
| Perchloric acid (60%) | VG | F | G | G |
| Perchloroethylene | F | P | P | G |
| Petroleum distillates (naphtha) | G | P | P | VG |
| Phenol | VG | F | G | F |
| Phosphoric acid | VG | G | VG | VG |
| Potassium hydroxide | VG | VG | VG | VG |
| Propyl acetate | G | F | G | F |
| Propyl alcohol | VG | VG | VG | VG |
| Propyl alcohol (iso) | VG | VG | VG | VG |
| Sodium hydroxide | VG | VG | VG | VG |
| Styrene | P | P | P | F |
| Stryene (100%) | P | P | P | F |
| Sulfuric acid | G | G | G | G |
| Tannic acid | VG | VG | VG | VG |
| Tetrahydrofuran | P | F | F | F |
| *Toluene | F | P | P | F |
| Toluene diisocyanate | F | G | G | F |
| *Trichloroethylene | F | F | P | G |
| Triethanolamine | VG | G | G | VG |
| Tung oil | VG | P | F | VG |
| Turpentine | G | F | F | VG |
| *Xylene | P | P | P | F |

# *APPENDIX B: COMMON LABORATORY CORROSIVES*

**Common Laboratory Corrosives**

This list is provided as a guide and is not all inclusive. Always review material safety data sheets before working with chemicals.

| **ORGANIC ACIDS** | | **INORGANIC ACIDS** | |
|---|---|---|---|
| Formic acid | Chloroacetyl chloride | Hydrofluoric acid Acetic | Titanium tetrachloride |
| acid, glacial | Oxalic acid | Hydrochloric acid | Perchloric acid |
| Propionic acid | Propionyl chloride | Hydrobromic acid | Nitric acid |
| Butyric acid | Propionyl bromide | Hydriotic acid | Phosphoric acid |
| Chloroacetic acid | Acetic anhydride | Sulfuric acid | Phosphorous trichloride |
| Trichloroacetic acid | Methyl chloroformate | Chromerge ™ | Phosphorous tribromide |
| Acetyl chloride | Dimethyl sulfate | No-Chromix ™ | Phosphorous pentachloride |
| Acetyl bromide | Chlorotrimethylsilane | Chlorosulfonic acid | Phosphorous pentoxide |
| Dichlorodimethylsilane | Benzoyl chloride | Sulfuryl chloride | |
| Phenol | Benzoyl bromide | Bromine pentafluoride | |
| Benzyl chloride | Benzyl bromide | Thionyl chloride | |
| Salicylic acid | | Tin chloride | |

| **ORGANIC BASES** | | **INORGANIC BASES** | |
|---|---|---|---|
| Ethylenediamine | Trimethylamine aq. sol. | Ammonium hydroxide | Sodium hydride |
| Ethylimine | Triethylamine | Calcium hydroxide | Hydrazine |
| Tetramethylethylenediamine | Phenylhydrazine | Sodium hydroxide | Ammonium sulfide Hydroxylamine |
| Hexamethylenediamine | Piperazine | Potassium hydroxide | Tetramethylammonium hydroxide |
| | Calcium oxide | Calcium hydride | |

| **ACID SALTS** | | **ELEMENTS** | |
|---|---|---|---|
| Aluminum trichloride | Calcium fluoride | Fluorine (gas) | Iodine (crystal) |
| Antimony trichloride | Ferric chloride | Chlorine (gas) | Phosphorus |
| Ammonium bifluoride | Sodium bisulfate | Bromine (liquid) | |

| | | | |
|---|---|---|---|
| | Sodium fluoride | | |

# *APPENDIX C: COMMON LABORATORY OXIDIZERS*

**Common Laboratory Oxidizer**

This list is provided as a guide and is not all inclusive. Always review safety data sheets before working with chemicals.

| **COMMON LABORATORY OXIDIZERS** | | | |
|---|---|---|---|
| Bleach | Dichromates | Nitrites | Percarbonates |
| Bromates | Fluorine | Nitrous oxide | Perchlorates |
| Bromine | Haloate | Ozanates | Perchloric acid |
| Butadiene | Halogens | Oxides | Permanganates |
| Chlorates | Hydrogen peroxide | Oxygen | Peroxides |
| Chloric acid | Hypochlorites | Oxygen difluoride | Persulfate |
| Chlorine | Iodates | Ozone | Sodium borate |
| Chlorite | Mineral acid | Peracetic acid | Sulfuric acid |
| Chromates | Nitrates | Perhaloate | |
| Chromic acid | Nitric acid | Perborates | |

# *APPENDIX D: PEROXIDIZABLE CHEMICAL*

**Peroxidizable Chemical**

These lists are provided as a guide and are not all inclusive. Always review material safety data sheets before working with chemicals.

Storage length recommendations:

- List A: May form peroxides simply on storage after air exposure. Concentration by evaporation is not required for hazardous concentrations to develop.
- List B: Peroxide-forming solvents which are typically not hazardous until concentrated.
- List C: Monomers which may undergo explosive polymerization following peroxide formation.

| List A (12 months) | List B (18 months) | List C (18 months) |
|---|---|---|
| | | Styrene |
| Diethyl ether | Acetal | |
| Isopropyl ether | Dioxane | Butadiene |
| Divinyl acetylene | Tetrahydrofuran | Tetrafluoroethylene |
| Vinylidene chloride | Vinyl ethers | Chlorotrifluoroethylene |
| Ethylene glycol | Vinyl acetate | |
| Di-Methyl ether | Vinyl chloride | |
| Dicyclopentadiene | Pyridine | |
| Diacetylene Vinyl | Cholobutadiene | |
| Methyl acetylene | (Chloroprene) | |
| Cumene | Methylcyclopentane | |
| Tetrahydronaphthalene | | |
| Cyclohexene | | |

Sodium and – especially – potassium metal are susceptible to peroxide formation; use 18 month limit.

Guidelines for ordering and storing peroxidizable chemicals:

1. Order only in small containers and only for anticipated next six month use.
2. Date containers upon receipt and upon opening.
3. Store in dark cool place, preferably in chemical safety cabinet.
4. Do not store if opened longer than limits listed.
5. Dispose of properly and promptly.

# *APPENDIX E: PEROXIDE DETECTION AND REMOVAL*

**Peroxide Detection and Removal**

TEST PROCEDURE FOR PEROXIDES

Ethers, particularly cyclic ethers and those synthesized from primary and secondary alcohols (such as tetrahydrofuran, diethyl ether and diisopropyl ether) form peroxides. Aldehydes, alkenes that have allylic hydrogen atoms (such as isopropyl benzene) and vinyl compounds (vinyl acetate) may also form peroxides. Although peroxides are not powerful explosives, they are extremely sensitive to shock, sparks, light, heat, friction, and impact. When peroxide- forming compounds are distilled, the peroxide has a higher boiling point than the parent compound and remains in the distilling flask as a residue which can become overheated and explode. Thus, never distill any compound which may contain peroxide impurities to dryness to avoid explosion.

Peroxide formation often occurs in stored ethers. Since ethers are frequently used solvents and form peroxides easily, the solvent container should be dated when opened. If not used within one month, the container must be tested for peroxide formation. Do not test an uninhibited ether, which has been opened for more than six months, or an inhibited ether, which has been opened and stored more than one year.

PEROXIDE DETECTION

Sodium Iodide Detection Method

Add 1 ml of the liquid suspected of containing a peroxide to a solution of 0.1 g sodium iodide in 1 ml of glacial acetic acid. If the mixture turns brown, a high concentration of peroxide is present; whereas a yellow solution indicates that a low level of peroxide exists in solution.

Ferrous Thiocyanate Detection Method

Mix a solution of 5 ml of 1% ferrous ammonium sulfate, 0.5 ml of 1 N sulfuric acid and 0.5 ml of 0.1 N ammonium thiocyanate (if necessary, decolorize with a trace of zinc dust). Shake with an equal quantity of the solvent to be tested. If peroxides are present, a red color will develop.

Peroxide Test Strips

Strips are available from laboratory supply companies. Strips quantify peroxides up to a concentration of 25 ppm. The actual concentration at which peroxides become hazardous is not specifically stated in the literature. A number of publications use 100 ppm as control valve for managing the material safely.

PEROXIDE REMOVAL

The solvent containing peroxides should be poured through a column of basic activated

alumina, which will simultaneously remove peroxide and dry the solvent. During peroxide removal, do not let the column dry out. Be sure to test the solvent again to determine if peroxide is still present. When the alumina column no longer removes peroxide, wash the column with 5% aqueous ferrous sulfate and discard the material as chemical waste.

# *APPENDIX F: SHOCK SENSITIVE AND EXPLOSIVE CHEMICALS*

**Shock Sensitive and Explosive Chemicals**

This list is provided as a guide and is not all inclusive. Always review material safety data sheets before working with chemicals.

| **COMPOUNDS** | | | |
|---|---|---|---|
| Acetylene | Cyclotrimethylenetrinitramine | Gelatinized nitrocellulose | Nitrourea |
| Acetylides of heavy metal | Dinitrophenol | Guanyl | Organic nitramines |
| Amatex | Dinitrophenol hydrazine | Guanyl nitrosoamino | Ozonides |
| Amatol | Dinitrotoluene | Guanyltetrazene | Pentolite |
| Ammonal | Ednatol | Hydrazine | Perchlorates of heavy metals |
| Ammonium nitrate | Erythritol tetranitrate | Nitrated carbohydrate | Peroxides |
| Ammonium perchlorate | Fulminate of mercury | Nitrated glucoside | Picramic acid |
| Ammonium picrate | Fulminate of silver | Nitrogen triiodide | Picramide |
| Azides of heavy metals | Ethylene oxide | Nitrogen trichloride | Picratrol |
| Baratol | Ethyl-tetryl | Nitroglycerin | Picric acid |
| Calcium nitrate | Fulminating gold | Nitroglycide | Picryl sulphonic acid |
| Chlorate | Fulminating mercury | Nitroglycol | Silver acetylide |
| Copper acetylide | Fulminating platinum | Nitroguanidine | Silver azide |
| Cyanuric triazide | Fulminating silver | Nitroparaffins | Tetranitromethane |

| **MIXTURES** | | | |
|---|---|---|---|
| Germanium | Lead azide | Manntol hexanitrate | Trinitrocresol |
| Hexanitrodiphenyamine | Lead mononitroresorcinate | Sodium picramate | Trinitroresorcinol |
| Hexogen | Lead styphnate | Tetranitrocarbazole | Trinitonal |
| Hydrazoic acid | Hexanitrostilbene | Trinitrobenzoic acid | Urea nitrate |

# *APPENDIX G: CARCINOGENS*

## Carcinogens

This list of select and suspected carcinogens is supplied as a guide and is not all inclusive. Always review material safety data sheets before working with chemicals.

| NAME | C.A.S. NUMBER |
|---|---|
| A-alpha C | 26148-68-5 |
| Acetaldehyde | 76-07-0 |
| Acetamide | 60-35-5 |
| Acetochlor | 34256-82-1 |
| 2-Acetylaminofluorene | 53-96-3 |
| Acifluorfen | 62476-59-9 |
| Acrylamide | 79-06-1 |
| Acrylonitrile | 107-13-1 |
| Actinomycin D | 50-76-0 |
| Adriamycin | 23214-92-8 |
| AF-2 | 3588-53-7 |
| Aflatoxins | |
| Alachlor | 15972-60-8 |
| Aldrin | 309-00-2 |
| Allyl chloride | 107-05-1 |
| 2-Aminoanthraquinone | 117-79-3 |
| p-Aminoazobenzene | 60-09-3 |
| Ortho-Aminoazotoluene | 97-56-3 |
| 4-Aminobiphenyl | 92-67-1 |
| 3-Amino-9ethylcarbazole hydrochloride | 6109-97-3 |
| 1-Amino-2-methylanthraquinone | 82-28-0 |
| 2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole | 712-68-5 |
| Amitrole | 61-82-5 |
| Aniline | 62-53-3 |
| Ortho-Anisidine | 90-04-0 |
| Ortho-Anisidine hydrochloride | 134-29-2 |
| Antimony oxide (Antimony trioxide) | 1309-64-4 |
| Aramite | 140-57-8 |
| Arsenic (inorganic arsenic compounds) | |
| Asbestos | 1332-21-4 |
| Auramine | 492-80-8 |
| Azaserine | 115-02-6 |
| Azathiprine | 336-86-6 |
| Azacitidine | 320-67-2 |
| Azobenzene | 103-33-3 |
| Benz(a)anthracene | 56-55-3 |

| Name | C.A.S. Number |
|---|---|
| Benzene | 71-43-2 |
| Benzidine (and its salts) | 92-87-5 |
| Benzo [b] fluoranthene | 205-99-2 |
| Benzo [j] fluoranthene | 205-82-3 |
| Benzo [k] fluoranthene | 207-08-9 |
| Benzofuran | 271-89-6 |
| Benzo [a] pyrene | 50-32-8 |
| Benzotrichloride | 98-07-7 |
| Benzyl chloride | 100-44-7 |
| Benzyl violet 4B | 1694-09-3 |
| Beryllium and beryllium compounds | |
| Betel quid with tobacco | |
| Bis(2-chloroethyl)ether | 111-44-4 |
| N,N,-Bis(2-chloroethyl)-2-naphthylamine<br><br>(Chlornapazine) | 494-03-1 |
| Bischloroethyl nitrosourea (BCNU) (Carmustine) | 154-93-8 |
| Bis (chloromethyl) ether | 542-88-1 |
| Bitumens, extraxts of steam-refined and air-refined | |
| Bracken fern | |
| Bromodichloromethane | 75-27-4 |
| Bromoform | 75-25-2 |
| 1,3-Butadiene | 106-99-0 |
| 1,4-Butanediol dimethylsulfonate (Busulfan) | 55-98-1 |
| Butylated hydroxyanisole | 25013-16-5 |
| beta-Butyrolactone | 3068-88-0 |
| Cadmium and cadmium compounds | |
| Captafol | 2425-06-1 |
| Captan | 133-06-2 |
| Carbon tetrachloride | 56-23-5 |
| Carbon-blac extracts | |
| Ceramic fibers | |
| Chlroambucil | 305-03-3 |
| Chloramphenicol | 56-75-7 |
| Chlordane | 57-74-9 |
| Chlordecone (Kepone) | 143-50-0 |
| Chlordimeform | 6164-98-3 |
| Chlorendic acid | 115-28-6 |
| Chlorinated paraffins | 108171-26-2 |
| Chlordibromethane | 124-48-1 |
| Chlorethane (Ethyl chloride) | 75-00-3 |

| | |
|---|---|
| 1-(2-Chloroethyl)-3-cyclohexyl-1- nitrosourea | 13010-47-4 |
| 1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU) | 13909-09-6 |
| Chloroform | 67-66-3 |
| Chloromethyl methyl ether | 107-30-2 |
| 3-Chloro-2-methylpropene | 563-47-3 |
| 4-Chloro-ortho-phenylenediamine | 95-83-0 |
| p-Chloro-o-orthotoludidene | 95-69-2 |
| Chlorothalonil | 1897-45-6 |
| Chlorozotocin | 54749-90-5 |
| Chromium (hexavalent) | |
| Chrysene | 218-01-9 |
| C. I. Acid Red 114 | 6459-94-5 |
| C. I. Basic Red 9 monohydrochloride | 569-61-9 |
| Ciclosporin (Cyclosporin A; Cyclosporine) | 59865-13-3; 79217-60- |
| Cinnamyl anthranilate | 87-29-6 |
| Cisplatin | 15663-27-1 |
| Citrus Red No. 2 | 6358-53-8 |
| Cobalt metal powder | 7440-48-4 |
| Cobalt [II] oxide | 1307-96-6 |
| Conjugated estrogens | |
| Creosotes | |
| para-Cresidine | 120-71-8 |
| Cupferron | 135-20-6 |
| Cycasin | 14901-08-7 |
| Cyclophosphamide (anhydrous) | 50-18-0 |
| Cyclophosphamide (hydrated) | 6055-19-2 |
| D&C Orange No. 17 | 346-83-1 |
| D&C Red No. 8 | 2092-56-0 |
| D&C Red No. 9 | 5160-02-1 |
| D&C Red No. 19 | 81-88-9 |
| Dacarbazine | 4342-03-4 |
| Daminozide | 1596-84-5 |
| Dantron (Chysazin; 1-8- Dihydroanthraquinone | 117-10-2 |
| Daunomycin | 20830-81-3 |
| DDD (Dicholorodiphenyldicholoroethane) | 72-54-8 |
| DDE (Dicholorodiphenyldicholoroethylene) | 72-55-9 |
| DDT (Dicholorodiphenyltricholoroethane) | 50-29-3 |
| DDVP (Dichlorvos) | 62-73-7 |
| N,N'-Diacetylbenzidine | 613-35-4 |
| 2,4-Diaminoanisole | 615-05-4 |
| 2,4-Diaminoanisole sulfate | 39156-41-7 |

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|---|---|
| 4,4’-Diaminodipohenyl ether (4,4’- Oxydianiline) | 101-80-4 |
| 2,4-Diaminotoluene (mixed) | |
| Dibenz[a,h]acridine | 226-36-8 |
| Dibenz[a,j]acridine | 224-42-0 |
| Dibenz[a,h]anthracene | 53-70-3 |
| 7H-Dibenzo[c,g]carbazole | 194-65-4 |
| Dibenzo[a,e]pyrene | 192-65-4 |
| Dibenzo[a,h]pyrene | 189-64-0 |
| Dibenzo[a,i]pyrene | 189-55-9 |
| Dibenzo[a,l]pyrene | 191-30-0 |
| 1,2-Dibromo-3-chloropropane (DBCP) | 96-12-8 |
| p-Dichlorobenzene | 106-46-7 |
| 3,3’-Dichlobenzidine | 91-94-1 |
| 1,4-Dichloro-2-butene | 764-41-0 |
| 3,3’Dichloro-4,4’-diaminodiphenyl ether | 28434-86-8 |
| 1,1-Dichloroethane | 75-34-3 |
| Dichloromethane (Methylene chloride) | 75-09-2 |
| 1,2-Dichloropropane | 78-87-5 |
| 1,3-Dichloropropene | 542-75-6 |
| Dieldrin | 60-57-1 |
| Dienestrol | 84-17-3 |
| Diepoxybutane | 1464-53-5 |
| Diesel engine exhaust | |
| Di(2-ethylhexyl)phthalate | 117-81-7 |
| 1,2-Diethylhydrazine | 1615-80-1 |
| Diethyl sulfate | 64-67-5 |
| Diethylstilbestrol | 56-53-1 |
| Diglycidyl resorcinol ether (DGRE) | 101-90-6 |
| Dihydrosafole | 94-58-6 |
| 3,3’-Dimethoxybenzidine (ortho- Dianisidine) | 119-90-4 |
| 3,3’-Dimethoxybenzidine dihydrochloride (ortho-Dianisidine dihydrochloride) | 20325-40-0 |
| Dimethylcarbamoyl chloride | 79-44-7 |
| 1,1-Dimethylhydrazine (UDMH) | 57-14-7 |
| 1,2-Dimethylhydrazine | 540-73-8 |
| Dimethylvinylchloride | 513-37-1 |
| 1,6-Dinitropyrene | 42397-64-8 |
| 1,8-Dinitropyrene | 42397-65-9 |
| 2,4-Dinitrotoluene | 121-14-2 |
| 1,4-Dioxane | 123-91-1 |
| Diphenylhydantoin (Phenytoin) | 57-41-0 |
| Diphenylhydantoin (Phenytoin), sodium salt | 630-93-3 |
| Direct Black 38 (technical grade) | 1937-37-7 |

| | |
|---|---|
| Direct Blue 6 (technical grade) | 2602-46-2 |
| Direct Brown 95 (technical grade) | 16071-86-6 |
| Disperse Blue 1 | 2475-45-8 |
| Epichlorohydrin | 106-89-8 |
| Erionite | 12510-42-8 |
| Estradiol 17B | 50-28-2 |
| Estrone | 53-16-7 |
| Ethinylestradiol | 57-63-6 |
| Ethyl acrylate | 140-88-5 |
| Ethyl methanesulfonate | 62-50-0 |
| Ethyl-4-4'-dichlorobenzilete | 510-15-6 |
| Ethylene dibromide | 106-93-4 |
| Ethylene dichloride (1,2-Dichloroethane) | 107-06-2 |
| Ethylene oxide | 75-21-8 |
| Ethylene thiourea | 96-45-7 |
| Ethyleneimine | 151-56-4 |
| Folpet | 133-07-3 |
| Formaldehyde | 50-00-0 |
| 2-(2-Formylhydrazino)-4-(5-nitro-2- furyl)thiazole | 67730-11-4 |
| Furazolidone | 67-45-8 |
| Furmecyclox | 60568-05-0 |
| Glu-P-1 (2-Amino-6-methyldipyrido[1,2- a:3',2'-d]imidazole) | 67730-11-4 |
| Glycialdehyde | 765-34-4 |
| Glycidol | 556-52-5 |
| Griseofulvin | 126-07-8 |
| Gyromitrin (Acetaldehyde methylformylhydrazone) | 16568-02-8 |
| HC Blue 1 | 2784-94-3 |
| Heptachlor | 76-44-8 |
| Heptachlor epoxide | 1024-57-3 |
| Hexachlorobenzene | 118-74-1 |
| Hexachlorocyclohexane (technical grade) | |
| Hexachlorodibenzodioxin | 34465-46-8 |
| Hexachloroethane | 67-72-1 |
| Hexamethylphosphoramide | 680-31-9 |
| Hydrazine | 302-01-2 |
| Hydrazine sulfate | 10034-93-2 |
| Hydrazobenzene (1,2-Diphenylhydrazine) | 122-66-7 |
| Indeno [1,2,3-cd]pyrene | 193-39-5 |
| IQ (2-Amino-3-methylimidazo[4,5- f]quinoline) | 76180-96-6 |
| Iron dextran complex | 9004-66-4 |
| Isoafrole | 120-58-1 |

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|---|---|
| Lactofen | 77501-63-4 |
| Lasiocarpine | 303-34-4 |
| Lead acetate | 301-04-2 |
| Lead phosphate | 7446-27-7 |
| Lead subacetate | 1335-32-6 |
| Lindane | |
| Mancozeb | 8018-01-7 |
| Maneb | 12427-38-2 |
| Me-A-alpha-C (2-Amino-3-methyl-9H- pyrido[2,3-b]indole) | 68005-83-7 |
| Medroxyprogesterone acetate | 71-58-9 |
| Melphalan | 148-82-3 |
| Merphalan | 531-76-0 |
| Maestranol | 72-33-3 |
| 8-Methoxypsoralen with ultraviolet A<br><br>tehrapy | 298-81-7 |
| 5-Methoxypsoralen with ultraviolet A<br><br>tehrapy | 484-20-8 |
| 2-Methylaziridine (Propyleneimine) | 75-55-8 |
| Methylazoxymethanol | 590-96-5 |
| Methylazoxymethanol acetate | 592-62-1 |
| 3-Methylcholanthrene | 56-49-5 |
| 5-Methylchrysene | 3697-24-3 |
| 4,4’-Methylene bis(2-choroaniline) | 101-14-4 |
| 4,4’-Methylene bis(N,N- dimethyl)benzenamine | 101-61-1 |
| 4,4’-Methylene bis(2-methylaniline) | 838-88-0 |
| 4,4’-Methylenedianiline | 101-77-9 |
| 4,4’-Methylenedianiline dihydrochloride | |
| Methylhydrazine and its salts | |
| Methyl iodide | 74-88-4 |
| Methyl methanesulfonate | 66-27-3 |
| 2-Methyl-1-nitroanthraquinone | 129-15-7 |
| N-Methyl-N’-nitro-N-nitrosoguanidine | 70-25-7 |
| N-Methylolcrylamide | 924-42-5 |
| Methylthiouracil | 56-04-2 |
| Metiram | 9005-42-2 |
| Metronidazole | 443-48-1 |
| Michler’s ketone | 90-94-8 |
| Mirex | 2385-85-5 |
| Mitomycin C | 50-07-7 |
| Monocrotaline | 315-22-0 |
| 5-(Morpholinomethyl)-3-([5-nitro- furfurylidene)-amino]-2-oxalodidinone | 139-91-3 |

| | |
|---|---|
| Mustard gas | 505-60-2 |
| Nafenopin | 3771-19-5 |
| 1-Naphthylamine | 124-32-7 |
| 2-Naphthylamine | 91-59-8 |
| Nickel and certain nickel compounds | |
| Nickel carbonyl | 13463-39-3 |
| Nickel subsulfide | 12035-72-2 |
| Niridazole | 61-47-4 |
| Nitrilotriacetic acid | 139-13-9 |
| Nitrilotriacetic acid, trisodium salt monohydrate | 18662-53-8 |
| 5-Nitroacenaphthene | 602-87-9 |
| 5-Nitro-o-anisidine | 99-59-2 |
| 4-Nitrobiphenyl | 93-93-3 |
| 6-Nitrochrysene | 7496-02-8 |
| Nitrofen (technical grade) | 1836-75-5 |
| 2-Nitrofluorene | 607-57-8 |
| Nitrofurazone | 59-87-0 |
| 1-[5-Nitrofurfulydene)-amino]-2- imidazolidine | 555-84-0 |
| N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide | 531-82-8 |
| Nitrogen mustard | 51-75-2 |
| Nitrogen mustard hydrochloride (Mechlorethamine hydrochloride) | 55-86-7 |
| Nitrogen mustad N-oxide | 126-85-2 |
| Nitrogen mustad N-oxide hydrochloride | 302-70-5 |
| 2-Nitropropane | 79-46-9 |
| 1-Nitropyrene | 5522-43-0 |
| 4-Nitropyrene | 57835-92-4 |
| N-nitrosodi-n-butylamine | 924-16-3 |
| N-Nitrosodiethanolamine | 1116-54-7 |
| N-Nitrosodiethylamine | 55-18-5 |
| N-Nitrosodimethylamine | 62-75-9 |
| p-Nitrosodiphenylamine | 86-30-6 |
| N-Nitrosodi-n-propylamine | 621-64-7 |
| N-Nitroso-N-ethylurea | 759-73-9 |
| 3-(N-Nitrosomethylamino)-1-(3-pyridil)1- butanone | 64091-91-4 |
| N-Nitrosomethylethylamine | 10595-95-6 |
| N-Nitroso-N-methylurea | 684-93-5 |
| N-Nitroso-N-methylurethane | 615-53-2 |
| N-Nitrosomethylvinylamine | 4549-40-0 |
| N-Nitrosomorpholine | 59-89-2 |
| N-Nitrosonornicotine | 16543-55-8 |
| N-Nitrosopiperidine | 100-75-4 |

| | |
|---|---|
| N-Nitrosopyrrolidine | 930-55-2 |
| N-Nitrososarcosine | 13256-22-9 |
| Norethisterone (Norethindrone) | 68-22-4 |
| Ochratoxin A | 303-47-9 |
| Oxadiazon | 19666-30-9 |
| Oxymetholone | 434-07-1 |
| Panufuran S | |
| Pentachlorphenol | 87-86-5 |
| Phenacetin | 62-44-2 |
| Phenazopyridine | 94-78-0 |
| Phenazopyridine hydrochloride | 136-40-3 |
| Phenesterin | 3546-10-9 |
| Phenobarbital | 50-06-6 |
| Phenoxybenzamine | 59-96-1 |
| Phenoxybenzamine hydrochloride | 63-92-3 |
| Phenyl glycidyl ether | 122-60-1 |
| Phenylhydrazine and its salts | |
| o-Phenylphenate, sodium | 132-27-4 |
| Polybrominated biphenyls | |
| Polychlorinated biphenyls | |
| Polygeenan | 53973-98-1 |
| Ponceau MX | 3761-53-3 |
| Ponceau 3R | 3564-09-8 |
| Potassium bromate | 7758-01-2 |
| Procarbazine | 671-16-9 |
| Procarbazine hydrochloride | 366-70-1 |
| Progesterone | 57-83-0 |
| 1,3-Propane sultone | 1120-71-4 |
| Beta-Propiolectone | 57-57-8 |
| Propylene oxide | 75-56-9 |
| Propylthiouracil | 51-52-5 |
| Reserpine | 50-55-5 |
| Saccharin | 81-07-2 |
| Saccharin, sodium | 128-44-9 |
| Safrole | 94-59-7 |
| Selenium sulfide | 7446-34-6 |
| Silica, crystalline | |
| Streptozotocin | 18883-66-4 |
| Styrene oxide | 96-09-3 |
| Sulfallate | 95-06-7 |
| Talc containing asbestiform fibers | |
| Testosterone and its esters | 58-22-0 |
| 2,3,7,8-Tetrachlorodibenzo-para-dioxin(TCDD) | 1746-01-6 |

| | |
|---|---|
| 1,1,2,2-Tetrachloroethane | 79-34-5 |
| Tetrachloroethylene (Perchloroethylene) | 127-18-4 |
| p-a, a, a-Tetrachlorotoluene | 5216-25-1 |
| Tetranitromethane | 509-14-8 |
| Thioacetamide | 62-55-5 |
| 4,4'-Thiodianiline | 139-65-1 |
| Thiourea | 62-56-6 |
| Thiorium dioxide | 1314-20-1 |
| Toluene diisocyanate | 26471-62-5 |
| ortho-Toluidine | 95-53-4 |
| ortho-Toluidine hydrochloride | 636-21-5 |
| para-Toluidine | 106-49-0 |
| Toxaphene (Polychlorinated camphenes) | 8001-35-2 |
| Trasulfan | 299-75-2 |
| Trichlormethine (Trimustine hydrochloride) | 817-09-4 |
| 2,4,6-Trichlorphenol | 88-06-2 |
| Triphenyltin hydroxide | 76-87-9 |
| Trichloroethylene | 79-01-6 |
| Tris (aziridinyl)-para-benzoquinone (Triaziquone) | 68-76-8 |
| Tris (1-aziridinyl) phosphine sulfide (Thiotepa) | 52-24-4 |
| Tris (2-chlorethyl) phosphate | 115-96-8 |
| Tris (2,3-dibromopropyl) phosphate | 126-72-7 |
| Trp-P-1 (Tryptophan-P-1) | 62450-06-0 |
| Trp-P-2 (Tryptophan-P-2) | 62450-07-1 |
| Trypan blue (commercial grade) | 72-57-1 |
| Uracil mustard | 66-75-1 |
| Urethane (Ethyl carbamate) | 51-79-6 |
| Vinyl bromide | 593-60-2 |
| Vinyl chloride | 75-01-4 |
| 4-Vinyl-1-cyclohexene diepoxide (Vinyl cyclohexene dioxide) | 106-87-6 |
| Vinyl trichloride (1,1,2-Trichloroethane) | 79-00-5 |
| 2,6-Xylidine (2,6-Dimethylaniline) | 87-62-7 |
| Zineb | 12122-67-7 |

# *APPENDIX H: REPRODUCTIVE HAZARDS*

**Reproductive Hazards**

This list is provided as a guide and is not all inclusive. Always review material safety data sheets before working with chemicals.

| NAME | CAS NUMBER |
|---|---|
| Acetaldehyde | 75-07-0 |
| Arsenic | 7440-38-2 |
| Aniline | 62-53-3 |
| Aflatoxins | |
| Benzene | 71-43-2 |
| Benzo(a)pyrene | 50-32-8 |
| Carbon disulfide | 75-15-0 |
| Chloroform | 67-66-3 |
| Chloroprene | 126-99-8 |
| Dimethyl formamide | 68-12-2 |
| Di-sec-octyl-phthalate | 117-81-7 |
| Dinitrooctyl phenol | 63149-81-5 |
| Dithane | 111-54-6 |
| 2-Ethoxy ethanol | 110-80-5 |
| 2-Ethoxyethyl acetate | 111-15-9 |
| Ethylene thiourea | 96-45-7 |
| 2-Ethyhexanol | 104-76-7 |
| Glycol ethers Hydrazine(s) | 302-01-2 |
| Hexafluoroacetone | 684-16-2 |
| Halothane | 151-67-7 |
| Karathane | 131-72-6 |
| Lead (inorganic compounds) | 7439-92-1 |
| 2-Methoxyethanol | 109-86-4 |
| 2-Methoxyethyl acetate | 110-49-6 |
| Methyl chloride | 74-87-3 |
| N-Methyl-2-pyrrolidone | 872-50-4 |
| Propylene glycol monomethyl ether | 107-98-2 |
| Propylene glycol monomethyl ether acetate | 108-65-6 |
| Propylene oxide | 75-56-9 |
| Trichloroethylene | 79-01-6 |
| RH-7592 Systhane/RH-3866 | 88671-89-0 |
| TOK (herbicide) | 1836-75-5 |
| Toluene | 108-88-3 |
| Vinyl chloride | 75-01-4 |

# *APPENDIX I: LASER CLASSIFICATION*

## Laser Classification

All lasers are classified by the manufacturer and labeled with the appropriate warning labels. Any modification of an existing laser or an unclassified laser must be classified by qualified personnel prior to use. The following criteria are used to classify lasers:

Wavelength. If the laser is designed to emit multiple wavelengths the classification is based on the most hazardous wavelength.

For continuous wave (CW) or repetitively pulsed lasers the average power output (Watts) and limiting exposure time inherent in the design are considered.

For pulsed lasers, the total energy per pulse (Joule), pulse duration, pulse repetition frequency and emergent beam radiant exposure are considered.

Laser devices are classified into 7 different classes- Class 1, 1M, 2, 2M, 3R, 3B and 4 based on the ability of the laser beam to cause biological damage to the eye or skin during use. Examples:

**A Class 1 laser system is:**

- Considered to be incapable of producing damaging radiation levels during operation; and
- Exempt from any controls or other forms of surveillance.

Any laser, or laser system containing a laser that cannot emit accessible radiation levels during operation in excess of the applicable Class 1 accessible emission level (AEL) for any duration within the maximum duration (30,000 s except for infrared system where 100 s shall be used) inherent in the design or intended use of the laser or laser system.

Products which have previously been classified as Class IIa (emitting visible radiation less than 0.4 mW) under Federal Laser Product Performance Standard (FLPPS) should be treated as Class 1.

**A Class 1M laser system is:**

- Considered to be incapable of producing hazardous exposure conditions during operation unless the beam is viewed with an optical instrument such as an eye-loupe (diverging beam) or a telescope (collimated beam); and
- Exempt from any controls measures other than to prevent potentially hazardous optically aided viewing; and is exempt from other forms of surveillance.

Any laser, or laser system containing a laser that cannot emit during operation, accessible radiation levels in excess of the applicable Class 1 AEL under the conditions of measurement for the unaided eye, but exceeds the Class 1 AEL for telescopic viewing and does not exceed the Class 3B AEL, for any emission duration within the maximum duration (30,000 s) inherent in the design or intended use of the laser or laser system.

**A Class 2 laser system:**

- Emits in the visible portion of the spectrum (0.4 to 0.7 µm); and
- Eye protection is normally afforded by the aversion response.

**A Class 2M laser system:**

- Emits in the visible portion of the spectrum (0.4 to 0.7 μm); and
- Eye protection is normally afforded by the aversion response for unaided viewing.
- However, Class 2M is potentially hazardous if viewed with optical aids.

Class 2 and 2M lasers and laser systems are visible CW and repetitive-pulse lasers systems which can emit accessible radiation energy exceeding the appropriate Class 1 AEL for the maximum duration inherent in the design or intended use of the system, but not exceeding the Class 1 AEL for any applicable pulse emission duration < 0.25 s and not exceeding average radiation power of 1 mW. Class 2M lasers and laser systems pose the same ocular hazards to the unaided eye as Class 2, but are potentially hazardous when viewed with optical aids.

Any laser, or laser system that cannot emit during operation accessible radiation levels in excess of the applicable Class 2 AEL under the conditions of measurement for the unaided eye, but exceeds the Class 2 AEL for telescopic viewing and does not exceed the Class 3B AEL, for any emission duration within the maximum duration (0.25 s) inherent in the design or intended use of the laser or laser system is a Class 2M laser, or laser system.

**A Class 3R laser system is:**

- Potentially hazardous under some direct and specular reflection viewing condition if the eye is appropriately focused and stable, but the probability of an actual injury is small. This laser will not pose either a fire hazard or diffuse-reflection hazard.

Class R lasers and laser systems include lasers and laser systems which have an accessible output between 1 and 5 times the Class 1 AEL for wavelengths shorter than 0.4 μm or longer than 0.7 μm, or less than 5 times the Class 2 AEL for wavelengths between 0.4 and 0.7 μm.

**A Class 3B laser system:**

- May be hazardous under direct and specular reflection viewing conditions, but is normally not a diffuse-reflection or fire hazard.

AEL for class 3B lasers is greater than that for class 3R lasers and average radiant power $\leq$ 0.5 W for exposure time $\geq$ 0.25 s. Radiant energy for class 3B lasers is $\leq$ 0.125 J for UV (0.18 to 0.4 μm) and infrared (1.4 μm to 1 mm) lasers for exposure times < 0.25 s. Radiant energy limit for class 3B visible (0.4 - 0.7 μm) and near infrared lasers (0.7 - 1.4 μm) is $\leq$ 0.03 J $C_A$ per pulse. Where $C_A = 10^{2(\lambda - 0.700)}$ for wavelength (λ) from 0.700 to 1.050 μm; and $C_A$ = 5 for λ from 1.050 to 1.400 μm. Class 3B lasers require labeling and physical controls to prevent viewing of direct and reflected beam.

**A Class 4 laser system (high power):**

- Is a hazard to eye or skin from the direct beam; and
- May pose a diffuse-reflection or fire hazard.
- May also produce laser generated air contaminants (LGAC) and hazardous plasma radiation.

AEL for Class 4 lasers and laser systems is greater than that for class 3B lasers.

Laser and laser systems designated for a specific class by a manufacturer in accordance with the Federal Laser Product Performance Standard (FLPPS) (or latest version thereof) or International Electrotechnical Commission (IEC) 60825-1 (or latest version thereof) may be considered as fulfilling all classification requirements of the ANSI standards. In cases where the Laser and laser system classification is not provided, or where the class level may change because of addition or deletion of engineering controls, the Laser and laser system classification shall be classified by the Laser Safety Officer (LSO).

**Changes in classification in the new standard:**

- All former Class 1 are now Classes 1 and 1M.
- Most former Class 2 are now Class 2 (or 2M if a highly diverging beam, e.g., a diode laser).
- All former products labeled as ANSI Class 3a (IEC 3B) with a "Danger" logo, such as most laser pointers are renamed Class 3R.
- Laser products previously classified as Class 3a are now 3R unless beam diameter exceeded 7 mm, in which case they could Class 1M and 2M if reassessed.

**Embedded Systems:**

Class 2, 3 or 4 lasers or laser systems contained in a protective housing and operated in a lower classification mode may be classified at a lower classification. Specific control measures may be required to maintain the lower classification. For embedded systems that are non-commercial design and construction, the University LSO shall determine the classification.

For the purposes of laser safety, a direct beam, which has been reflected from a mirror or polished surface, is considered to be as intense as the direct beam. Laser beams, which hit flat or non-mirror like surfaces are considered to be diffused and the diffusely reflected beam is not as intense or as well defined as the direct beam.

# *APPENDIX J: CHEMICAL COMPATIBILITY STORAGE GUIDELINES*

## Chemical Compatibility Storage Guidelines

| | |
|---|---|
| Flammables | Vapors ignite easily at room temperature. Examples include alcohols, esters, ketones, ethers, and pyrophorics.<br><br>Store flammable liquids in approved flammable storage cabinets or approved flammable storage areas<br><br>Keep away from heat, sun, flame, and spark sources<br><br>Separate flammable solids from other hazard classes |
| Oxidizers | Materials which yield oxygen.: react with water, fire, flammables and combustibles. Examples include inorganic nitrates, permanganates, persulfates, and perchlorates.<br><br>Oxidizers should not be stored directly on wooden shelves or on paper liners. Spills may react with the organic portion of the shelf or paper and ignite spontaneously. Perchloric acid presents special hazards and should be given special consideration to assure isolation from oxidizable materials and dehydrating agents. Hypochlorite solutions (i.e. bleach) are oxidizers; however, they will release chlorine gas on contact with acids and thus should be stored separately.<br><br>Keep separate from flammables and other organic materials. Keep separate from reducing agents (i.e., zinc, alkaline metals, formic acid)<br><br>Peroxide formers should be labeled with date received and opened, and should be discarded as hazardous waste within three to six months of opening. Depending on the chemical, unopened peroxide formers should be discarded within 12 months of receipt. |
| Acids | Materials with pH<5. Examples include acetic, chromic, and hydrofluoric.<br><br>Separate from bases and materials which could evolve toxic vapors on contact (i.e., sodium cyanide)<br><br>Store large bottles low to the ground - at least below eye level.<br><br>Separate inorganic acids from organic acids (i.e., acetic, oxalic, etc.)<br><br>Separate from active metals (i.e., sodium, potassium)<br><br>Store perchloric and nitric acid as oxidizers |

| | |
|---|---|
| Toxics | Dangerous if inhaled, swallowed or absorbed through the skin. Examples include phenol and hydrazine.<br>Store according to label directions<br>Separate from other hazard classes<br>Keep tightly sealed |
| Bases | Materials with pH>9. Examples include ammonium hydroxide, calcium hydroxide, and sodium hydroxide<br>Separate from acids<br>Store solutions of inorganic hydroxides in polyethylene containers<br>Store large containers below eye level |
| Water Reactives | React with water to yield flammable or toxic gases, or other hazardous conditions. Examples include hypochlorite compounds and metal hydrides<br>Keep away from water sources-do nor store above or below sinks<br>Use dry chemical extinguisher for fire |
| Gases | Materials contained under pressure in metal cylinders.<br>Examples include hydrogen, nitrogen, and carbon dioxide. Segregate according to hazard class. Acutely toxic and toxic gases should be stored in gas cabinets.<br>Cylinders should be chained or strapped to a substantial, fixed surface<br>Cylinders should be turned off at the cylinder when not in use and should be capped when stored. |

# *APPENDIX K: LIMITS FOR AIR CONTAMINANTS – TABLE Z-1*

**Limits for Air Contaminants: Table Z-1**

**TABLE Z-1**

| SUBSTANCE | CAS NO.(c) | PPM (a) \1\ | mg/m$^3$ (b) \1\ | SKIN |
|---|---|---|---|---|
| Acetaldehyde | 75-07-0 | 200 | 360 | |
| Acetic acid | 64-19-7 | 10 | 25 | |
| Acetic anhydride | 108-24-7 | 5 | 20 | |
| Acetone | 67-64-1 | 1000 | 2400 | |
| Acetonitrile | 75-05-8 | 40 | 70 | |
| 2-Acetylaminofluorine; see 29 CFR 1910.1014 | 53-96-3 | | | |
| Acetylene dichloride; see 1,2-Dichloroethylene | | | | |
| Acetylene tetrabromide | 79-27-6 | 1 | 14 | |
| Acrolein | 107-02-8 | 0.1 | 0.25 | |
| Acrylamide | 79-06-1 | | 0.3 | X |
| Acrylonitrile; see 29 CFR 1910.1045 | 107-13-1 | | | |
| Aldrin | 309-00-2 | | 0.25 | X |
| Allyl alcohol | 107-18-6 | 2 | 5 | X |
| Allyl chloride | 107-05-1 | 1 | 3 | |
| Allyl glycidyl ether (AGE) | 106-92-3 | (C)10 | (C)45 | |
| Allyl propyl disulfide | 2179-59-1 | 2 | 12 | |
| Alpha-Alumina Total dust Respirable fraction | 1344-28-1 | | 15 | |
| Aluminum, metal (as Al) Total dustRespirable fraction | 7429-90-5 | | 15 | |
| 4-Aminodiphenyl; see 29 CFR 1910.1011 | 92-67-1 | | | |
| 2-Aminoethanol; see Ethanolamine | | | | |
| 2-Aminopyridine | 504-29-0 | 0.5 | 2 | |
| Ammonia | 7664-41-7 | 50 | 35 | |
| Ammonium sulfamate Total dust Respirable fraction | 7773-06-0 | | 15 | |
| n-Amyl acetate | 628-63-7 | 100 | 525 | |

| | | | | |
|---|---|---|---|---|
| sec-Amyl acetate | 626-38-0 | 125 | 650 | |
| Aniline and homologs | 62-53-3 | 5 | 19 | X |
| Anisidine (o-, p- isomers) | 29191-52-3 | | 0.5 | X |
| Antimony and compounds (as Sb) | 7440-36-0 | | 0.5 | |
| ANTU (alpha Naphthylthiourea) | 86-88-4 | | 0.3 | |
| Arsenic, inorganic compounds (as As) ; see 29 CFR 1910.1018 | 7440-38-2 | | | |
| Arsenic, organic compounds (as As) | 7440-38-2 | | 0.5 | |
| Arsine | 7784-42-1 | 0.05 | 0.2 | |
| Asbestos; see 29 CFR 1910.1001 | (\4\) | | | |
| Azinphos-methyl | 86-50-0 | | 0.2 | X |
| Barium, soluble compounds (as Ba) | 7440-39-3 | | 0.5 | |
| Barium sulfate Total dust<br>Respirable fraction | 7727-43-7 | | <br>15 | |
| Benomyl Total dust<br>Respirable fraction | 17804-35-2 | | <br>15 | |
| Benzene; see 29 CFR 1910.1028<br>See Table Z-2 for the limits applicable in the operations or sectors excluded in | 71-43-2 | | | |
| Benzidine; see 29 CFR 1910.1010 | 92-87-5 | | | |
| p-Benzoquinone; see Quinone | | | | |
| Benzo(a)pyrene; see Coal tar pitch Volatiles | | | | |
| Benzoyl peroxide | 94-36-0 | | 5 | |
| Benzyl chloride | 100-44-7 | 1 | 5 | |
| Beryllium and beryllium compounds (as Be) | 7440-41-7 | | (\2\) | |
| Biphenyl; see Diphenyl | | | | |
| Bismuth telluride, Undoped<br>Total dust | 1304-82-1 | | <br>15 | |
| Boron oxide Total dust | 1303-86-2 | | <br>15 | |
| Boron trifluoride | 7637-07-2 | (C)1 | (C)3 | |
| Bromine | 7726-95-6 | 0.1 | 0.7 | |

| | | | | |
|---|---|---|---|---|
| Bromoform | 75-25-2 | 0.5 | 5 | X |
| Butadiene (1,3-Butadiene); see 29 CFR 1910.1051; 29 CFR | 106-99-0 | 1 ppm/5 ppm STEL | | |
| 1910.19(1) | | | | |
| Butanethiol; see Butyl mercaptan | | | | |
| 2-Butanone (Methyl ethyl ketone) | 78-93-3 | 200 | 590 | |
| 2-Butoxyethanol | 111-76-2 | 50 | 240 | X |
| n-Butyl acetate | 123-86-4 | 150 | 710 | |
| Sec-Butyl acetate | 105-46-4 | 200 | 950 | |
| Tert-Butyl acetate | 540-88-5 | 200 | 950 | |
| n-Butyl alcochol | 71-36-3 | 100 | 300 | |
| Sec-Butyl alcohol | 78-92-2 | 150 | 450 | |
| Tert-Butyl alcohol | 75-65-0 | 100 | 300 | |
| Butylamine | 109-73-9 | (C)5 | (C)15 | X |
| Tert-Butyl chromate (as$CrO_3$) | 1189-85-1 | | (C)0.1 | X |
| n-Butyl glycidyl ether (BGE) | 2426-08-6 | 50 | 270 | |
| Butyl mercaptan | 109-79-5 | 10 | 35 | |
| p-tert-Butyltoluene | 98-51-1 | 10 | 60 | |
| Cadmium (as Cd); see 29 CFR 1910.1027 | 7440-43-9 | | | |
| Calcium carbonate Total dust Respirable fraction | 1317-65-3 | | 15 | |
| Calcum hydroxide Total dust Respirable fraction | 1305-62-0 | | 15 | |
| Calcium oxide | 1305-78-8 | | 5 | |
| Calcium silicate Total dust Respirable fraction | 1344-95-2 | | 15 | |
| Calcium sulfate Total dust Respirable fraction | 7778-18-9 | | 15 | |
| Camphor, synthetic | 76-22-2 | | 2 | |
| Carbaryl (Sevin) | 63-25-2 | | 5 | |
| Carbon black | 1333-86-4 | | 3.5 | |
| Carbon dioxide | 124-38-9 | 5000 | 9000 | |
| Carbon disulfide | 75-15-0 | | (\2\) | |
| Carbon monoxide | 630-08-0 | 50 | 55 | |
| Carbon tetrachloride | 56-23-5 | | (\2\) | |
| Cellulose Total dust Respirable fraction | 9004-34-6 | | 15 | |
| Chlordane | 57-74-9 | | 0.5 | X |
| Chlorinated camphene | 8001-35-2 | | 0.5 | X |
| Chlorinated diphenyl oxide | 55720-99-5 | | 0.5 | |

| | | | | |
|---|---|---|---|---|
| Chlorine | 7782-50-5 | (C)1 | (C)3 | |
| Chlorine dioxide | 10049-04-4 | 0.1 | 0.3 | |
| Chlorine trifluoride | 7790-91-2 | (C)0.1 | (C)0.4 | |
| Chloroacetaldehyde | 107-20-0 | (C)1 | (C)3 | |
| a-Chloroacetophenone (Phenacyl chloride) | 532-27-4 | 0.05 | 0.3 | |
| Chlorobenzene | 108-90-7 | 75 | 350 | |
| o-Chlorobenzylidene malonitrile | 2698-41-1 | 0.05 | 0.4 | |
| Chlorobromomethane | 74-97-5 | 200 | 1050 | |
| 2-Chloro-1,3-butadiene; see beta-Chloroprene | | | | |
| Chlorodiphenyl (42% Chlroine) (PCB) | 53469-21-9 | | 1 | X |
| Chlorodiphenyl (54% Chlorine) (PCB) | 11097-69-1 | | 0.5 | X |
| 1-Chloro-2, 3-epoxypropane; see Epichlorohydrin | | | | |
| 2-Chloroethanol; see Ethylene chlorohydrin | | | | |
| Chloroethylene; see Vinyl chloride | | | | |
| Chloroform (Trichloromethane) | 67-66-3 | (C)50 | (C)240 | |
| bis(Chloromethyl) ether; see 29 CFR 1910.1008 | 542-88-1 | | | |
| Chloromethyl methyl ether; see29 CFR 1910.1006 | 107-30-2 | | | |
| 1-Chloro-1-nitropropane | 600-25-9 | 20 | 100 | |
| Chloropicrin | 76-06-2 | 0.1 | 0.7 | |
| beta-Chloroprene | 126-99-8 | 25 | 90 | X |
| 2-Chloro-6-(trichloromethyl) pyridine Total dust Respirable fraction | 1929-82-4 | | | |
| Chromic acid and chromates (as $CrO_3$) | (\4\) | | (\2\) | |
| Chromium (II) compounds (as Cr) | 7440-47-3 | | 0.5 | |
| Chromium (III) compounds (as Cr) | 7440-47-3 | | 0.5 | |
| Chromium metal and insol. Salts (as Cr) | 7440-47-3 | | 1 | |
| Chrysene; see Coal tar pitch volatiles | | | | |
| Clopidol Total dust<br>Respirable fraction | 2971-90-6 | | 15 | |
| Coal dust (less than 5% $SiO_2$), respirable fraction | | | (\3\) | |

| | | | | |
|---|---|---|---|---|
| Coal dust (greater than or equal to 5% $SiO_2$), respirable fraction | | | (\3\) | |
| Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene | 65966-93-2 | | 0.2 | |
| Cobalt metal, dust, and fume (as Co) | 7440-48-4 | | 0.1 | |
| Coke oven emissions; see 29 CFR 1910.1029 | | | | |
| Copper Fume (as Cu) | 7440-50-8 | | 0.1 | |
| Cotton dust[e]; see 29 CFR 1910.1043 | | | 1 | |
| Crag herbicide (Sesone) Total dust Respirable fraction | 136-78-7 | | 15 | |
| Cresol, all isomers | 1319-77-3 | 5 | 22 | X |
| Crotonoaldehyde | 123-73-9; 4170-30-3 | 2 | 6 | |
| Cumene | 98-82-8 | 50 | 245 | X |
| Cyanides (as CN) | (\4\) | | 5 | X |
| Cyclohexane | 110-82-7 | 300 | 1050 | |
| Cyclohexanol | 108-93-0 | 50 | 200 | |
| Cyclohexanone | 108-94-1 | 50 | 200 | |
| Cyclohexene | 110-83-8 | 300 | 1015 | |
| Cyclopentadiene | 542-92-7 | 75 | 200 | |
| 2,4-D (Dichlorophenoxyacetic acid) | 94-75-7 | | 10 | |
| Decaborane | 17702-41-9 | 0.05 | 0.3 | X |
| Demeton (Systox) | 8065-48-3 | | 0.1 | X |
| Diacetone alcohol (4-Hydroxy-4- methyl-2-pentanone) | 123-42-2 | 50 | 240 | |
| 1,2-Diaminoethane; see Ethylenediamine | | | | |
| Diazomethane | 334-88-3 | 0.2 | 0.4 | |
| Diborane | 19287-45-7 | 0.1 | 0.1 | |
| 1,2-Dibromo-3-chloropropane (DBCP); see 29 CFR 1910.1044 | 96-12-8 | | | |
| 1,2-Dibromoethane; see Ethylene dibromide | | | | |
| Dibutyl phosphate | 107-66-4 | 1 | 5 | |
| Dibutylphthalate | 84-74-2 | | 5 | |

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|---|---|---|---|---|
| o-Dichlorobenzene | 95-50-1 | (C)50 | (C)300 | |
| p-Dichlorobenzene | 106-46-7 | 75 | 450 | |
| 3,'-Dicholobenzidine; see 29 CFR 1910.1007 | 91-94-1 | | | |
| Dichlorodifluoromethane | 75-71-8 | 1000 | 4950 | |
| 1,3-Dichloro-5,5-dimethyl hydantoin | 118-52-5 | | 0.2 | |
| Dicholorodiphenyltricholoroethan e (DDT) | 50-29-3 | | 1 | X |
| 1,1-Dichloroethane | 75-34-3 | 100 | 400 | |
| 1,2-Dichloroethane; see Ethylene chloride | | | | |
| 1,2-Dichloroethylene | 540-59-0 | 200 | 790 | |
| Dicholoroethyl ether | 111-44-4 | (C)15 | (C)90 | X |
| Dicholoromethane; see Methylene chloride | | | | |
| Dicholoromonofluoromethane | 75-43-4 | 1000 | 4200 | |
| 1,1-Dichloro-1-nitroethane | 594-72-9 | (C)10 | (C)60 | |
| 1,2-Dicholoropropane; see Propylene dichloride | | | | |
| Dichlorotetrafluoroethane | 76-14-2 | 1000 | 7000 | |
| Dichlorvos (DDVP) | 62-73-7 | | 1 | X |
| Dicyclopentadienyl iron Total dust Respirable fraction | 102-54-5 | | 15 | |
| Dieldrin | 60-57-1 | | 0.25 | X |
| Diethylamine | 109-89-7 | 25 | 75 | |
| 2-Diethylaminoethanol | 100-37-8 | 10 | 50 | X |
| Diethyl ether; see Ethyl ether | | | | |
| Difluorodibromomethane | 75-61-6 | 100 | 860 | |
| Diglycidyl ether (DGE) | 2238-07-5 | (C)0.5 | (C)2.8 | |
| Dihydroxybenzene; see Hydroquinone | | | | |
| Disiobutyl ketone | 108-83-8 | 50 | 290 | |
| Diisopropylamine | 108-18-9 | 5 | 20 | X |
| 4-Dimethylaminoazobenzene; see 29 CFR 1910.1015 | 60-11-7 | | | |
| Dimethoxymethane; see Methylal | | | | |
| Dimethyl acetamide | 127-19-5 | 10 | 35 | X |
| Dimethylamine | 124-40-3 | 10 | 18 | |
| Dimethylaminobenzene; see Xylidine | | | | |
| Dimethylaniline (N,N-Dimethylaniline) | 121-69-7 | 5 | 25 | X |
| Dimethylbenzene; see Xylene | | | | |

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|---|---|---|---|---|
| Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate | 300-76-5 | | 3 | |
| Dimethylformamide | 68-12-2 | 10 | 30 | X |
| 2,6-Dimethyl-4-heptanone; see Diisobutyl ketone | | | | |
| 1,1-Dimethylhydrazine | 57-14-7 | 0.5 | 1 | X |
| Dimethylphthalate | 131-11-3 | | 5 | |
| Dimethyl sulfate | 77-78-1 | 1 | 5 | X |
| Dinitrobenzene (all isomers) (ortho)<br>(metha)<br>(para) | <br>528-29-0<br>99-65-0 | | 1 | X |
| Dinitro-o-cresol | 534-52-1 | | 0.2 | X |
| Dinitrotoluene | 25321-14-6 | | 1.5 | X |
| Dioxane (Diethylene dioxide) | 123-91-1 | 100 | 360 | X |
| Diphenyl (Biphenyl) | 92-52-4 | 0.2 | 1 | |
| Diphenylmethane diisocyanate; see Methylene bisphenyl isocyanate | | | | |
| Dipropylene glycol methyl ether | 34590-94-8 | 100 | 600 | X |
| Di-sec octyl phthalate (Di-(2-ethylhexyl) phthalate) | 117-81-7 | | 5 | |
| Emery Total dust Respirable fraction | 12415-34-8 | | | |
| Endrin | 72-20-8 | | 0.1 | X |
| Epichlorohydrin | 106-89-8 | 5 | 19 | X |
| EPN | 2104-64-5 | | 0.5 | X |
| 1,2-Epoxypropane; see Propylene oxide | | | | |
| 2,3-Epoxy-1-propanol; see Glycidol | | | | |
| Ethanethiol; see Ethyl mercaptan | | | | |
| Ethanolamine | 141-43-5 | 3 | 6 | |
| 2-Ethoxyethanol (Cellosolve) | 110-80-5 | 200 | 740 | X |
| 2-Ethoxyethyl acetate (Cellosolve acetate) | 111-15-9 | 100 | 540 | X |
| Ethyl acetate | 141-78-6 | 400 | 1400 | |
| Ethyl acrylate | 140-88-5 | 25 | 100 | X |
| Ethyl alcohol (Ethanol) | 64-17-5 | 1000 | 1900 | |
| Ethylamine | 75-04-7 | 10 | 18 | |
| Ethyl amyl ketone (5-Methyl-3-heptanone) | 541-85-5 | 25 | 130 | |
| Ethyl benzene | 100-41-4 | 100 | 435 | |
| Ethyl bromide | 74-96-4 | 200 | 890 | |
| Ethyl butyl ketone (3-Heptanone) | 106-35-4 | 50 | 230 | |

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|---|---|---|---|---|
| Ethyl chloride | 75-00-3 | 1000 | 2600 | |
| Ethyl ether | 60-29-7 | 400 | 1200 | |
| Ethyl formate | 109-94-4 | 100 | 300 | |
| Ethyl mercaptan | 75-08-1 | (C)10 | (C)25 | |
| Ethyl silicate | 78-10-4 | 100 | 850 | |
| Ethylene chlorohydrin | 107-07-3 | 5 | 16 | X |
| Ethylenediamine | 107-15-3 | 10 | 25 | |
| Ethylene dibromide | 106-93-4 | | (\2\) | |
| Ethylene dichloride (1,2-Dichloroethane) | 107-06-2 | | (\2\) | |
| Ethylene glycol dinitrate | 628-96-6 | (C)0.2 | (C)1 | X |
| Ethylene glycol methyl acetate; see Methyl cellosolve acetate | | | | |
| Ethyleneimine; see 29 CFR 1910.1012 | 151-56-4 | | | |
| Ethylene oxide; see 29 CFR 1910.1047 | 75-21-8 | | | |
| Ethylidene chloride; see 1,1-Dichloroethane | | | | |
| N-Ethylmorpholine | 100-74-3 | 20 | 94 | X |
| Ferbam Total dust | 14484-64-1 | | | |
| Ferrovanadium dust | 12604-58-9 | | 1 | |
| Fluorides (as F) | (\4\) | | 2.5 | |
| Fluorine | 7782-41-4 | 0.1 | 0.2 | |
| Fluorotrichloromethane (Trichlorofluoromethane) | 75-69-4 | 1000 | 5600 | |
| Formaldehyde; see 29 CFR 1910.1048 | 50-00-0 | | | |
| Formic acid | 64-18-6 | 5 | 9 | |
| Furfural | 98-01-1 | 5 | 20 | X |
| Furfuryl alcohol | 98-00-0 | 50 | 200 | |
| Grain dust (oat, wheat, barley) | | | 10 | |
| Glycerin (mist) Total dust<br>Respirable fraction | 56-81-5 | | <br>15 | |
| Glycidol | 556-52-5 | 50 | 150 | |
| Glycol monoethyl ether; see 2-Ethoxyethanol | | | | |
| Graphite, natural, respirable dust | 7782-42-5 | | (\3\) | |
| Graphite, synthetic Total dust Respirable fraction | | | 15 | |
| Guthion; see Azinphos methyl | | | | |
| Gypsum | 13397-24-5 | | | |

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|---|---|---|---|---|
| Total dust<br>Respirable fraction | | | 15<br>5 | |
| Hafnium | 7440-58-6 | | 0.5 | |
| Heptachlor | 76-44-8 | | 0.5 | X |
| Heptane (n-Heptane) | 142-82-5 | 500 | 2000 | |
| Hexachloroethane | 67-72-1 | 1 | 10 | X |
| Hexachloronaphthalene | 1335-87-1 | | 0.2 | X |
| n-Hexane | 110-54-3 | 500 | 1800 | |
| 2-Hexanone (Methyl n-butyl ketone) | 591-78-6 | 100 | 410 | |
| Hexone (Methyl isobutyl ketone) | 108-10-1 | 100 | 410 | |
| Sec-Hexyl acetate | 108-84-9 | 50 | 300 | |
| Hydrazine | 302-01-2 | 1 | 1.3 | X |
| Hydrogen bromide | 10035-10-6 | 3 | 10 | |
| Hydrogen chloride | 7647-01-0 | (C)5 | (C)7 | |
| Hydrogen cyanide | 74-90-8 | 10 | 11 | X |
| Hydrogen fluoride (as F) | 7664-39-3 | | (\2\) | |
| Hydrogen peroxide | 7722-84-1 | 1 | 1.4 | |
| Hydrogen selenide ( as Se) | 7783-07-5 | 0.05 | 0.2 | |
| Hydrogen sulfide | 7783-06-4 | | (\2\) | |
| Hydroquinone | 123-31-9 | | 2 | |
| Iodine | 7553-56-2 | (C)0.1 | (C)1 | |
| Iron oxide fume | 1309-37-1 | | 10 | |
| Isoamyl acetate | 123-92-2 | 100 | 525 | |
| Isoamyl alcohol (primary and secondary) | 123-51-3 | 100 | 360 | |
| Isobutyl acetate | 110-19-0 | 150 | 700 | |
| Isobutyl alcohol | 78-83-1 | 100 | 300 | |
| Isophorone | 78-59-1 | 25 | 140 | |
| Isopropyl acetate | 108-21-4 | 250 | 950 | |
| Isopropyl alcohol | 67-63-0 | 400 | 980 | |
| Isopropylamine | 75-31-0 | 5 | 12 | |
| Isopropyl ether | 108-20-3 | 500 | 2100 | |
| Isopropyl glycidyl ether (IGE) | 4016-14-2 | 50 | 240 | |
| Kaolin<br>Total dust | 1332-58-7 | | <br>15 | |
| Ketene | 463-51-4 | 0.5 | 0.9 | |
| Lead, inorganic (as Pb); see 29 CFR 1910.1025 | 7439-91-1 | | | |
| Limestone Total dust<br>Respirable fraction | 1317-65-3 | | <br>15 | |
| Lindane | 58-89-9 | | 0.5 | X |
| Lithium hydride | 7580-67-8 | | 0.025 | |

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| L.P.G. (Liquefied petroleum gas) | 68476-85-7 | 1000 | 1800 | |
| Magnesite Total dust<br>Respirable fraction | 546-93-0 | | 15 | |
| Magnesium oxide fume<br>Total particulate | 1309-48-4 | | 15 | |
| Malathion<br>Total dust | 121-75-5 | | 15 | X |
| Maleic anhydride | 108-31-6 | 0.25 | 1 | |
| Manganese compounds (as Mn) | 7439-96-5 | | (C)5 | |
| Manganese fume (as Mn) | 7439-96-5 | | (C)5 | |
| Marble<br>Total dust | 1317-65-3 | | 15 | |
| Mercury (aryl and inorganic) (as Hg) | 7439-97-6 | | (\2\) | |
| Mercury (organo) alkyl compounds (as Hg) | 7439-97-6 | | (\2\) | |
| Mecury (vapor) (as Hg) | 7439-97-6 | | (\2\) | |
| Mesityl oxide | 141-79-7 | 25 | 100 | |
| Methanethiol; see Methyl mercaptan | | | | |
| Methoxychlor<br>Total dust | 72-43-5 | | 15 | |
| 2-Methoxyethanol (Methyl cellosolve) | 109-86-4 | 25 | 80 | X |
| 2-Methoxyethyl acetate (Methyl cellsolve acetate) | 110-49-6 | 25 | 120 | X |
| Methyl acetate | 79-20-9 | 200 | 610 | |
| Methyl acetylene (Propyne) | 74-99-7 | 1000 | 1650 | |
| Methyl acetylene-propadiene mixture (MAPP) | | 1000 | 1800 | |
| Methyl acrylate | 96-33-3 | 10 | 35 | X |
| Methylal (Dimethoxy-methane) | 109-87-5 | 1000 | 3100 | |
| Methyl alcohol | 67-56-1 | 200 | 260 | |
| Methylamine | 74-89-5 | 10 | 12 | |
| Methyl amyl alcohol; see Methyl isobutyl carbinol | | | | |
| Methyl n-amyl ketone | 110-43-0 | 100 | 465 | |
| Methyl bromide | 74-83-9 | (C)20 | (C)80 | X |
| Methyl butyl ketone; see 2-Hexanone | | | | |

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| Methyl cellosolve; see 2-Methoxyethyl acetate | | | | |
| Methyl chloride | 74-87-3 | | (\2\) | |
| Methyl chloroform (1,1,1-Trichloroethane) | 71-55-6 | 350 | 1900 | |
| Methylcyclohexane | 108-87-2 | 500 | 2000 | |
| Methylcyclohexanol | 25639-42-3 | 100 | 470 | |
| o-Methylcyclohexanone | 583-60-8 | 100 | 460 | X |
| Methylene chloride | 75-09-2 | | (\2\) | |
| Methyl ethyl ketone (MEK); see 2-Butanone | | | | |
| Methyl formate | 107-31-3 | 100 | 250 | |
| Methyl hydrazine (Monomethyl hydrazine) | 60-34-4 | (C)0.2 | (C)0.35 | X |
| Methyl iodide | 74-88-4 | 5 | 28 | X |
| Methyl isoamyl ketone | 110-12-3 | 100 | 475 | |
| Methyl isobutyl carbinol | 108-11-2 | 25 | 100 | X |
| Methyl isobutyl ketone; see Hexone | | | | |
| Methyl isocyanate | 624-83-9 | 0.02 | 0.05 | X |
| Methyl mercaptan | 74-93-1 | (C)10 | (C)20 | |
| Methyl methacrylate | 80-62-6 | 100 | 410 | |
| Methyl propyl ketone; see 2-Pentanone | | | | |
| alpha-Methyl styrene | 98-83-9 | (C)100 | (C)480 | |
| Methylene bisphenyl isocyanate (MDI) | 101-68-8 | (C)0.02 | (C)0.2 | |
| Mica; see Silicates | | | | |
| Molybdenum (as Mo) Soluble compounds Insoluble compounds Total dust | 7439-98-7 | | 5 | |
| Monomethyl aniline | 100-61-8 | 2 | 9 | X |
| Monomethyl hydazine; see Methyl hydrazine | | | | |
| Morpholine | 110-91-8 | 20 | 70 | X |
| Naphtha (Coal tar) | 8030-30-6 | 100 | 400 | |
| Naphthalene | 91-20-3 | 10 | 50 | |
| alpha-Naphthylamine; see 29 CFR 1910.1004 | 134-32-7 | | | |
| beta-Naphthylamine; see 29 CFR 1910.1009 | 91-59-8 | | | |

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| Nickel carbonyl (as Ni) | 13463-39-3 | 0.001 | 0.007 | |
| Nickel, metal and insoluble compounds ( as Ni) | 7440-02-0 | | 1 | |
| Nickel, soluble compounds ( as Ni) | 7440-02-0 | | 1 | |
| Nicotine | 54-11-5 | | 0.5 | X |
| Nitric acid | 7697-37-2 | 2 | 5 | X |
| Nitric oxide | 10102-43-9 | 25 | 30 | |
| p-Nitroaniline | 100-01-6 | 1 | 6 | X |
| Nitrobenzene | 98-95-3 | 1 | 5 | X |
| p-Nitrochlorobenzene | 100-00-5 | | 1 | X |
| 4-Nitrodiphenyl; se 29 CFR 1910.1003 | 92-93-3 | | | |
| Nitroethane | 79-24-3 | 100 | 310 | |
| Nitrogen dioxide | 10102-44-0 | (C)5 | (C)9 | |
| Nitrogen trifluoride | 7783-54-2 | 10 | 29 | |
| Nitroglycerin | 55-63-0 | (C)0.2 | (C)2 | X |
| Nitromethane | 75-52-5 | 100 | 250 | |
| 1-Nitropropane | 108-03-2 | 25 | 90 | |
| 2-Nitropropane | 79-46-9 | 25 | 90 | |
| N-Nitrosodimethylamine; see 29 CFR 1910.1006 | | | | |
| Nitrotoluene (all isomers)<br>o-isomer m-<br>isomer p-<br>. | <br>88-72-2<br>99-08-1 | 5 | 30 | X |
| Nitrotrichloromethane; see Chloropicrin | | | | |
| Octacholoronaphthalene | 2234-13-1 | | 0.1 | X |
| Octane | 111-65-9 | 500 | 2350 | |
| Oil mist, mineral | 8012-95-1 | | 5 | |
| Osmium tetroxide (as Os) | 20816-12-0 | | 0.002 | |
| Oxalic acid | 144-62-7 | | 1 | |
| Oxygen difluoride | 7783-41-7 | 0.05 | 0.1 | |
| Ozone | 10028-15-6 | 0.1 | 0.2 | |
| Paraquat, respirable dust | 4685-14-7;<br>1910-42-5;<br>2074-50-2 | | 0.5 | X |
| Parathion | 56-38-2 | | 0.1 | X |

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| Particulates not otherwise regulated (PNOR)[f]<br>Total dust<br>Respirable fraction | | | 15<br>5 | |
| PCB; see Chlorodiphenyl (42% and 54% chlorine) | | | | |
| Pentaborane | 19624-22-7 | 0.005 | 0.01 | |
| Pentachloronaphthalene | 1321-64-8 | | 0.5 | X |
| Pentachlorophenol | 87-86-5 | | 0.5 | X |
| Pentaerythritol Total dust<br>Respirable fraction | 115-77-5 | | 15 | |
| Pentane | 109-66-0 | 1000 | 2950 | |
| 2-Pentanone (Methyl propyl ketone) | 107-87-9 | 200 | 700 | |
| Perchloroethylene (Tetrachloroethylene) | 127-18-4 | | (\2\) | |
| Perchloromethyl mercaptan | 594-42-3 | 0.1 | 0.8 | |
| Perchloryl fluoride | 7616-94-6 | 3 | 13.5 | |
| Petroleum distillates (Naphtha)(Rubber solvent) | | 500 | 2000 | |
| Phenol | 108-95-2 | 5 | 19 | X |
| p-Phenylene dyamine | 106-50-3 | | 0.1 | X |
| Phenyl ether, vapor | 101-84-8 | 1 | 7 | |
| Phenyl ether-biphenyl mixture, vapor | | 1 | 7 | |
| Phenylethylene; see Styrene | | | | |
| Phenyl glycidyl ether (PGE) | 122-60-1 | 10 | 60 | |
| Phenylhydrazine | 100-63-0 | 5 | 22 | X |
| Phosdrin (Mevinphos) | 7786-34-7 | | 0.1 | X |
| Phosgene (Carbonyl chloride) | 75-44-5 | 0.1 | 0.4 | |
| Phosphine | 7803-51-2 | 0.3 | 0.4 | |
| Phosphoric acid | 7664-38-2 | | 1 | |
| Phosphorus (yellow) | 7723-14-0 | | 0.1 | |
| Phosphorus pentachloride | 10026-13-8 | | 1 | |
| Phosphorus pentasulfide | 1314-80-3 | | 1 | |
| Phosphorus trichloride | 7719-12-2 | 0.5 | 3 | |
| Phthalic anhydride | 85-44-9 | 2 | 12 | |
| Picloram Total dust<br>Respirable fraction | 1918-02-1 | | 15 | |
| Picric acid | 88-89-1 | | 0.1 | X |

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| Pindone (2-Pivalyl-1,3-indandione) | 83-26-1 | | 0.1 | |
| Plaster of Paris Total dust<br>Respirable fraction | 26499-65-0 | | <br>15 | |
| Platinum (as Pt) Metal<br>Soluble salts | 7440-06-4 | | | |
| Portland cement<br>Total dust | 65997-15-1 | | <br>15 | |
| Propane | 74-98-6 | 1000 | 1800 | |
| beta-Propriolactone; see 29 CFR 1910.1013 | 57-57-8 | | | |
| n-Propyl acetate | 109-60-4 | 200 | 840 | |
| n-Propyl alcohol | 71-23-8 | 200 | 500 | |
| n-Propyl nitrate | 627-13-4 | 25 | 110 | |
| Propylene dichloride | 78-87-5 | 75 | 350 | |
| Propylene imine | 75-55-8 | 2 | 5 | X |
| Propylene oxide | 75-56-9 | 100 | 240 | |
| Propyne; see Methyl acetylene | | | | |
| Pyrethrum | 8003-34-7 | | 5 | |
| Pyridine | 110-86-1 | 5 | 15 | |
| Quinone | 106-51-4 | 0.1 | 0.4 | |
| RDX; see Cyclonite | | | | |
| Rhodium (as Rh), metal fume and insoluble compounds | 7440-16-6 | | 0.1 | |
| Rhodium (as Rh), soluble compounds | 7440-16-6 | | 0.001 | |
| Ronnel | 299-84-3 | | 15 | |
| Rotenone | 83-79-4 | | 5 | |
| Rouge Total dust Respirable fraction | | | 15 | |
| Selenium compounds (as Se) | 7782-49-2 | | 0.2 | |
| Selenium hexafluoride (as Se) | 7783-79-1 | 0.05 | 0.4 | |
| Silica, amorphous, precipitated and gel | 112926-00-8 | | (\3\) | |
| Silica, amorphous, diatomeceous earth, containing less than 1% crystalline silica | 61790-53-2 | | (\3\) | |
| Silica crystalline cristobalite, respirable dust | 14464-46-1 | | (\3\) | |
| Silica, crystalline quartz, respirable dust | 14808-60-7 | | (\3\) | |

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| Silica, crystalline tripoli, (as quartz), respirable dust | 1317-95-9 | | (\3\) | |
| Silica, crystalline tridymite, respirable dust | 15468-32-3 | | (\3\) | |
| Silica, fused, respirable dust | 60676-86-0 | | (\3\) | |
| Silicates (less than 1% crystalline silica) Mica (respirable dust) Soapstone, total dust Soapstone, respirable dust Talc (containing asbestos); Use asbestos limit; see 29 CFR 1910.1001 Talc (containing no asbestos), respirable dust | 12001-26-2 | | (\3\)<br>(\3\)<br>(\3\)<br>(\3\)<br>(\3\) | |
| Tremolite, asbestiform; see 29 CFR 1910.1001 | | | | |
| Silicon Total dust Respirable fraction | 7440-21-3 | | 15<br>5 | |
| Silicon carbide Total dust Respirable fraction | 409-21-2 | | 15 | |
| Silver, metal and soluble compounds (as Ag) | 7440-22-4 | | 0.01 | |
| Soapstone; see Silicates | | | | |
| Sodium fluoroacetate | 62-74-8 | | 0.05 | X |
| Sodium hydroxide | 1310-73-2 | | 2 | |
| Starch Total dust | 9005-25-8 | | 15 | |
| Stribine | 7803-52-3 | 0.1 | 0.5 | |
| Stoddard solvent | 8052-41-3 | 500 | 2900 | |
| Strychnine | 57-24-9 | | 0.15 | |
| Styrene | 100-42-5 | | (\2\) | |
| Sucrose Total dust | 57-50-1 | | 15 | |
| Sulfur dioxide | 7446-09-5 | 5 | 13 | |
| Sulfur hexafluoride | 2551-62-4 | 1000 | 6000 | |
| Sulfuric acid | 7664-93-9 | | 1 | |
| Sulfur monochloride | 10025-67-9 | 1 | 6 | |
| Sulfur pentafluoride | 5714-22-7 | 0.025 | 0.25 | |
| Sulfuryl fluoride | 2699-79-8 | 5 | 20 | |
| Systox; see Demeton | | | | |
| 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) | 93-76-5 | | 10 | |

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| Talc; see Silicates | | | | |
| Tantalum, metal and oxide dust | 7440-25-7 | | 5 | |
| TEDP (Sulfotep) | 3689-24-5 | | 0.2 | X |
| Tellurium and compounds (as Te) | 13494-80-9 | | 0.1 | |
| Tellurium hexafluoride (as Te) | 7783-80-4 | 0.02 | 0.2 | |
| Temephos Total dust<br>Respirable fraction | 3383-96-8 | | <br>15 | |
| TEPP (Tetraethyl pyrophosphate) | 107-49-3 | | 0.05 | X |
| Terphenyls | 26140-60-3 | (C)1 | (C)9 | |
| 1,1,1,2-Tetrachloro-2,2-difluoroethane | 76-11-9 | 500 | 4170 | |
| 1,1,2,2-Tetrachloro-1,2-difluoroethane | 76-12-0 | 500 | 4170 | |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 5 | 35 | X |
| Tetrachloroethylene; see Perchloroethylene | | | | |
| Tetrachloromethane; see Carbon tetrachloride | | | | |
| Tetrachloronaphthalene | 1335-88-2 | | 2 | X |
| Tetraethyl lead (as Pb) | 78-00-2 | | 0.075 | X |
| Tetrahydrofuran | 109-99-9 | 200 | 590 | |
| Tetramethyl leas (as Pb) | 75-74-1 | | 0.075 | X |
| Tetramethyl succinonitrile | 3333-52-6 | 0.5 | 3 | X |
| Tetranitromethane | 509-14-8 | 1 | 8 | |
| Tetryl (2,4,6-Trinitrophenylmethylnitramine) | 479-45-8 | | 1.5 | X |
| Thallium, soluble compounds (as Tl) | 7440-28-0 | | 0.1 | X |
| 4,4’-Thiobis (6-tert, Butyl-m- Cresol)<br>Total dust<br>Respirable fraction | 96-69-5 | | <br>15<br>5 | |
| Thiram | 137-26-8 | | 5 | |
| Tin, inorganic compounds (except oxides) (as Sn) | 7440-31-5 | | 2 | |
| Tin, organic compounds (as Sn) | 7440-31-5 | | 0.1 | |
| Titanium dioxide<br>Total dust | 13463-67-7 | | <br>15 | |
| Toluene | 108-88-3 | | (\2\) | |
| Toluene-2,4-diisocyanate (TDI) | 584-84-9 | (C)0.02 | (C)0.14 | |
| o-Toluidine | 95-53-4 | 5 | 22 | X |

| | | | | |
|---|---|---|---|---|
| Toxaphene; see Chlorinated camphene | | | | |
| Tremolite; see Silicates | | | | |
| Tributyl phosphate | 126-73-8 | | 5 | |
| 1,1,1-Trichloroethane; see Methyl chloroform | | | | |
| 1,1,2-Trichloroethane | 79-00-5 | 10 | 45 | X |
| Trichloroethylene | 79-01-6 | | (\2\) | |
| Trichloromethane; see Chloroform | | | | |
| Trichloronaphthalene | 1321-65-9 | | 5 | X |
| 1,2,3-Trichloropropane | 96-18-4 | 50 | 300 | |
| 1,1,2-Trichloro-1,2,2-trifluorethane | 76-13-1 | 1000 | 7600 | |
| Triethylamine | 121-44-8 | 25 | 100 | |
| Trifluorobromomethane | 75-63-8 | 1000 | 6100 | |
| 2,4,6-Trinitrophenol; see Picric acid | | | | |
| 2,4,6- Trinitrophenylmethylnitramine; see Tetryl | | | | |
| 2,4,6-Trinitrotoluene (TNT) | 118-96-7 | | 1.5 | X |
| Triorthocresyl phosphate | 78-30-8 | | 0.1 | |
| Triphenyl phosphate | 115-86-6 | | 3 | |
| Turpentine | 8006-64-2 | 100 | 560 | |
| Uranium (as U)<br>Soluble compounds<br>Insoluble compounds | 7440-61-1 | | <br>0.05<br>0.25 | |
| Vanadium<br>Respirable dust (as$V_2O_5$) Fume (as $V_2O_5$) | 1314-62-1 | | <br>(C)0.5<br>(C)0.1 | |
| Vegetable oil mist Total dust<br>Respirable fraction | | | <br>15 | |
| Vinyl benzene; see Styrene | | | | |
| Vinyl chloride; see 29 CFR 1910.1017 | 75-01-4 | | | |
| Vinyl cyanide; see Acrylonitrile | | | | |
| Vinyl toluene | 25013-15-4 | 100 | 480 | |
| Warfarin | 81-81-2 | | 0.1 | |
| Xylenes (o-, m-, p-isomers) | 1330-20-7 | 100 | 435 | |
| Xylidine | 1300-73-8 | 5 | 25 | X |
| Yttrium | 7440-65-5 | | 1 | |

| | | | | |
|---|---|---|---|---|
| Zinc chloride fume | 7646-85-7 | | 1 | |
| Zinc oxide fume | 1314-13-2 | | 5 | |
| Zinc oxide Total dust<br>Respirable fraction | 1314-13-2 | | 15<br>5 | |
| Zinc stearate Total dust<br>Respirable fraction | 557-05-1 | | 15<br>5 | |
| Zirconium compounds (as Zr) | 7440-67-7 | | 5 | |

\1\ The PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit. They are to be determined from breathing zone air samples.

(a) Parts of vapor or gas per million parts of contaminated air by volume at 25 C and 760 torr. (b) Milligrams of substance per cubic meter of air. When entry is in this column only, the value is exact; when listed with a ppm entry, it is approximate.

(c) The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound, measured as the metal, the CAS number for the metal is given—not CAS numbers for the individual compounds.(d) The final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some circumstances the distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures; for the excepted subsegments, the benzene limits in Table Z-2 apply. See 29 CFR 1910.1028 for specific circumstances.

(e) This 8-hour TWA applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The time-weighted average applies to the cotton waste processing operations of waste recycling (sorting, blending, cleaning, and willowing) and garnetting. See also 29 CFR 1910.1043 for cotton dust limits applicable to other sectors.

(f) All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by the Particulates Not Otherwise Regulated (PNOR) limit which is the same as the inert or nuisance dust limit of Table Z-3.

\2\ See Table Z-2.

\3\ See Table Z-3.

\4\ Varies with compound.

# *APPENDIX L: LIMITS FOR AIR CONTAMINANTS – TABLE Z-2*

**Limits for Air Contaminants: Table Z-2**

**TABLE Z-2**

| Substance | 8-hour time weighted average | Acceptable ceiling concentration | Acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift | |
|---|---|---|---|---|
| | | | Concentration | Max. Duration |
| Benzene (a) (Z37.40-1969) | 10 ppm | 25 ppm | 50 ppm | 10 minutes |
| Beryllium andberyllium compounds (Z37.29-1970) | 2 <greek-m>g/$m^3$ | 5 <greek-m>g/$m^3$ | 25 <greek-m>g/$m^3$ | 30 minutes |
| Cadmium fume (b) (Z37.5-1970) | 0.1 mg/$m^3$ | 0.3 mg/$m^3$ | | |
| Cadmium dust (b) (Z37.5-1970) | 0.2 mg/$m^3$ | 0.6 mg/$m^3$ | | |
| Carbon disulfide (Z37.3-1968) | 20 ppm | 30 ppm | 100 ppm | 30 minutes |
| Carbon tetrachloride (Z37.17-1967) | 10 ppm | 25 ppm | 200 ppm | 5 min. in any 4 hrs. |
| Chromic acid and chromates (Z37.7-1971) | | 1 mg/10 $m^3$ | | |
| Ehtylene dibromide (Z37.31- | 20 ppm | 30 ppm | 50 ppm | 5 minutes |
| Ehtylene dichloride (Z37.21-1969) | 50 ppm | 100 ppm | 200 ppm | 5 min. in any 3 hrs. |
| Fluoride as dust (Z37.28-1969) | 2.5 mg/$m^3$ | | | |
| Formaldehyde; see 29 CFR 1910.1048 | | | | |
| Hydrogen fluoride (Z37.28-1969) | 3 ppm | | | |
| Hydrogen sulfide (Z37.2-1966) | | 20 ppm | 50 ppm | 10 mins. once, only if no other meas. exp occurs. |
| Mercury (Z37.8-1971) | | 1 mg/10 $m^3$ | | |
| Methyl chloride (Z37.18-1969) | 100 ppm | 200 ppm | 300 ppm | 5 mins. in any 3 . |
| Methylene chloride; see Sec. 1919.52 | | | | |

| | | | | |
|---|---|---|---|---|
| Organo (alkyl) mercury (Z37.30-1969) | 0.01 mg/m$^3$ | 0.04 mg/m$^3$ | | |
| Styrene (Z37.15-1969) | 100 ppm | 200 ppm | 600 ppm | |
| Tetrachloroethylene (Z37.22-1967) | 100 ppm | 200 ppm | 300 ppm | 5 mins. in any 3 hrs. |
| Toluene (Z37.12-1967) | 200 ppm | 300 ppm | 500 ppm | 5 mins. in any 3 . |
| Trichloroethylene (Z37.19-1967) | 100 ppm | 200 ppm | 300 ppm | 10 minutes |
| | | | | |

(a) This standard applies to the industry segments exempt from the 1 ppm 8-hour TWA and 5 ppm STEL of the benzene standard at 29 CFR 1910.1028.

(b) This standard applies to any operations or sectors for which the Cadmium standard, 29 CFR 1910.1027, is stayed or not otherwise in effect.

# *APPENDIX M: LIMITS FOR AIR CONTAMINANTS – TABLE Z-3*

**Limits for Air Contaminants: TABLE Z-3**

**TABLE Z-3 MINERAL DUSTS**

| Substance | mppcf (a) | $mg/m^3$ |
|---|---|---|
| Silica: Crystalline<br><br>Quartz (Respirable)<br><br><br>Quartz (Total Dust) Cristobalite: Use ½ the value<br>Calculated from the count or mass formulae for quartz<br>Tridymite: Use ½ the value calculated<br>From the formulae for quartz<br><br>Amorphous, including natural diatomaceous | <br><br><br>250 (b)<br>%$SiO_2$ +5 | <br><br><br>10 $mg/m^3$ (e)<br>% $SiO_2$ +2<br><br>30 $mg/m^3$<br>% $SiO_2$ +2 |
| Silicates (less than 1% crystalline silica):<br>Mica<br>Soapstone<br>Talc (not containing asbestos) Talc (containing asbestos) Use<br>asbestos limit Tremolite, asbestiform (see 29 CFR<br>1910.1001) Portland cement | <br>20<br>20<br>20 (c) | |
| Graphite (Natural) | 15 | |
| Coal Dust:<br>Respirable fraction less than 5% SiO2 | | 2.4 $mg/m^3$<br>(e)<br>%$SiO_2$ +2 |
| Inert or Nuisance Dust: (d) Respirable fraction Total dust | 15 | 5 $mg/m^3$ |

Note—Conversion factors – mppcf x 35.3 = million particles per cubic meter = particles per c.c.

(a) Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.

(b) The percentage of crystalline silica in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.

(c) Containing less than 1% quartz or more, use quartz limit.

(d) All inert nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by this limit, which is the same as the Particulates Not Otherwise Regulated (PNOR) limit in Table Z-1.

(e) Both concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector. The measurements under this note refer to the use of an AEC (now NRC) instrument. The respirable fraction of coal dust is determined with an MRE; the figure corresponding to that of 2.4 mg/m3 in the table for coal dust is 4.5 mg/m$^{3K}$

# *APPENDIX N: CHEMICAL INCOMPATIBILITY*

**Chemical Incompatibility**

Violent reaction can occur when mixing certain hazardous chemicals because they are unsuitable for mixing or incompatible. Before mixing chemicals refer to this list and to the chemicals' SDSs.

| CHEMICAL | INCOMPATIBLE CHEMICALS |
|---|---|
| Acetic acid | Aldehyde, bases, carbonates, hydroxides, metals, oxidizers, peroxides, phosphates, xylene |
| Acetone | Acids, amines, oxidizers, plastics. |
| Acetylene | Halogens (chlorine, fluorine, etc.), mercury, potassium, |
| Alkali and alkaline earth metals | Acids, chromium, ethylene, halogens, hydrogen, mercury, nitrogen, oxidizers, plastics, sodium chloride, sulfur |
| Ammonia | Acids, aldehydes, amides, halogens, heavy metals, oxidizers, plastics, sulfur |
| Ammonium nitrate | Acids, alkalis, chloride salts, combustible materials, metals, organic materials, phosphorous, reducing agents, urea |
| Aniline | Acids, aluminum, dibenzoyl peroxide, oxidizers, plastics |
| Azides | Acids, heavy metals, oxidizers |
| Bromine | Acetaldehyde, alcohols, alkalis, amines, combustible materials, ethylene, fluorine, hydrogen, ketones (acetone, carbonyls, etc.) |
| Calcium oxide | Acids, ethanol, fluorine, organic materials |
| Carbon (activated) | Alkali metals, calcium hypochlorite, halogens, oxidizers |
| Carbon tetrachloride | Benzoyl peroxide, ethylene, fluorine, metals, oxygen, plastics, |
| Chlorates | Powdered metals, sulfur, finely divided organic or combustible materials |
| Chromic acid | Acetone, alcohols, alkalis, ammonia, bases |
| Chromium trioxide | Benzene, combustible materials, hydrocarbons, metals, organic materials, phosphorous, plastics |
| Chlorine | Alcohols, ammonia, benzene, combustible materials, flammable compounds (hydrazine), hydrocarbons (acetylene, ethylene, etc.), hydrogen peroxide, iodine, metals, nitrogen, |
| Chlorine dioxide | Hydrogen, mercury, organic materials, phosphorous, potassium hydroxide, sulfur |
| Copper | Calcium, hydrocarbons, oxidizers |
| Cyanides | Acids, alkaloids, aluminum, iodine, oxidizers, strong bases |
| Flammable liquids | Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens |
| Fluorine | Alcohols, aldehydes, ammonia, combustible materials, halocarbons, halogens, hydrocarbons, ketones, metals, organic |
| Hydrocarbons (Such as butane, propane, benzene, turpentine, etc.) | Acids, bases, oxidizers, plastics |

| | |
|---|---|
| Hydrofluoric acid | Metals, organic materials, plastics, silica (glass), (anhydrous) sodium |
| Hydrogen peroxide | Acetylaldehyde, acetic acid, acetone, alcohols, carboxylic acid, combustible materials, metals, nitric acid, organic compounds, phosphorous, sulfuric acid, sodium, aniline |
| Hydrogen sulfide | Acetylaldehyde, metals, oxidizers, sodium |
| Hypochlorites | Acids, activated carbon |
| Iodine | Acetylaldehyde, acetylene, ammonia, metals, sodium |
| Mercury | Acetylene, aluminum, amines, ammonia, calcium, fulminic acid, lithium, oxidizers, sodium |
| Nitrates | Acids, nitrites, metals, sulfur, sulfuric acid |
| Nitric acid | Acetic acid, acetonitrile, alcohols, amines, (concentrated) ammonia, aniline, bases, benzene, cumene, formic acid, ketones, metals, organic materials, plastics, sodium, toluene |
| Oxalic acid | Oxidizers, silver, sodium chloride |
| Oxygen | Acetaldehyde, secondary alcohols, alkalis and alkalines, ammonia, carbon monoxide, combustible materials, ethers, flammable materials, hydrocarbons, metals, phosphorous, polymers |
| Perchloric acid | Acetic acid, alcohols, aniline, combustible materials, dehydrating agents, ethyl benzene, hydriotic acid, hydrochloric acid, iodides, ketones, organic material, oxidizers, pyridine |
| Peroxides, organic | Acids (organic or mineral) |
| Phosphorous (white) | Oxygen (pure and in air), alkalis |
| Potassium | Acetylene, acids, alcohols, halogens, hydrazine, mercury, oxidizers, selenium, sulfur |
| Potassium chlorate | Acids, ammonia, combustible materials, fluorine, hydrocarbons, metals, organic materials, sugars |
| Potassium perchlorate (also see chlorates) | Alcohols, combustible materials, fluorine, hydrazine, metals, organic matter, reducing agents, sulfuric acid |
| Potassium permanganate | Benzaldehyde, ethylene glycol, glycerol, sulfuric acid |
| Silver | Acetylene, ammonia, oxidizers, ozonides, peroxyformic acid |
| Sodium | Acids, hydrazine, metals, oxidizers, water |
| Sodium peroxide | Acetic acid, benzene, hydrogen sulfide, metals, oxidizers, peroxyformic acid, phosphorous, reducers, sugars, water |
| Sulfides | Acids |
| Sulfuric acid | Potassium chlorates, potassium perchlorate, potassium |

# *APPENDIX O: FLAMMABLE AND COMBUSTIBLE CHEMICALS*

## Flammable and Combustible Chemicals

This list is provided as a guide and is not all inclusive. Always review safety data sheets before working with chemicals.

The following table includes some common flammable and combustible chemicals, their flash points and boiling points, and associated National Fire Protection Association (NFPA) classes.

| Chemical | Flash Point | | Boiling Point | | NFPA Class |
|---|---|---|---|---|---|
| | °F | °C | °F | °C | |
| Acetaldehyde | -38 | -39 | 69 | 21 | IA |
| Dimethyl sulfide | -36 | -38 | 99 | 37 | IA |
| Ethyl ether | -49 | -45 | 95 | 35 | IA |
| Ethylene oxide | -20 | -29 | 55 | 13 | IA |
| Pentane | -57 | -49 | 97 | 36 | IA |
| Propane | -157 | -105 | -44 | -42 | IA |
| Benzene | 12 | -11 | 176 | 80 | IB |
| Carbon disulfide | -22 | -30 | 115 | 46 | IB |
| Cyclohexane | -4 | -20 | 179 | 81 | IB |
| Ethyl alcohol | 55 | 13 | 173 | 78 | IB |
| n-Hexane | -7 | -22 | 156 | 69 | IB |
| Isopropyl alcohol | 53 | 12 | 180 | 82 | IB |
| Methyl alcohol | 52 | 11 | 149 | 65 | IB |
| Methyl ethyl ketone | 16 | -9 | 176 | 80 | IB |
| Pyridine | 68 | 20 | 239-241 | 116 | IB |
| Tetrahydrofuran | 6 | -14 | 153 | 67 | IB |
| Toluene | 40 | 4 | 231 | 111 | IB |
| Triethylamine | 20 | -7 | 193 | 89 | IB |
| tert Butyl isocyanate | 80 | 27 | 185-187 | 85-86 | IC |
| Chlorobenzene | 82 | 28 | 270 | 132 | IC |
| Epichlorohydrin | 88 | 31 | 239-243 | 115-117 | IC |
| 2-Nitropropane | 75 | 24 | 248 | 120 | IC |
| Xylene | 81-90 | 27-32 | 280-291 | 138-144 | IC |
| Acetic acid, glacial | 103 | 39 | 244 | 48 | II |
| Bromobenzene | 118 | 48 | 307-316 | 153-158 | II |
| Formic acid | 156 | 69 | 213 | 101 | II |
| Morpholine | 100 | 38 | 263 | 128 | II |
| Stoddard solvent | 100-140 | 38-60 | 300-400 | 150-200 | II |
| Benzaldehyde | 145 | 63 | 352 | 178 | IIIA |
| Cyclohexanol | 154 | 68 | 322 | 161 | IIIA |
| Methacrylic acid | 170 | 77 | 316 | 158 | IIIA |
| Nitrobenzene | 190 | 88 | 412 | 211 | IIIA |
| Tetrahydronaphthalene | 160 | 71 | 406 | 208 | IIIA |

| | | | | | |
|---|---|---|---|---|---|
| Benzyl alcohol | 213 | 101 | 401 | 205 | IIIB |
| Caproic acid | 215 | 102 | 400 | 204 | IIIB |
| Ethylene glycol | 232 | 111 | 388 | 198 | IIIB |
| Phenyl ether | 239 | 115 | 498 | 258 | IIIB |
| Stearic acid | 385 | 196 | 726 | 386 | IIIB |

# 13.0 GLOSSARY

**ACGIH:** American Conference of Governmental Industrial Hygienists: A voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions engaged in occupational safety and health programs. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLV's) for hundreds of chemicals, physical agents, and Biological Exposure Indices (BEI).

**Actinic Radiation:** Energy in the form of rays of short wavelength, occurring in the violet and ultraviolet parts of the spectrum, that produce chemical changes.

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

**Acute Exposure:** An intense exposure over a relatively short period of time

**Chronic**: Persistent, prolonged, or repeated conditions.

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

**ANSI:** American National Standards Institute: A privately funded, voluntary membership organization that identifies industrial and public needs for national consensus standards and coordinates development of such standards.

**Asphyxiant:** A chemical (vapor or gas) which can cause unconsciousness or death by suffocation (lack of oxygen). Most simple asphyxiants are harmful to the body only when they become so concentrated that they reduce oxygen in the air (normally about 21%) to dangerous levels (18% or lower). Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.

**ASTM** American Society for Testing and Materials: A voluntary membership organization with members from broad spectrum of individuals, agencies, and industries concerned with materials. ASTM is a resource for sampling and testing methods, health and safety aspects of materials, safe performance guidelines, effects of physical and biological agents and chemicals.

**Autoclave:** A device to expose items to steam at a high pressure in order to decontaminate the materials or render them sterile.

**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 vapor. The boiling point is expressed in degrees Celsius or Fahrenheit. If a flammable material has a low boiling point, it indicates a special fire hazard.

**Carcinogen:** A substance or physical agent that causes cancer in humans, or, on the basis of causing cancer in animal experiments, is suspected of being able to cause cancer in humans.

**Ceiling:** The maximum allowable human exposure limit for an airborne substance, not to be exceeded even momentarily. It may be written as TLV-C of Threshold Limit Value-Ceiling.

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

**CERCLA:** Comprehensive Environmental Responsibility Compensation Liability Act.

**CFR**: Code of Federal Regulations. The Code of Federal Regulations is a codification of the general and permanent rules published in the Federal Register by the Executive departments and agencies of the Federal Government.

**Chemical reaction:** A change in the arrangement of atoms or molecules to yield substances of different composition and properties.

**Flammable Liquid:** According to the DOT and NFPA, flammable liquids are those having a flash point below 100° F (37.8° C). Flammable liquids are Class I liquids and may be subdivided as follows: Class IA - those having a flash point below 73° F and having a boiling point below 100° F. Class IB - those having flash points below 73° F and having a boiling point at or above 100° F. Class IC - those having flash points at or above 73° F and below 100° F.

**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 flame, cigarettes, etc.) is present. There are several flash point test methods, and flash points may vary for the same material depending on the method used, so the test method is indicated when the flash point is given.

**Combustible:** According to the DOT and NFPA, combustible liquids are those having a flash point at or above 100° F (37.8° C), or liquids that will burn. They do not ignite as easily as flammable liquids. However, combustible liquids can be ignited under certain circumstances, and must be handled with caution. Class II liquids have flash points at or above 100° F but below 140° F. Class III liquids are subdivided into two subclasses: Class IIIA - Those having flash points at or above 140° F but below 200° F. Class IIIB - Those having flash points at or above 200° F.

**Compressed Gas:** A gas or mixture of gases that, in a container, will have an absolute pressure exceeding 40 psi at 70°F or 21.1°C. A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F or 54.4°C, regardless of the pressure at 70°F. A liquid having a vapor pressure exceeding 40 psi at 100°F or 37.8°C.

**Concentration:** The relative amount of a material in combination with another material. For example; 5 parts (of acetone) per million (parts of air).

**Corrosive:** A substance that, according to the DOT, causes visible destruction or permanent changes in human skin tissue at the site of contact or is highly corrosive to steel.

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

**DOT:** Department of Transportation: 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.

**EPA:** Environmental Protection Agency: 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 diseases in populations.

**Evaporation Rate:** The rate at which a material is converted to vapor (evaporates) at a given

temperature and pressure when compared to the evaporation rate of a given substance. 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.

**Fume:** A solid particle that has condensed from the vapor state.

**Gas:** Chemical substances that exist in the gaseous state at room temperature.

**Hazardous Chemical:** 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 carcinogens, toxins, irritants, corrosives, sensitizers, or other agents that can damage the lungs, skin, eyes, or mucous membranes.

**Hazardous Material:** Any substance or compound that has the capability of producing adverse effects on the health and safety of humans.

**Ignitable:** A solid, liquid or compressed gas waste that has a flash point of less than 140° F. Ignitable material may be regulated by the EPA as a hazardous waste, as well.

**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.

**Infrared Radiation:** Electromagnetic radiation of wavelength from 700 nm to 1 mm.

**Ingestion:** Taking a substance into the body through the mouth as food, drink, medicine, etc.

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

**Inhibitor**: A substance that is added to another to prevent or slow down an unwanted reaction or change.

**Irritant:** A substance that produces an irritating effect when it contacts skin, eyes, nose, or respiratory system.

**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.

**Laser:** Acronym for Light Amplification by Stimulated Emission of Radiation.

**LEL:** Lower Explosive Limit (Also known as Lower Flammable Limit-LFL): The lowest concentration of a substance that will produce a fire or flash when an ignition source (flames, spark, etc.,) is present. 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.

**PEL:** Permissible Exposure Limit: 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 (STEL), or a ceiling (C).

**Lethal Concentration 50:** The concentration of an air contaminant (LC50) that will kill 50 percent of the test animals in a group during a single exposure.

**Lethal Dose 50:** The dose of a substance or chemical that will (LD50) kill 50 percent of the test animals in a group within the first 30 days following exposure.

**Lower Explosive Limit (LEL):** The lower limit of flammability of a gas or vapor. It is usually expressed in percentages of gas or vapor.

**Maximum Permissible Exposure (MPE):** The maximum level of laser radiation to which a human can be exposed without adverse biological effects to the eye or skin

**Mutagen:** A substance or agent capable of causing a change (or mutation) in the genetic materials of a living cell.

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

**NFPA:** National Fire Protection Association: The National Fire Protection Association is a voluntary membership organization whose aim is to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Code.

**NIOSH:** National Institute for Occupational Safety and Health: 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.

**Nominal Hazard Zone (NHZ):** The zone inside which laser radiation that is direct, reflected or scattered exceeds the Maximum Permissible Exposure (MPE) for the laser.

**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 in which an atom loses electrons.

**Oxidizer:** Is a substance that gives up oxygen easily to stimulate combustion of organic material.

**Oxygen Deficiency:** An atmosphere having less than the normal percentage of oxygen found in normal air. Normal air contains 21% oxygen at sea level.

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

**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.

**PPM:** Parts (of vapor or gas) per million (parts of air) by volume.

**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, other chemicals, and dropping, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on a SDS.

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

**SARA:** Superfund Amendments and Reauthorization Act.

**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.

**STEL:** Short Term Exposure Limit: 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.

**Substance:** Any chemical entity.

**Synonym:** Another name by which the same chemical may be known.

**Systemic:** Spread throughout the body; affecting many or all body systems or organs, not localized in one spot or area.

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

**TLV:** Threshold Limit Value: 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 effects. TLV's 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).

**Toxicity:** The potential of a substance to exert a harmful effect on humans or animals and a description of the effect and the conditions or concentration under which the effect takes place.

**Trade Name:** The commercial name or trademark by which a chemical is known. One chemical may have a variety of trade names depending on the manufacturers or distributors involved.

**TSCA:** Toxic Substances Control Act

**TWA:** Time Weighted Average. The average time, over a given work period (e.g. 8-hour workday), of a person's exposure to a chemical or an agent. The average is determined by sampling for the contaminant throughout the time period. Represented as TLV-TWA.

**UEL:** Upper Explosive Limit: Also known as Upper Flammable Limit (UFL). Is 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 said to be too "rich" to support combustion. The difference between the LEL and the UEL constitutes the flammable 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.

**Ultraviolet Radiation:** Electromagnetic radiation with wavelengths from 180-400 nm.

**Unstable Liquid:** A liquid that in its pure state or as commercially produced, will react vigorously in some hazardous way under shock conditions (i.e., dropping), certain temperatures, or pressures.

**Vapor:** The gaseous form of a substance 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 point will evaporate

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

**Visible Radiation:** Electromagnetic radiation which is visible to the human eye; wavelengths from 400-700 mm.