HAZARDOUS MATERIALS

MANAGEMENT MANUAL

2ND EDITION

University of Missouri-Columbia

Prepared by:

Environmental Health and Safety

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Chapter 1: Introduction

This chapter contains general information about the University of Missouri-Columbia (MU) Hazardous Materials Management program. Of particular interest are the campus policies, roles, and responsibilities.

1.1 Manual Purpose

This manual provides guidance to the campus community on the safe handling of hazardous materials, focusing on procedures for materials that are no longer needed. In this manual, the term "hazardous materials" will mean hazardous chemicals unless a broader meaning is specifically stated.

1.2 What's New in the Second Edition

The first edition was issued in December 1993. The original document outlined program requirements and focused primarily on hazardous waste regulations. The second edition has been rewritten to emphasize safety and provide guidance on compliance procedures. This edition places greater emphasis on how to reduce waste and prevent pollution.

The most recent edition of the Hazardous Materials Management Manual is available on the EHS Web site (http://web.missouri.edu/~muehs).

1.3 What are Hazardous Materials?

In this document, hazardous materials are chemicals that exhibit one or more of the following characteristics: ignitability, corrosivity, reactivity, and toxicity. MU generally takes the most restrictive definition in determining guidance about what is a hazardous material.

1.3.1 Ignitability

A chemical falls into this category if its flash point is less than 200°F. Materials labeled as flammable or combustible are also considered hazardous due to ignitability.

1.3.2 Corrosivity

Chemicals with a pH less than 5.5 or greater than 9.5 are considered to be corrosive. This range complies with the Columbia sanitary sewer system discharge limits. Chemicals labeled as corrosive, caustic, acid, or alkaline are also considered hazardous due to corrosivity.

1.3.3 Reactivity

Chemicals that undergo hazardous polymerization, decomposition, and/or reaction at room temperature are classified as reactive. This category includes explosives, oxidizers, reducers, pyrophorics, water reactives, shock sensitive compounds, and toxic gas evolvers. Cyanide and sulfide bearing chemicals that release toxic gases, vapors, and/or fumes when exposed to pH conditions between 2 and 12.5 also are reactive.

1.3.4 Toxicity

Toxicity classifications are based on studies with laboratory animals. Specific toxic levels are presented in Section 5.2.2.

1.4 MU Hazardous Materials Management

The Hazardous Materials Management group of Environmental Health and Safety (EHS) administers the MU Hazardous Materials Management program. Our mission is to work with the campus community to develop and implement an efficient, convenient, comprehensive, and forward-looking hazardous materials management program. Our priorities are to:

- protect the health and well-being of students, faculty, staff, and visitors to MU
- develop and implement programs to reduce the amount and toxicity of unwanted hazardous materials

- provide safe storage of hazardous wastes pending disposition
- dispose of hazardous wastes in an environmentally sound and cost-effective manner
- comply with federal, state, and local regulations

The campus has a Hazardous Materials Management Committee to provide policy oversight of the program.

1.5 Campus Policies

Section 7:050 of the *Business Policies and Procedures Manual* of the University of Missouri-Columbia states:

- The management of environmental hazards, including transportation and use of all hazardous materials and the proper treatment and/or disposal of hazardous waste generated through University research, academic, and service and support staff operations, must comply with the provisions of applicable Federal and State statutes and their associated rules and regulations.
- Faculty members, students, and other University employees are responsible for being informed of the applicable rules and regulations and to comply with these rules and regulations. The University will make every appropriate effort to protect faculty members and other employees from civil penalties imposed by outside agencies as a result of the alleged improper use, storage, or waste management practices provided they have made bona fide efforts to comply with appropriate regulations.
- Non-Compliance—Non-compliance with Federal and/or State statutes and their associated regulations can result in significant penalties and fines to the University and to its employees as individuals. Failure to comply with the applicable rules and regulations constitutes possible grounds for dismissal of students and termination for cause of faculty and staff.

1.6 Roles and Responsibilities

For the purposes of the hazardous materials management program, the campus community is divided into six categories. Individuals may fall into more than one of these categories:

- Registered Users
- Hazardous Materials Supervisor/Workers
- Ancillary Workers
- Deans, Directors, Administrators, and Department Heads
- Environmental Health and Safety (EHS)
- Hazardous Materials Management Committee

1.6.1 Registered Users

Registered Users (RU) are principal investigators or supervisors, who have primary responsibility for campus locations where hazardous materials are used. Their responsibilities include:

- Submitting a registration form to EHS of locations where hazardous materials are used (Section 4.2)
- Notifying EHS of all persons who use hazardous materials in their work locations (Chapter 7)
- Attending the Hazardous Materials Management Introduction training course, and the Hazardous Materials Refresher course every three years thereafter (Chapter 3)
- Ensuring that all workers whom they supervise receive appropriate hazardous materials training (Chapter 3)
- Reducing the usage of hazardous materials and subsequent generation of unwanted hazardous materials (Chapter 2)
- Maintaining an inventory of hazardous materials (Section 7.1.1)
- Requesting collection of hazardous materials in a timely manner (Section 6.5)
- Ensuring availability of Material Safety Data Sheets (MSDS) for all hazardous materials used, and ensuring that all staff understand how to use MSDS (Section 3.4)
- Conduct hazard assessments for each task involving hazardous materials or physical hazards (Section 5.3.3)
- Ensuring that all workers whom they supervise use proper Personal Protective Equipment (Chapter 5)

- Understanding the proper procedures to use in the event of a spill or other emergency (Chapter 8)
- Working with EHS Monitoring personnel to maintain safe work areas in compliance with MU policies and government regulations

1.6.2 Hazardous Materials Supervisor/Workers

Hazardous Materials Supervisor/Workers are persons under the supervision of a Registered User. Most of these employees work with hazardous materials on a daily basis. Their responsibilities include:

- Attending the Hazardous Materials Introduction training course and the Hazardous Materials Refresher course every three years thereafter (Chapter 3)
- Reducing the usage of hazardous materials and subsequent generation of unwanted hazardous materials, whenever possible (Chapter 2)
- Understanding and following the proper procedures for working with and disposing of hazardous materials (Chapters 5 and 6)
- Knowing where to find MSDS and understanding how to read them (Section 3.4)
- Reporting spills and other unsafe conditions to the supervisor
- Knowing how to respond to spills and other emergencies involving hazardous materials (Chapter 8)
- Being familiar with and using Personal Protective Equipment needed for safety (Chapter 5)
- Working with EHS monitoring personnel to maintain safe work areas that comply with MU policies and government regulations

1.6.3 Ancillary Workers

Ancillary Workers are persons who work in areas containing hazardous materials, but who do not normally work directly with these hazardous materials. Examples of Ancillary Workers are custodial staff, housekeeping staff, Procurement/Materials Management staff, and police officers. Their responsibilities are as follows:

- Attending the Ancillary Worker Hazardous Materials training course and subsequent refresher training courses (Chapter 3)
- Taking precautions when working near hazardous materials to avoid disturbing the hazardous materials
- Reporting spills and other unsafe conditions involving hazardous materials to their supervisor
- Being familiar with and using the proper Personal Protective Equipment safely (Chapter 5)
- Requesting assistance from Supervisor or EHS when uncertain about risks related to hazardous materials.

1.6.4 Deans, Directors, Administrators, and Department Heads

Deans, Directors, Administrators, and Department Heads have the following responsibilities:

- Being familiar with the Hazardous Materials Management program guidelines
- Assisting EHS in identification of appropriate personnel for Registered User status
- Reviewing EHS Hazardous Materials Management Monitoring reports, and assisting both Registered Users and EHS personnel in resolving problem situations
- Identifying funding sources when needed to correct safety hazards

1.6.5 Environmental Health and Safety

Environmental Health and Safety (EHS) is the campus administrative unit that oversees the Hazardous Materials Management program. Specific responsibilities of EHS include:

- Working with Registered Users to maintain safe work areas that comply with MU policies and government regulations
- Developing guidelines for the campus community so that hazardous materials are used safely and in compliance with government regulations
- Providing or arranging appropriate training programs for the campus community

- Periodic reconciliation of hazardous material inventories
- Periodically monitoring areas where hazardous materials are used to assure that program guidelines are met
- Advising the campus community on matters of Personal Protective Equipment and other safety concerns
- Collecting unwanted hazardous materials
- Determining when an unwanted hazardous material constitutes a hazardous waste or recyclable material
- Managing the Chemical Recycling Building and providing leadership for other pollution prevention initiatives
- Managing the Resource Recovery Center, including storage and disposal of hazardous wastes
- Maintaining databases of information related to the Hazardous Materials Management program
- Serving as the liaison with regulatory agencies such as the U.S. Environmental Protection Agency, the Missouri Department of Natural Resources, the Department of Transportation, and the Nuclear Regulatory Commission

1.6.6 The MU Hazardous Materials Management Committee

The MU Hazardous Materials Management Committee is appointed by the Provost to oversee the campus Hazardous Materials Management program. Specific responsibilities of the committee include:

- Reviewing and recommending policies
- Reviewing hazardous waste minimization proposals for award of funds (Chapter 2)
- Performing an annual audit of the Hazardous Materials Management program
- Reviewing the EHS monitoring of Registered Users, and assisting in resolving problems
- Providing a campus forum for addressing issues involving hazardous materials

1.7 Related Environmental Health and Safety Programs

The mission of EHS is to provide leadership and services to ensure a safe and healthful environment, and to maintain the campus in compliance with regulations. At the same time, EHS recognizes that the mission of MU is to provide teaching, research, and public outreach.

This manual focuses on hazardous (chemical) materials. EHS offers training and guidance on a variety of issues that pose potential hazards to people and the environment. These issues include, but are not limited to:

- Asbestos
- Biological Safety
- Environmental Permits
- Ergonomics
- Fire Safety
- Food Safety
- General Safety Issues
- Personal Protective Equipment
- Radiation Safety

For further information about these programs, contact EHS at 882-7018 or http://web.missouri.edu/~muehs.

Chapter 2: Pollution Prevention

This chapter contains general information about pollution prevention. Development and implementation of specific pollution prevention practices are the responsibility of the Registered User.

2.1 Why Pollution Prevention?

The general theory behind pollution prevention is that if less hazardous waste is produced there is less danger to people and the environment. Pollution prevention practices not only reduce waste, but also improve safety and decrease disposal costs. Therefore, pollution prevention is a cornerstone of the MU Hazardous Materials Management program.

2.2 General Strategies

MU defines pollution prevention as any procedure that reduces the amount and/or toxicity of wastes that must be shipped off campus for disposal. There are three general pollution prevention strategies: source reduction, recycling, and treatment.

2.2.1 Source Reduction

Source reduction is any activity that reduces or eliminates the amount of waste produced. Anyone working with hazardous materials may accomplish this by good materials management, substitution of less hazardous materials, and good operating procedures.

Good materials management means purchasing only the amount of chemicals actually needed—purchasing in bulk quantities in order to save on the unit price is often not economical when the disposal costs of excess chemicals are factored in. Good operating procedures include planning procedures to reduce the amount of waste, good housekeeping, labeling all chemical containers, and handling and storing chemicals with spill prevention in mind.

2.2.2 Recycling

Recycling is any activity that uses unwanted materials for another purpose. The MU chemical redistribution program is an example of recycling.

2.2.3 Treatment

Treatment is any activity that changes unwanted materials into a product that is less hazardous. Many treatment procedures require government permits unless conducted as part of the experimental process. Before treating unwanted hazardous materials, contact EHS for guidance to make sure the procedures comply with government regulations.

2.3 MU Pollution Prevention Initiatives

The following programs have been designed to encourage pollution prevention at MU.

2.3.1 Chemical Redistribution Program

EHS moves unwanted hazardous materials of good quality to the Chemical Recycling Building. These chemicals are then made available to the campus community free of charge. A recent copy of the chemical recycling inventory can be found on the EHS Web site at http://web.missouri.edu/~muehs. For more information, contact EHS at 882-3736.

Note: Materials may be donated to the recycling program by listing the good unwanted hazardous material on a pick-up request form, checking the "unused materials" box, and submitting this form to EHS (Chapter 6). EHS will evaluate the material, and either place it in the recycling inventory or dispose of it by appropriate means.

2.3.2 On-line Inventory System

Registered Users are required to maintain a current inventory of chemicals used and submit the inventory annually to EHS. EHS provides an on-line inventory system to assist Registered Users in this task. The on-line inventory system can be searched to locate desired chemicals on campus, and save unnecessary purchases. The on-line inventory system is available through the EHS Web site at http://web.missouri.edu/~muehs.

2.3.3 Waste Minimization Incentive Award Program

MU has established a fund to assist the campus community in purchasing equipment that results in less hazardous waste. The Hazardous Materials Management Committee reviews proposals and awards these funds. Contact EHS (882-7018) or visit the EHS Web site for more information about this program.

2.3.4 Mercury Reduction Program

Mercury is a highly toxic material and is involved in more spills than any other hazardous material on campus. Mercury has also been classified as a "persistent, bioaccumulative, and toxic material" by the Environmental Protection Agency. As a result, EHS is implementing a program to reduce the use of mercury on campus. This program involves replacing mercury-containing items, such as thermometers, manometers, mercury switches, and sphygmomanometers, with non-mercury alternatives. The campus community is strongly discouraged from buying items containing elemental mercury. Contact EHS (882-3736) to help identify non-mercury alternatives and replacement options. (Note: EHS has some funds available for replacement of items containing mercury.)

2.3.5 EHS Monitoring Program

On a periodic basis, EHS monitors areas where hazardous materials are used and stored. During these visits, EHS reviews inventories of hazardous materials, and may recommend non-hazardous alternatives when available. The monitoring program also serves to encourage good housekeeping, which is an essential pollution prevention practice.

2.3.6 Multi-hazardous Waste

There are three types of hazards that can make a waste dangerous in the general sense of the word: biological, chemical, and radioactive. When two or more of these hazards are present in a container of waste, the waste is classified as multi-hazardous. The term "mixed waste" is often used by regulators to refer to wastes that contain both chemical and radioactive hazards.

Multi-hazardous wastes are often expensive to dispose of and create significant regulatory burdens. As a result, Registered Users are encouraged to contact EHS before conducting activities that might produce multi-hazardous wastes. EHS can provide advice on alternate processes and procedures that prevent or minimize the production of multi-hazardous wastes.

2.3.7 Other Pollution Prevention Activities

EHS can provide additional suggestions for pollution prevention activities upon request. Contact the EHS Recycling Coordinator at 882-3736 for more information.

Chapter 3: Training and Information Resources

This chapter describes training and information resources available to assist the MU community in working safely with hazardous materials.

3.1 Training Policies

MU requires anyone working with hazardous materials to have appropriate training. New employees are required to take an introductory course. A separate training course is available for Ancillary Workers. Once initial training is received, a refresher is required every three years.

Anyone involved in shipping hazardous materials must have the Department of Transportation (DOT) hazardous materials training.

3.2 Training Courses Provided by EHS

EHS provides the following training courses for those involved with hazardous materials.

- Introduction to Hazardous Materials Management
- Hazardous Materials Management for Ancillary Workers
- Hazardous Materials Management Refresher
- DOT Hazardous Materials Training

These courses are provided to general audiences, or can be customized to the specific needs of individual departments or work groups. EHS also provides training to meet related departmental needs or interests upon request.

In addition to hazardous materials training courses, EHS offers training on a variety of other safety topics, such as radiation safety, biological safety, and general laboratory safety.

3.3 Schedules and Registration

The current EHS course schedule and registration information can be found at http://web.missouri.edu/~muehs/Schedule.htm. EHS may add courses if demand warrants. If a course is not available at a convenient time, contact EHS (882-7018) to find out if additional sessions can be scheduled.

3.4 Material Safety Data Sheets

Manufacturers are required to provide a Material Safety Data Sheet (MSDS) for each chemical product sold. MSDSs should be the first source of information about the hazards associated with a chemical.

Typically, MSDSs will contain the following information:

- name, address, and phone number of manufacturer
- chemical name, synonyms, and Chemical Abstracts (CAS) Number
- physical properties
- a listing of hazardous constituents for mixtures
- health hazard information
- first-aid measures
- fire fighting measures
- handling and storage precautions
- exposure controls/personal protection
- stability and reactivity

Newer MSDSs will contain the following additional information:

- toxicological information
- ecological information

- disposal considerations
- transport information
- regulatory information
- other information

Each Registered User is required to have a MSDS readily accessible for each hazardous chemical in the work area. This may be accomplished by maintaining hard copies of MSDSs or by making provisions for electronic access to MSDSs. If the hard copy approach is selected, Registered Users must obtain the MSDSs and inform all staff where the MSDS file is located. If the electronic approach is selected, EHS suggests that the Registered User create a bookmark in the Web browser to the following page: http://web.missouri.edu/~muehs/material.htm.

3.5 Other Safety Resources

EHS maintains a variety of resources on hazardous materials safety. The two publications EHS has found most useful for laboratories are:

Prudent Practices in the Laboratory, National Research Council, National Academy Press, 1995.

Safety in Academic Chemistry Laboratories, 6th Edition, Committee on Chemical Safety, American Chemical Society: Washington, D.C., 1995.

Chapter 4: Acquisition of Hazardous Materials

Chapter four provides information about MU policies and procedures for acquiring hazardous materials.

4.1 Acquisition Policy

Hazardous materials may only be obtained under the authority of a Registered User. This policy requires a Registered User number whenever hazardous materials are acquired.

Note: There is a similar requirement for the acquisition of radioactive materials (see the MU Radiation Safety Manual). Acquisition of biohazardous materials must be registered with the Institutional Biological Safety Committee (contact EHS Biological Safety Professional at 882-7018 for guidance).

4.2 Becoming a Registered User

Principal investigators and supervisors who are responsible for laboratories, and other locations where chemicals are used, are required to submit a User Registration Form to EHS prior to purchasing, using, or storing hazardous materials. This form provides EHS with information about the Registered User's name, location of work areas, and types of hazardous materials used or stored at each location. Upon receipt of a completed User Registration Form, EHS assigns a Registered User number.

4.3 Acquisition of Hazardous Materials

This section describes the various methods by which hazardous materials may be acquired at MU.

4.3.1 Chemical Recycling Program

The campus community is encouraged to participate in the Chemical Recycling Program before purchasing chemicals from vendors. This program is described in Chapter 2.

4.3.2 Purchases

When ordering hazardous materials, a Registered User number must be placed on University order forms. The Registered User number can be used by any person authorized by the Registered User. This might apply to supervisors, hazardous materials workers, or departmental accounting personnel. Because information on whether a material is hazardous may not be readily available, EHS encourages the campus community to use the Registered User number on all chemical purchases. The following list is a brief summary of the various methods of acquiring hazardous materials (for additional guidance, see Section 3:185 of the Business Policy and Procedures Manual):

- **Fisher Scientific/General Stores/University Bookstore:** Use normal procedures for purchasing hazardous materials from these suppliers.
- **Purchasing Requisition:** Use form UM 10 to purchase hazardous materials in amounts greater than $1,000. **Note:** Blanket orders will not be issued for the purchase of hazardous materials without the written permission of both the Director of Environmental Health and Safety and the Director of Procurement/Materials Management.
- **Departmental Orders:** Hazardous materials may be purchased in amounts under $1,000 using the on-line purchasing system or form UM 359. If using form UM 359, the department must acquire a "W" (campus) number from

Procurement/Materials Management at 882-3201, or an "HW" (hospital) number from the Hospital Purchasing Department at 882-7178.

- **University Credit Card:** Hazardous materials may be purchased in amounts up to $2,500 per transaction. Each purchase of hazardous materials must be recorded on the credit card hazardous materials log. Individuals must undergo training provided by Procurement/Materials Management to obtain a University credit card.
- **Gifts/Donations:** For each gift or donation of hazardous materials, a Gift Advice Form (UMUW Form 9 or 9A) must be completed. A gift or donation may consist of multiple containers of hazardous materials. Do not accept gifts of hazardous materials unless you have a use for them within the next six months. The donor must provide sufficient information about the donated materials to assess hazards and to determine the proper disposal method. Proprietary materials do not need to be specifically identified as long as hazards can be assessed and the donor provides sufficient information in regard to disposal of the used material once MU research is completed.

4.4 Compressed Gases

Compressed gas cylinders may be purchased using Requisition or Departmental Order forms in accordance with the above procedures. Purchases of compressed gas cylinders using the University credit card must have the prior approval of EHS.

4.5 Consumer Commodity Exemption

Chemicals purchased in the small quantities typical of household use are considered consumer commodities. Examples of such materials are:

- batteries
- paint and paint related materials
- fluorescent lamps
- over the counter drugs and medicines
- office supplies such as white-out, toners, and rubber cement
- vehicle care products, such as motor oil and gasoline
- lawn and garden supplies
- food, food additives, and beverages
- kitchen supplies, such as cooking oils, matches, and propane cylinders
- soaps, cleaners, disinfectants, and detergents
- film and photo supplies

Consumer commodities do not need to be procured under the authority of a Registered User. Although consumer commodities are exempted from the MU hazardous materials purchasing policy, they must be properly stored, handled, and disposed. When consumer commodities containing hazardous materials become unwanted, they must be disposed of as hazardous materials through EHS.

EHS discourages unnecessary stockpiling of hazardous materials procured under the consumer commodity exemption.

Chapter 5: Working Safely with Hazardous Materials

This chapter contains guidance on working safely with hazardous materials. Emphasis is placed on chemical safety. More detailed information on radiation safety and biological safety can be found in other EHS documents.

5.1 Basic Chemical Safety Practices

The following four steps are fundamental to using chemicals safely:

- **Develop and follow a written safety plan.** Follow the guidance in this document, or include additional procedures for the specific hazards present in the work area.
- **Know where Material Safety Data Sheets (MSDSs) and other information sources for the chemicals can be found.** Knowing the potential hazards of the chemicals is essential. Become familiar with the location of all MSDSs and other safety information.
- **Make sure all chemical containers are labeled.** Each container of hazardous materials must be labeled with the chemical name(s) and hazard warning(s). Containers of non-hazardous materials need only the chemical name on the label.
- **Maintain good housekeeping.** Good housekeeping is the most important step to improve safety. It also leaves a good impression upon visitors.

5.2 Chemical Safety Principles and Concepts

The hazards of chemicals vary widely, and appropriate precautions must always be used. Every chemical can be hazardous in certain circumstances. An understanding of the hazards of chemicals and how they enter the body can help persons working with chemicals to develop safe procedures.

5.2.1 Physical Hazards

The following terms are frequently used when describing physical hazards associated with chemicals.

- **Combustible liquid**: Any liquid, or mixture with 1% or more of a liquid, with a flash point above 141°F, but below 200°F.
- **Compressed gas**: A gas or gas mixture with an absolute pressure exceeding 40 p.s.i. at 70°F, or exceeding 104 p.s.i. at 130°F, or a liquid having a vapor pressure exceeding 40 p.s.i. at 100°as determined by ASTM D-232-72, a standard of the American Society of Testing and Materials.
- **Explosive**: A chemical that causes a sudden, almost instantaneous release of gas, pressure, and heat when subjected to sudden shock, high temperature, or pressure.
- **Flammable**:
  - *Aerosol*: A material that can produce a flame or flashback from a valve opening.
  - *Gas*: Any gas at ambient conditions that will cause a flammable mixture with air in concentrations of 13% or less.
  - *Liquid*: Any liquid, or mixture with 1% or more of a liquid, with a flash point below 141°F.
  - *Solid*: A material that is liable to cause fire through friction, contact with moisture, spontaneous reaction or retained heat, or which can be readily ignited and burns with enough persistence or violence to cause a serious health hazard.

- **Organic peroxides**: An organic compound with a bivalent O-O structure, which may be considered a peroxide derivative when one or both of the hydrogen atoms are replaced with an organic molecule. They present dangerous fire and explosion risks; many are strong oxidizers.
- **Oxidizer**: A chemical that initiates or supports combustion of other materials, causing fire by itself or by the release of oxygen or other gasses.
- **Pyrophoric**: A material that will ignite spontaneously in air at or below 130°F.
- **Unstable**: Any material which will vigorously decompose, polymerize, condense, or will become self-reactive when exposed to conditions of shock, pressure, or temperature.

5.2.2 Health Hazards

The following are health hazard classes as defined by the Occupational Safety and Health Administration (OSHA):

- **Carcinogen**: A material which can cause cancer according to the International Research on Cancer, or is listed as such in the National Toxicity Program "Annual Report on Carcinogens" http://ehis.niehs.nih.gov/roc/.
- **Corrosives**: Chemicals that cause visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.
- **Irritants**: Chemicals which are not corrosive, but which cause reversible inflammatory effects on living tissue at the site of contact.
- **Mutagen**: A material that damages chromosomes.
- **Sensitizer**: A chemical that will cause an allergic reaction in a substantial number of exposed people.
- **Target organ effects**:

  Cutaneous hazards: damage the skin

  Eye hazards: damage the eye

  Hematopoetic toxins: damage the blood and/or blood forming organs

  Hepatotoxic: damage the liver

  Nephrotoxic: damage the kidneys

  Neurotoxins: damage the nervous system

  Pulmonary toxins: damage the lungs

  Reproductive toxins: affect the fetus

- **Teratogen**: A material that causes birth defects.
- **Toxic**: A chemical with an oral lethal dose in rats of 50-500 mg/kg, a cutaneous lethal dose in rabbits of 200-1000 mg/kg, or a lethal concentration in air for rats of 200-2000 ppm.
- **Highly toxic**: A material with an oral lethal dose in rats of <50 mg/kg, a cutaneous lethal dose in rabbits of <200 mg/kg, or lethal concentration in air for rats of <200 ppm.

5.2.3 Factors Affecting Toxicity

All chemicals are hazardous under some conditions. Knowing which factors affect toxicity is helpful in developing safe procedures to prevent hazardous exposures. Some of these safety factors are briefly discussed below:

- **Dose**: Perhaps the single most significant factor of concern is the amount of exposure to the chemical. An exposure to a large amount of the chemical is usually of more concern than exposure to a small amount. For most chemicals, there is a level of exposure below which no adverse effects are likely to be observed.
- **Toxicity**: Chemicals vary widely in how toxic (poisonous) they are. Exposure to small amounts of highly toxic chemicals can be a greater danger than exposure to large amounts of less toxic chemicals.
- **Duration and frequency**: One-time exposures that are short in duration are of less concern than multiple exposures of long duration, all other factors being equal. Thus, when there has been a chemical exposure, an important piece of information concerns how long and how often.
- **Synergistic effects**: Many situations involve exposure to two or more chemicals at the same time. When this happens, it is possible that the combined exposures are more hazardous than simply adding the two effects together. While information about exposures to a single chemical is often available, good

information on the possible toxic effects from chemical mixtures is often not available.

- **Individual characteristics**: Each person is unique. While there are many similarities in response to chemical exposures, responses may vary dramatically among individuals. For example, males can react differently than females. Special concern is often given to women who are pregnant. Some individuals are allergic or hypersensitive to certain chemicals.
- **Acute and chronic effects**: Acute effects are those that show up immediately after a chemical exposure occurs. A good example of an acute effect is the spillage of acid on the skin. A chemical burn will occur immediately. Chronic effects are those that occur after a significant amount of time passes, and usually are the result of multiple exposures over a period of time. Cancer is an example of a chronic effect because cancers caused by chemical exposures often do not appear for 20 or more years after the initial exposure.

5.2.4 Routes of Exposure

By understanding how chemicals enter the body, procedures or controls to prevent hazardous exposures can be developed.

Inhalation hazards: Inhalation of chemicals is the most common route of entry a chemical can take to enter the body. Chemicals that could be inhaled include:

- gases
- the vapors of volatile liquids
- mists and sprays of both volatile and non-volatile liquid substances
- solid chemicals in the form of particles, fibers, and dusts

Direct (skin/eye) contact hazards: Many chemicals (e.g., corrosives) can injure the skin directly, while others may cause irritation or an allergic reaction. In addition to causing local toxic effects, many chemicals may be absorbed through the skin and/or eyes in sufficient quantity to cause systemic effects. The main avenues by which chemicals enter the body through the skin are hair follicles, sebaceous glands, sweat glands, and cuts or abrasions of the skin. Direct contact and absorption of chemicals through the skin depend on a number of factors including:

- chemical concentration
- chemical reactivity
- the solubility of the chemical in fat and water
- the condition of the skin
- the duration of contact

Ingestion hazards: Anyone using chemicals can easily ingest chemicals into the body through contaminated hands not washed prior to eating, drinking, smoking, applying cosmetics, or sticking part of the hand or a writing tool that is contaminated into the mouth.

Injection hazards: This route is the least likely for chemical exposures. Accidental injection of chemicals through needles is unlikely. However, if needles are contaminated or contaminated glassware breaks, there is the possibility of injecting chemicals into the body. Injections can also occur through high-pressure streams of liquids or gases.

5.2.5 Controlling Chemical Exposures

Using the information presented in the earlier sections of this chapter, and knowing the specific hazards of the chemicals to be used, helps one to design procedures to reduce hazards. At no time should any campus employee be exposed to any chemical above the OSHA Permissible Exposure Limit (PEL) or Short Term Exposure Limit (STEL). These limits have been established by OSHA as protective of virtually all workers. Request assistance from EHS in developing or reviewing procedures to control chemical exposures.

Control techniques fall into three broad classes in order of preference: engineering controls, administrative controls, and personal protective equipment. These techniques are presented in order of desirability; however, in many cases multiple techniques should be used to control exposures.

Engineering controls: Options for engineering controls are those that eliminate the hazard by changing the procedures, equipment, or facilities. Examples of engineering controls are conducting work with hazardous materials in a

fume hood or glove box, and providing secondary containment in the event of spills. Substitution of less hazardous materials is also an example of an engineering control.

Administrative controls: Whereas engineering controls work passively once they are established, administrative controls require that workers take active steps. Examples of administrative controls are posting hazard signs on laboratory doors, reducing exposure time when working with hazardous chemicals, restricting access to areas where hazardous chemicals are used, working with highly odorous chemicals during non-office hours, and adopting standard operating procedures like those listed in Section 5.3.

Personal protective equipment: Personal protective equipment includes items such as gloves, eye protection, suitable clothing, and respirators. Because such equipment is the last line of defense against exposure to hazardous chemicals, these are the options used last. Note that selection of appropriate personal protective equipment is not always simple. In the case of gloves, there are a wide variety of types depending on the specific application. Although some types of personal protective equipment may be suitable for a wide range of applications, each operation should be assessed individually.

5.3 Standard Operating Procedures

The following information represents a minimum set of guidelines for handling hazardous materials on campus. Individual administrative units, laboratories, or research groups are expected to develop more detailed procedures as appropriate. Safety references such as those listed in Chapter 3 may be useful in developing additional procedures. As outlined in Chapter 1, supervisors and principal investigators are responsible for complying with and/or enforcing appropriate safety and health measures in the work areas they supervise. EHS is available for consultative assistance to develop safe procedures for situations not covered in this guide.

5.3.1 General Procedures

Respect and understand the safety and health hazards associated with the chemicals and equipment you use, and practice the following general safety guidelines at all times:

- **Accident response**. If an injury requiring emergency medical assistance occurs, call 911. If an emergency occurs in one of the hospitals, there is a special number to call. See Chapter 8 for more information.
- **Chemical spills**. If a toxic/hazardous chemical makes contact with the skin, start flushing the area immediately. If emergency assistance is required, call 911.
- **Children and unauthorized persons**. Children and other unauthorized persons should not be in laboratories where hazardous materials or hazardous equipment are used.
- **Disposal of chemicals**. Request pickup of unwanted hazardous materials as outlined in Chapter 6. Questions about unwanted hazardous materials management should be directed to EHS at 882-3736.
- **Electrical**. Access to electrical equipment (e.g., plugs, switches, and electrical panels) should be maintained at all times. Obstructions should never prevent immediate access in an emergency. All receptacle outlets in laboratory spaces should be polarized and grounded. Ground Fault Circuit Interrupters (GFCIs) should be used in those locations involving wet processes or outdoor work, including electrical outlets within six feet of sinks. All electrical hand tools used inside laboratories should be grounded or double insulated.

  All electrical extension cords used should be visible and inspected on a periodic basis for damage and/or defects. Cords should not run in aisles or corridors where they might be damaged or create a tripping hazard. Cords should also not run through doors, walls or partitions, under rugs, or above dropped ceilings. They should not be wrapped around fixtures, tied in knots, or draped over pipes, lights, or ventilation ductwork.

  Extension cords should not be used as substitutes for fixed receptacle outlets. Cords used for 110-120 volt service should be UL

listed standard heavy-duty, three-wire equipped with a polarized three-prong plug. Two-wire type extension cords should not be used.

- **Emergency eyewash and safety showers**. Be certain safety showers and emergency eyewash units are properly located and maintained. These units should be located in areas that are immediately accessible (reachable within 10 seconds). There should be no obstructions that might inhibit the use of this equipment.

  Eye washes and safety showers should be flushed on a regular basis to verify that the units are working, and to clear the lines of stale water and debris. Whenever these emergency units are checked for proper functioning, written documentation showing the date and person's initials performing the check, should be maintained.

- **Equipment**. Use proper equipment that is in good condition. For example, never use chipped or cracked glassware. Shield pressurized or vacuum apparatus, and safeguard against bumping or overheating.

- **Fire extinguishers**. Fire extinguishers must be available, charged, and hung in a location that is immediately accessible (reachable within 10 seconds). There should be no obstructions that might inhibit the use of this equipment. Make sure that all extinguishers are checked at least annually. Each extinguisher should have a tag indicating the date it was last checked. Contact Campus Facilities (882-8211) for assistance.

- **Food, drink, and cosmetics**. Eating, drinking, and the application of cosmetics are forbidden in areas where hazardous chemicals are used. Do not store food in the same refrigerator with hazardous materials. Food used for research should be labeled, "Not for Human Consumption."

- **Horseplay**. Practical jokes or other behaviors that might confuse, startle, or distract another worker, are forbidden when hazardous chemicals are present.

- **Housekeeping**. Exits, aisles, and safety equipment must not be obstructed in any way with equipment, furniture, or other items. Aisles within the laboratory should be 36 inches in clear width. Work areas and floors are not to be used for excessive storage. Doors which are not in use, but which are accessible from a corridor or adjacent room should be appropriately labeled if they are blocked in the interior of the room. Hallways are not to be used as storage areas.

- **Mercaptans**. To avoid false reporting of natural gas leaks, mercaptans should be used in such a manner (e.g., scrubbers for effluent) that persons outside of the laboratory cannot smell the mercaptan and suspect a natural gas leak in the building.

- **Mouth pipetting**. Mouth pipetting is forbidden in laboratories.

- **Perchloric acid**. If perchloric acid is heated above ambient temperature it may evaporate and condense on ductwork in the form of explosive perchlorates. Therefore, when heating perchloric acid above ambient temperature, a perchloric acid fume hood with a water wash down system or a local scrubbing or trapping system must be used.

- **Smoking**. Smoking is prohibited in laboratories. Wash hands before smoking whenever chemicals have been handled.

- **Spill preparedness**. Before working with chemicals, assess potential spill hazards. Each laboratory worker should be familiar with general spill response procedures. Written protocols should be developed when extremely hazardous or large quantities of chemicals are used. Keep all necessary personal protective equipment and spill cleanup materials readily available.

- **Unattended experiments**. If operations involving hazardous materials are carried out with no one present, it is the responsibility of the worker to design procedures to prevent the release of hazardous materials in the event of interruptions in utility services such as electricity, cooling water, or inert gas. Lights should be left on, and signs should be posted identifying the nature of the operation, the hazardous materials in use, and who to notify in the event of an emergency. If appropriate, arrangements should be made for other workers to periodically inspect the operation.

  Similarly, if unattended experiments require the use of running water, the worker should develop procedures to make sure the experiment is

checked periodically for water leakage from the system. Unattended experiments involving the use of running water have caused flooding damage in laboratories.

- **Working alone**. When working with hazardous materials, it is advisable to have a second person present, or at a minimum, maintain contact via telephone.

5.3.2 Personal Protective Equipment and Personal Hygiene

Wearing appropriate personal protective equipment and practicing good personal hygiene as described below will reduce exposure to hazardous chemicals during routine use, and in the event of an accident.

- **Attire**. Wear a lab coat or apron. If shorts or skirts are worn, the lab coat must be knee length or longer. Wear closed-toe shoes (no sandals or open-toed shoes). Confine loose clothing and long hair. Nylons or pantyhose are not recommended because they may melt upon contact with acid.
- **Eye protection**. It is state law and campus policy that personnel including students, staff, and visitors in laboratories wear safety glasses or goggles at all times where eye hazards are a possibility. Goggles are recommended when chemical splashes are possible.

  Contact lenses may be worn in the laboratory. However, they do not provide any protection for the eyes. Persons who wear contacts must use the same eye protective equipment as those who do not wear contacts.
- **Face shields**. Full-face shields must be worn when conducting a procedure which may result in a violent reaction. Full-face shields with bottom caps to protect the neck are preferred as they provide the best protection.
- **Glass tubing**. When inserting glass tubing into stoppers, lubricate tubing and wear leather gloves to protect hands from being cut in the event the tubing slips and breaks.
- **Gloves**. Gloves are essential when working with hazardous materials. The proper gloves will prevent skin absorption, infection, or burns. Glove materials vary in effectiveness. Disposable latex gloves rarely provide adequate protection against exposure to hazardous materials. Consult a glove manufacturer or contact EHS for assistance in appropriate selection.
- **Personal hygiene**. Hands should be washed frequently throughout the day — after glove removal, before leaving the lab, after contact with any hazardous material, and before eating, drinking, smoking, or applying cosmetics.
- **Respiratory protection**. Use a fume hood or ensure adequate ventilation when working with materials that produce hazardous vapors or fumes. If the use of a respirator is required, you must comply with the MU Respiratory Protection Program, which includes an annual medical assessment, semi-annual fit testings, and instructions on proper use. Contact EHS at 882-7018 for assistance.

5.3.3 Hazard Assessments

For each task involving hazardous materials or physical hazards, a written hazard assessment should be conducted and certified by the Registered User. Tasks involving similar hazards may be grouped together on a single assessment form. Sample assessment and certification forms for common chemical hazards are presented in Appendix 1.

Registered Users and Supervisors are responsible for conducting hazard assessments. Such assessments should not be limited to chemical hazards, but should also include such issues, when applicable, as radiation hazards, biological hazards, heat and cold hazards, and other physical hazards.

Contact the EHS Industrial Hygiene Section (882-7018) for assistance with hazard assessments.

5.3.4 Handling and Storage of Chemicals

Hazards associated with chemicals vary widely. Understanding the hazards associated with a compound and reducing the quantity used and stored in the lab will decrease chance of injury.

- **Compressed gases**. Use appropriate handcarts to move compressed gas cylinders. Gas cylinders should be capped and secured to a cart during transport. Highly toxic gases should not be moved through the corridors, particularly during business hours. Always

consider cylinders as full and handle them with corresponding care.

Gas cylinders should be stored in well-ventilated areas with their protective caps on. Gas cylinders should be secured (i.e., strapped or chained in place) to reduce the chance of being knocked over. Do not store cylinders near heat or high traffic areas. Do not store flammables and oxidizers together or empty and full cylinders together. Storage of large quantities of cylinders should be in an approved gas cylinder storage area.

- **Containers**. Verify the integrity of all containers. If deteriorated containers are found, dispose of the chemical, or transfer it to a properly labeled new container. Make sure that the container is appropriate for the chemical stored. For example, hydrofluoric acid must not be stored in glass, and some oxidizers should not be stored in plastic containers. Halogenated solvents may not be stored in metal safety cans due to the potential for corrosion.
- **Cryogenic liquids**. These items present the potential hazards of fire or explosion, pressure buildup, embrittlement of structural materials, frostbite, and asphyxiation. Work areas must be well ventilated. Cryogenic liquids must be stored, shipped, and handled in containers that are designed specifically for this purpose. Because of the extreme cold and splash hazards, skin protection and eye protection — preferably a face shield — should be worn when handling cryogenic liquids. First time users of cryogenic liquids should have direct supervision and instruction from an experienced user when attempting transfers from one container to another.
- **Handling**. Use poly-coated bottles or bottle carriers when transporting chemicals that are in glass containers. Pour chemicals carefully and close caps securely. Never add water to concentrated acid; rather prepare dilute solutions by adding acid to water. Containers holding more than five gallons should be grounded when transferring flammable liquids. Provide secondary containment for liquids when transferring between work areas.
- **Inventory**. Inventories should be reviewed on a regular basis to identify deteriorating chemicals before they become problems, and to avoid excess purchases. Having updated inventories improves emergency responses, helps EHS with activities such as hazardous waste determinations and safety reviews, and allows participation in the campus wide recycling program.

  Registered Users are required to maintain an inventory of all hazardous materials in their work areas. EHS also requires Registered Users to submit an inventory of hazardous materials at least annually. To assist Registered Users with these inventories, EHS has established an on-line inventory system (http://web.missouri.edu/~muehs). The on-line inventory system allows Registered Users to confirm that they have completed an annual inventory, print copies of the inventories, and query the entire database to determine if a certain hazardous material is available on campus.
- **Labels**. Make sure all labels are legible. Label all containers of hazardous materials with the chemical name and appropriate hazard class. Containers of non-hazardous materials need only to be labeled with the chemical name. See Section 6.4.2 for instructions on labeling unwanted hazardous materials.

  Date all peroxidizable and other chemicals which may become unstable over time; test and/or dispose of them when appropriate. Common examples of chemicals that form peroxides upon aging are ethyl ether, isopropyl ether, tetrahydrofuran, and dioxane. See Appendix 2 for a more complete listing of chemicals that can form peroxides upon aging.
- **Storage**. Avoid storing chemical containers in hard to reach areas. Containers larger than one gallon should not be stored above shoulder height. Chemicals should be segregated by hazard classification. Once segregated by hazard class, chemicals may be stored alphabetically. EHS recommends the following as a minimum:
  - store flammable solvents in a flammable storage cabinet; non-flammable solvents may be stored in the same cabinet
  - store acids in a separate storage cabinet
  - keep oxidizers away from organic materials
  - keep acids away from bases

- keep cyanides and sulfides away from acids

Laboratories with large numbers of hazard classifications may choose to further segregate chemicals.

Volatile chemicals may be stored temporarily in fume hoods when flammable storage cabinets are unavailable. If volatile substances are stored in a hood, other uses of the hood should be restricted to activities compatible with the chemical and physical properties of the stored or used chemicals. When volatiles must be stored in a cooled atmosphere, flammable material refrigerators, explosion-proof refrigerators, or cold rooms designed specifically for this purpose must be used.

5.3.5 Fume Hoods and Other Engineering Controls

Fume hoods and other engineering controls, such as vented gas cabinets and biological safety cabinets, should be surveyed annually for proper operation by a qualified person from EHS, Campus Facilities, or an outside contractor with a written report of the results maintained by the unit in charge of the laboratory.

Fume hood velocities for all hoods on campus are currently evaluated on an annual basis by EHS at no charge to the users. The face velocity of fume hoods should fall between 80 and 120 feet per minute (fpm) with the sash positioned at the mechanical stop or 18 inches, unless specified otherwise. (In general, fume hoods should not be used with the sash fully open.) If the face velocity is between 80 and 120 fpm on the day of the evaluation, the fume hood is considered to be in proper working condition. If the average face velocity is below 80 fpm, the hood is considered not suitable for use with hazardous materials. If the average face velocity is above 120 fpm, the hood needs to be reviewed by EHS on a case-by-case basis to prior use.

Users should be certain that the fume hood has a sticker on it, and that the date on the sticker is less than one year old. For maintenance of fume hoods, users should contact the Campus Facilities Work Order Desk at 882-8211. (In most cases, Campus Facilities is financially responsible for the maintenance of fume hoods.)

Because the status of the fume hood can change within one year, continuous airflow indicators are recommended. New fume hoods should be equipped with a monitoring device which will alert the user if there is a problem with airflow. For older hoods without airflow monitoring devices, a simple visible test to ensure flow into fume hoods and other ventilating devices is to tape a tissue to the hood and note its movement when the exhaust fan is turned on.

Biological safety cabinets are not specifically designed to control chemical exposures. If you wish to use hazardous chemicals in a biological safety cabinet, contact the EHS Biological Safety Professional (882-7018) to assess potential hazards and assist in developing safe procedures.

Engineering controls and protective equipment, other than fume hoods, should be checked periodically by the Registered User to ensure that the equipment is functioning properly. EHS will assist upon request. Any questions or requests for assistance in evaluation of fume hoods, and other protective equipment may be directed to EHS (882-7018) or Campus Facilities (882-8211).

5.3.6 Special Provisions for Select Carcinogens, Reproductive Toxins, and Acutely Toxic Chemicals

In addition to the general safety guidelines mentioned above, special precautions are required when handling carcinogens, reproductive toxins, and chemicals with a high degree of acute toxicity. The Registered User should ensure that precautions designed to minimize risk of exposure to these substances are taken. The following are minimum guidelines:

- Quantities of these chemicals used and stored in the laboratory should be minimized, as should their concentrations in solutions or mixtures.
- Work with carcinogens, reproductive toxins, and acutely toxic chemicals should be performed within a functioning fume hood, ventilated glove box, sealed system, or other system designed to reduce exposure to these substances. (The exhaust air from the ventilation systems may require scrubbing before being released into the atmosphere.) In all cases, work with these types of chemicals should be done in such a manner that the

Occupational Safety and Health Administration's (OSHA) permissible exposure limits, or similar standards, are not exceeded.

- Compressed gas cylinders that contain acutely toxic chemicals, such as arsine and nitrogen dioxide, should be kept in ventilated gas cabinets.
- The ventilation efficiency of the designated fume hood, glove box, or gas cabinet, and the operational effectiveness of mechanical and electrical equipment used to contain or manipulate these special substances should be evaluated periodically by the laboratory personnel at intervals determined by the Registered User. The interval of evaluating systems may vary from weekly to semiannually depending upon the frequency of usage, quantities employed, and level of hazard.
- Each laboratory using these substances must designate an area for this purpose, and sign or mark this area with an appropriate hazard warning. The designated area may be an entire laboratory, an area of the laboratory, or a device such as a fume hood or glove box. The designated area should be marked with a "DANGER, specific agent, AUTHORIZED PERSONNEL ONLY" or comparable warning sign.
- All laboratory workers and ancillary workers in a laboratory with an area designated for use with carcinogens, reproductive toxins, and/or acutely toxic chemicals must be trained in the harmful effects of these substances, including signs and symptoms of exposure to these substances. Training to safely handle and store these substances is required for those who use these materials. This training is the responsibility of the Registered User and must be done prior to the use of any of these materials.
- Laboratory workers using these chemicals must have access to appropriate personal protective equipment (available at no expense to the workers) and must be trained to properly use this equipment.
- Detection equipment may be required in laboratories where acutely toxic chemicals (especially poisonous gases) are used.
- All unwanted hazardous materials contaminated with these substances should be collected and disposed of promptly as outlined in Chapter 6. The designated working area must be thoroughly decontaminated and cleaned at regular intervals that are determined by the Registered User. The interval may be as short as one day or as long as six months, depending upon the frequency of usage and the level of hazard.
- Special precautions are required to avoid release and exposure of carcinogens, acutely toxic chemicals, and reproductive toxins. For instance, volatile substances should be kept cool and contained. Gas cylinders should have properly functioning valves, check valves, regulators, appropriate piping, and containment which can withstand pressure buildup; dispersive solids should be kept in closed containers and used in places with minimal air currents; and appropriate contact materials should be used to avoid static charging.
- Emergency response planning for releases or spills should be prepared by the Registered User, and included in the training of the laboratory workers and others who may be affected in the building. EHS (882-3736) can provide assistance with this planning.

Chapter 6: Disposal of Unwanted Hazardous Material

This chapter presents the procedures to be used when hazardous materials are no longer wanted.

6.1 Disposal Policy

All unwanted hazardous materials must be disposed through EHS. Alternate disposal methods may be used only with written authorization from EHS. If there is any doubt about whether a chemical is a hazardous material, contact EHS for guidance.

A note about terminology: Because of the complexity of hazardous waste *regulations, EHS makes all campus determinations about whether an unwanted material meets regulatory definitions of "waste" and/or "hazardous waste." As a result, this section refers to "unwanted hazardous materials" instead of "hazardous waste."*

6.2 Basic Steps to Comply with Government Regulations

When government inspectors visit MU to determine compliance with hazardous waste regulations, they frequently visit laboratories and other locations where hazardous materials are used. EHS recommends the following eight steps to ensure that all areas are in compliance with these regulations:

Label All Containers: Each container must have the chemical name displayed. Unwanted hazardous materials must have a yellow hazardous materials label (see Section 6.4.2).

Accumulation Start Date: Each container of unwanted hazardous materials must show the date (month/day/year) when accumulation began. There is a box on the yellow hazardous materials label for this information (see Section 6.4.2).

Dispose of Unwanted Hazardous Materials in a Timely Fashion: According to MU policy, all containers of unwanted hazardous materials are to be turned over to EHS within six months of the accumulation start date.

Avoid Large Accumulations of Unwanted Hazardous Materials: Do not accumulate more than 25 gallons of unwanted hazardous materials. For acutely hazardous materials (see Appendix 3), do not accumulate more than one pint. Contact EHS for removal before these limits are reached.

Securely Fasten Lids: Lids on containers of unwanted hazardous materials must be securely fastened except when filling or removing materials from the container. Do not leave open funnels in containers or open containers in fume hoods.

Segregate Hazardous Materials by Hazard Class: Do not store solely by alphabetical order. Guidance on segregation is provided in Section 5.3.4.

Use Compatible Containers and Closures: Containers for unwanted hazardous materials must be of good condition and not react with the unwanted hazardous materials they hold.

Good Housekeeping: Good housekeeping is the most important action to improve safety and minimize waste. Clean up spills promptly and thoroughly. Do not overfill containers. Make sure storage and work areas are not cluttered, so that visitors are presented with a good visual impression and no suggestion of general mismanagement.

6.3 Pollution Prevention

All campus employees are encouraged to evaluate pollution prevention opportunities periodically (see Chapter 2).

Planning for disposal of unwanted materials is a helpful pollution prevention activity. If you suspect that a proposed activity might produce unwanted materials that could be particularly hazardous, difficult or expensive to dispose, or have multiple hazards (chemical, radioactive, biohazard), contact EHS for guidance (882-3736) before conducting your activity.

6.4 Preparing Unwanted Hazardous Materials for Collection

This section contains procedures used at MU to prepare properly unwanted hazardous materials for collection by EHS.

6.4.1 Choosing Containers

Containers for accumulating unwanted hazardous materials must be of good quality and compatible with the waste being collected. Examples of unsuitable containers are food containers, such as milk jugs and soft drink bottles, and the use of metal containers for acidic materials. The use of metal safety cans for accumulating halogenated solvents is sometimes overlooked; this practice is unacceptable because halogenated solvents can dissociate to produce acids, which in turn corrode metal.

All containers holding liquids must have a screw-top cap.

Leftover hazardous materials in original containers do not need to be transferred to another container for disposal unless the original container has deteriorated to the point that spills are likely.

Plastic or plastic-coated glass containers are preferred due to potential breakage hazards of glass containers. However, EHS has no plans to prohibit the use of glass containers for collection of unwanted hazardous materials. EHS generally discourages the use of metal cans for accumulation of unwanted hazardous materials. For assistance in selecting containers for accumulation of unwanted hazardous materials, contact EHS (882-3736).

6.4.2 Labeling Containers

All non-empty containers must be labeled with their contents (see Section 5.3.4). With the exception of excess chemicals in their original containers, containers of unwanted hazardous materials must be labeled with a yellow Hazardous Materials Label provided by EHS. The label must contain the following information prior to placing unwanted hazardous materials into an accumulation container:

- accumulation start date (month/day/year)
- Registered User number
- accumulation location (building and room number)
- a name for the material
- a description of the contents in detail
- an “X” in the box of each hazard class of the material

Unidentified materials (unknowns) may be disposed of by contacting EHS for guidance. Note that EHS cannot dispose of unidentified materials. EHS will arrange for analysis of unknowns and charge the Registered User or the department for expenses incurred.

6.4.3 Segregation of Unwanted Hazardous Materials

Proper segregation of unwanted hazardous materials is important to enhance safety and to increase options for managing these materials. EHS recommends the following general segregation strategies:

- Evaluate possible mixing hazards before combining unwanted hazardous materials.
- Collect recyclable materials separately from non-recyclable materials.
- Collect unwanted hazardous materials separately from non-hazardous materials.
- Keep solids and liquids separate.
- Collect unwanted halogenated solvents separately from non-halogenated solvents.

- Collect unwanted organic materials separately from metal-bearing and inorganic materials.
- Collect unwanted mercury, mercury compounds, and mercury solutions separately from all other materials as much as possible. Do not mix mercury solutions of different concentrations.
- Collect highly toxic materials, such as cyanides, separately from all other materials.
- Collect radioactive waste separately from chemical materials.
- Collect vacuum pump oil and machine oil separately from solvents. (If solvents are present, the oil cannot be recycled.)

Contact EHS (882-3736) if you have questions about specific needs.

6.4.4 Storage and Treatment of Unwanted Hazardous Materials

Unwanted hazardous materials should be stored in accordance with the guidance presented in Chapter 5. Additional recommendations for unwanted hazardous materials awaiting pickup by EHS are:

- Store unwanted hazardous materials separately from those that will be kept.
- All containers must be kept closed except during filling. Do not leave open funnels in accumulation containers.
- Do not overfill accumulation containers—doing so increases the chances of spills and presents handling hazards to EHS personnel. As a rule of thumb, do not fill containers past the shoulder; for containers without shoulders leave at least one inch of head space.
- Do not allow more than 25 gallons of unwanted hazardous materials to accumulate. The limit is one pint for acutely hazardous materials, such as cyanides, strychnine, and benzyl chloride. See Appendix 3 for a list of acutely hazardous materials.
- Do not store unwanted hazardous materials more than six months after the accumulation start date.

As a general rule, treatment of unwanted hazardous materials for the purpose of rendering them non-hazardous is not permitted at MU due to regulatory constraints. Two exceptions apply. The first is unwanted materials that are both radioactive and corrosive. These may be treated by elementary neutralization. The second exception is that treatment is allowed if it is an integrated part of an existing laboratory procedure. Because of potential regulatory issues, treatment of unwanted hazardous materials may occur only after obtaining written approval from EHS.

6.5 Requesting Collection of Unwanted Hazardous Materials

Registered Users must submit a Pick Up Request Form (PURF) to EHS to have unwanted hazardous materials collected (see attached example). The PURF is used for unwanted hazardous materials—whether used or unused, and unlabeled materials. A separate form is used to request pick up of unwanted materials containing radioactive materials.

EHS reviews the PURF for completeness. EHS then schedules collection of the material. Typically, unwanted hazardous materials are collected within two weeks of receipt of the request.

For locations that generate relatively large amounts of the same unwanted hazardous material, EHS can set up a routine pick up. Routine pick ups are scheduled for the same day, or days, each week at a frequency of up to three times a week depending on the generation rate.

Large pick ups are defined as those that involve 25 different chemicals or more than 50 separate containers. After reviewing and approving the PURF, EHS will work with the Registered User to schedule a time for collection. EHS generally requires at least a two-week notice for large pick ups, such as laboratory cleanouts.

Unused materials that are suitable for the chemical recycling program should be placed on a separate PURF.

Contact EHS for guidance about disposal of unwanted materials exhibiting multiple hazards (biological, chemical, or radioactive).

6.6 Use of Sanitary Sewer and Normal Trash

Typically, hazardous material may not be disposed of in the regular trash (solids) or the sanitary sewer (liquids). Liquids may not be disposed of in the regular trash under any circumstances due to the potential for spills and injuries to custodians, and the need to keep as much liquid out of landfills as possible. No material, hazardous or non-hazardous, may be disposed of in a storm sewer.

A Registered User, who wishes to dispose of non-hazardous chemicals in the trash or down the sanitary sewer, may contact EHS (882-3736) for a hazardous waste determination. EHS will review the chemicals and the process/protocol by which the unwanted materials are generated. If EHS can verify that the waste produced will indeed be non-hazardous, EHS will issue a written Hazardous Waste Determination Plan (HWDP) document. The HWDP allows this specific material to be disposed of by the Registered User via the trash or sanitary sewer. Disposal of chemicals via the sanitary sewer or normal trash is only allowed after receiving a written HWDP from EHS.

6.7 What EHS Does with the Unwanted Hazardous Materials

EHS transports the unwanted hazardous materials to a central management facility, known as the Resource Recovery Center. There, EHS evaluates these materials to determine whether they can be recycled or are wastes. For materials that are wastes, EHS segregates the wastes by a variety of handling methods. Some wastes may be bulked together into drums to save money and simplify handling. Other wastes are packaged—container and contents—into drums, called labpacks, prior to shipment for disposal. EHS looks at recycling as the first option for disposal. If recycling is not possible, the wastes are shipped to a permitted facility where they are treated or destroyed to minimize the potential for future hazard.

Environmental Health & Safety

University of Missouri-Columbia

Resource Recovery Center

Columbia, MO 65211-3050

PHONE (573) 882-3736
FAX (573) 884-5270

HAZARDOUS WASTE MANAGEMENT 882-7018
INDUSTRIAL HYGIENE SERVICES 882-7018
RADIATION SAFETY OFFICE 882-7221

PICK UP REQUEST FORM

☐ Used Materials ☐ Unused Materials ☐ Unknown Materials

Please use separate forms for used materials, unused materials, and unknowns. Check the applicable box above. Fax or mail completed forms. See separate instruction sheet for aid in completing this form or call EHS for help. **Do not** write in the shaded areas.

FOR EHS USE ONLY: PICK UP DATE	BY	FORM NUMBER	NOTES

DATE _____ DEPARTMENT _____

NAME OF REGISTERED USER _____ REGISTERED USER NUMBER _____

PERSON REQUESTING THE PICK UP _____ PHONE _____

LOCATION OF PICK UP: BUILDING _____ ROOM _____ OTHER _____

ITEM NO.	NAME OF MATERIAL (Detail composition on back or on separate sheets of paper, including manufacturer)	CONTAINER TYPE	CONTAINER COUNT	TOTAL QUANTITY WITH UNIT	FOR EHS USE ONLY: HAZARD NH	IG	CO	RE	TO	IN	CLASS BR	CR	SC	WC	NOTES
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

CHARACTERISTICS CODES: NH-NONHAZARDOUS, CO-CORROSIVE, IG-IGNITABLE, IN-INFECTIOUS, RE-REACTIVE, TO-TOXIC
CLASS CODES: BR-BIOHAZARD REFUSE, CR-CONTAMINATED SOLID REFUSE, SC-SURPLUS CHEMICAL, WC-WASTE CHEMICAL
ADDITIONAL COMMENTS:

IMPROPERLY DOCUMENTED ITEMS WILL BE ANALYZED AT THE REGISTERED USER'S EXPENSE
I hereby certify that the items listed above are properly documented and containerized for pick up by EHS.

SIGNATURE _____ DATE _____

Chapter 7: Record Keeping

This chapter contains information about record keeping associated with the Hazardous Materials Management program.

7.1 Registered Users

Registered Users have four areas of responsibility as described in this section.

7.1.1 Hazardous Material Inventory

Registered Users are responsible for maintaining an inventory of hazardous materials for each of their respective locations. EHS has developed an on-line inventory program to assist with this task. Access the on-line inventory program via the EHS Web site (http://web.missouri.edu/~muehs/invento.htm). The on-line inventory system is password protected so that employees outside EHS will not be able to access other inventories. The Registered User is responsible for reviewing and updating the inventory as necessary, but at least once per year. EHS recommends that the inventory be reviewed and updated more frequently.

7.1.2 Material Safety Data Sheets

Each Registered User is responsible for maintaining access to Material Safety Data Sheets (MSDSs) for all hazardous chemicals used in their work areas. This may be done by either maintaining a set of hard copies or by providing ready access to MSDSs in electronic format via the EHS Web site (http://web.missouri.edu/~muehs/material.htm). If the option of electronic media is selected, all personnel operating under the Registered User's authority must be trained on how to access MSDSs electronically.

7.1.3 Training Records

Registered Users are required to maintain up-to-date records of all safety-training courses taken by themselves and each Supervisor/Worker in the work area. Safety courses include those that address hazardous materials, radioactive materials, biohazards, and general safety. Records should be maintained by the Registered User for the term of each employee's employment plus three years. EHS includes training summaries in mailings to Registered Users summarizing the results of monitoring visits. Currenlty, these mailings are sent three times per year. Discrepancies in training reports should be reported to EHS at 882-7018 or email ehs@missouri.edu.

7.1.4 Pick Up Request Forms (PURF)

EHS recommends that copies of PURFs be retained until EHS has collected the unwanted materials from the work area.

7.2 Supervisors/Workers and Ancillary Workers

Workers other than Registered Users may find it desirable to keep the following records.

7.2.1 Training Records

Workers should maintain a record of each hazardous material, radioactive material, biohazard, and general safety course taken. The record should include course name and date taken. It is the worker's responsibility to notify both the Registered User and EHS of this information.

7.2.2 Notification of EHS when changing jobs

Workers should notify EHS by phone (882-7018) or email (ehs@missouri.edu) of employment changes within the University, or transfers from one Registered User to another.

Chapter 8: Emergency Procedures

This chapter provides guidance on appropriate steps to take in response to various types of emergencies that may occur when hazardous materials are used.

8.1 Emergency Preparedness

Before working with hazardous materials:

- evaluate processes for potential hazards
- have personal protective equipment readily available
- develop spill response protocols
- have spill response materials readily available
- know how to get assistance in the event of an emergency

Note: Emergency procedures should be posted in a conspicuous location. You may obtain a copy of these emergency procedures by calling EHS (882-7018) or accessing the EHS Web site (http://web.missouri.edu/~muehs).

8.2 Injury or Medical Emergency

1. If the individual is **unconscious**:
    - Call for an ambulance (911).

      If the emergency arises at the University Hospital, call 882-7979; at Ellis Fischel, call 882-6700; at Columbia Regional, call 876-9333; at Missouri Rehabilitation Center, dial the Operator.
    - Do not move the individual unless authorized by a medical authority, or it is obvious that delay in movement would harm the individual.
2. If the individual is **conscious**:
    - Call for an ambulance (911) if requested by the individual. (Note: Be alert to the possibility that an injured individual may become disoriented and deny the need for emergency assistance even if it is needed.)

      If the emergency arises at University Hospital, call 882-7979; at Ellis Fischel, call 882-6700; at Columbia Regional, call 876-9333; at Missouri Rehabilitation Center, dial the Operator.
    - If the injured party is a University employee, assist them in contacting a care facility authorized by MU Worker's Compensation (882-7019).

      If urgent care is needed, proceed directly to the Urgent Care Center of University Hospital and Clinics. For emergency care, the employee may proceed to the nearest medical facility for treatment.
    - If the injured party is a student and fully conscious, call Student Health Services at 882-7481 and provide relevant information.
3. Notify MU Police Department (882-7201)
4. Notify appropriate supervisors.

8.3 Fires

1. Call 911 for the fire department. Give directions to the fire location.
2. Set off the building alarm (if present).
3. Evacuate the building and assist handicapped individuals.
4. Use a fire extinguisher, if feasible to do so without jeopardizing personal well-being.
5. Notify MU Police Department at 882-7201.
6. Notify Campus Facilities (days 882-8211 and nights 882-3333).
7. Report the incident to your supervisor.

8.4 Chemical Spill

1. Evacuate the area to the extent appropriate.

2. Warn coworkers and supervisors.
3. Call Environmental Health and Safety at 882-7018. At night, on weekends, or holidays, call MU Police Department at 882-7201.
4. Take action to contain the spill if it is possible to do so without jeopardizing personal well-being.
5. IF THE SPILL CAN BE CLEANED SAFELY:
    - Neutralize or absorb the spill if possible to do so without jeopardizing personal well-being.
    - Check with EHS for guidance on disposal of spill clean up materials.

Note: DO NOT call State or National chemical emergency numbers without prior authorization from EHS, unless the spill is of disaster proportions and immediate contact with EHS is impossible.

8.5 Incidents Involving Radioactive Materials

Note: Consult the Campus Radiation Safety Manual for more detailed information.

1. For fires and medical emergencies involving radiation: call 911, state the nature of the emergency, and inform emergency personnel that a radiation hazard may exist.
2. Evacuate personnel from the radiation area.
3. Assemble all personnel in a nearby safe area until the radiation surveys and personnel decontamination are performed by the EHS Radiation Safety Office.
4. Prevent the spread of contamination from the accident site. Use nearest telephone for communications and avoid walking through the building.
5. Close doors and windows and, if convenient, turn off air equipment that might transfer radioactive contamination throughout the building.
6. Control access to the radiation area and place warning signs indication radiation and contamination hazards.
7. Contact the EHS Radiation Safety Office (882-7221). At night, on weekends, or holidays, call MU Police Department at 882-7201.

8.6 Incidents Involving Biohazardous Materials

1. For fires and medical emergencies involving biohazards: as soon as you can safely do so, call 911, state the nature of the emergency, and inform emergency personnel that biohazardous materials may be present.
2. Hold your breath. Leave the room. Close the door behind you.
3. Access the required biosafety kit/station outside the laboratory.
4. Remove and place contaminated protective garments (including shoes) into a red biohazard bag immediately at the door after exiting.
5. Place a warning sign on the door handle and isolate the area.
6. Notify the supervisor responsible for the area immediately using emergency contact information on the laboratory entry door.
7. Wash hands and face or, if facilities are available, shower. Use germicidal soap.
8. Contact EHS Biological Safety Professional (882-7018). At night, on weekends, or holidays, call MU Police Department at 882-7201.

Appendix 1

PPE Chemical Hazard Assessment and Certification for HAZARDOUS SOLID CHEMICALS AND GASES		Date of Assessment
Glove recommendations are for dry applications only. The addition of liquids, including water, may require additional evaluations. Consult a Chemical Resistivity Chart for Gloves for additional information.		
HAZARD	**List chemicals for each group**	**Recommended Personal Protective Equipment**
Solid Chemicals		
CAUTION: Contact EHS (2-7018) for advice on proper PPE if work involves the use of highly toxic chemicals, or chemicals that are carcinogens or reproductive hazards.		
High toxicity poisons (low chance of dust formation)		• Safety glasses. • Chemical resistant gloves. • Coveralls or lab coat. • Closed toe shoes. *Weighing activities may require additional precautions.*
High toxicity poisons (chance of dust formation)		• Safety glasses. • Chemical resistant gloves. • Protective coveralls. • Closed toe shoes. • Obtain respiratory protection advice from EHS (2-7018). *Weighing activities may require additional precautions.*
Caustics (e.g. lime)		• Safety goggles if dust formation is likely; otherwise safety glasses. • Chemical resistant gloves. • Coveralls or lab coat. • Closed toe shoes.
Highly reactive and high energy oxidizers		• Safety glasses. (Face or body shield may also be required during the reaction depending on the scale of the reaction.) • Chemical resistant gloves. • Coveralls or lab coat. • Closed toe shoes.
All other solid chemicals		• Safety glasses. • Chemical resistant gloves. • Coveralls, long sleeve shirt, or lab coat. • Closed toe shoes.
Gases		
Compressed gases		• Safety goggles. • Chemical resistant gloves. • Coveralls or lab coat. • Closed toe shoes.
Pressurized vessels		• Safety glasses/goggles (+ face shield depending on substances in the vessel). • Chemical resistant gloves. • Coveralls or lab coat. • Closed toe shoes.

_____ _____

Person completing assessment (print) Signature

Appendix 1

PPE Chemical Hazard Assessment and Certification for HAZARDOUS LIQUID CHEMICALS		Date of Assessment
HAZARD	**List chemicals for each group**	**Recommended Personal Protective Equipment**
Corrosive Chemicals (Acids/Caustics)		
NOTE: If work is performed on an open bench rather than in a fume hood, goggles are required and a face shield may also be desirable.		
Small containers (<1 liter)		• Safety goggles/face shield preferred, safety glasses accepted. • Proper gloves *(specify on reverse side).* • Coveralls or lab coat. • Closed toe shoes.
Large containers (> 1 liter)		• Safety goggles/face shield. (Face shield + goggles required if high splash potential.) • Proper gloves *(specify on reverse side).* • Coveralls or lab coat AND acid-resistant apron. • Closed toe shoes.
Poisonous and Toxic Chemicals		
NOTE: If work involves possible exposure to toxic vapors, contact EHS (2-7018) for advice about respiratory protection.		
Highly toxic chemicals		• Safety goggles. • Proper gloves *(specify on reverse side).* • Coveralls or lab coat AND impermeable apron. • Closed toe shoes.
Chronic hazards, e.g. carcinogens		• Safety goggles preferred, safety glasses may be acceptable. • Proper gloves *(specify on reverse side).* • Coveralls or lab coat. • Closed toe shoes.
Other Liquid Chemicals		
Highly reactive and high energy oxidizers		• Safety goggles preferred, safety glasses may be acceptable. (Face or body shield may also be required during the reaction depending on the scale of the reaction.) • Proper gloves *(specify on reverse side).* • Coveralls or lab coat. • Closed toe shoes.
All other liquid chemicals		• Safety goggles preferred (+ face shield if high splash potential). Safety glasses may be acceptable • Proper gloves *(specify on reverse side).* • Coveralls or lab coat. • Closed toe shoes.

_____ _____

Person completing assessment (print) Signature

Appendix 1

PPE Chemical Hazard Assessment and Certification for HAZARDOUS LIQUID CHEMICALS—GLOVE SELECTION	
Glove recommendations should be made for NON-IMMERSIVE applications. Consult a Chemical Resistivity Chart for Gloves for immersion applications	
Chemical Name	**Proper Glove**
Corrosive Chemicals (Acids/Caustics)	
Poisonous and Toxic Chemicals	
Other Liquid Chemicals	

Appendix 2

Peroxide Forming Chemicals

Class I: Unsaturated materials, especially those of low molecular weight, may polymerize violently due to peroxide initiation. Discard or test for peroxides after 6 months (liquids) or 12 months (gases).

- acrylic acid
- acrylonitrile
- butadiene
- chlorobutadiene (chloroprene)
- chlorotrifluoroethylene
- methyl methacrylate
- styrene
- tetrafluoroethylene
- vinyl acetate
- vinyl acetylene
- vinyl chloride
- vinyl pyridine
- vinylidene chloride

Class II: The following chemicals are a peroxide hazard upon concentration (distillation / evaporation). A test for peroxides should be performed if concentration is intended or suspected. Discard or test for peroxides 6 months after container is opened.

- acetal
- cumene
- cyclohexene
- cyclooctene
- cyclopentene
- diacetylene
- dicyclopentadiene
- diethylene glycol dimethyl ether (diglyme)
- diethyl ether
- dioxane (p-dioxane)
- ethylene glycol dimethyl ether (glyme)
- furan
- methyl acetylene
- methyl cyclopentane
- methyl-I-butyl ketone
- tetrahydrofuran
- tetrahydronaphthalene
- vinyl ethers

Class III: Peroxides derived from the following compounds may explode without concentration. Discard 3 months after opening container.

Organic

- divinyl ether
- divinyl acetylene
- isopropyl ether
- vinylidene chloride

Inorganic

- potassium metal
- potassium amide
- sodium amide (sodamide)

Note: Lists are illustrative, but not exhaustive.

Source: National Research Council. *Prudent Practices in the Laboratory*. National Academy Press. Washington, D.C. 1995.

Appendix 3

List of acutely hazardous materials

Description	CAS Number	EPA Number
Formulations containing tri-, tetra-, or pentachlorophenol (except for formulations containing Hexachlorophene synthesized from prepurified 2,4,5-trichlorophenol as the sole component)		F027
Formulations containing compounds derived from tri-, tetra-, or pentachlorophenol (except for formulations containing Hexachlorophene synthesized from prepurified 2,4,5-trichlorophenol as the sole component)		F027
Acetaldehyde, chloro-	107–20–0	P023
Acetamide, N-(aminothioxomethyl)-	591–08–2	P002
Acetamide, 2-fluoro-	640–19–7	P057
Acetic acid, fluoro-, sodium salt	62–74–8	P058
1-Acetyl-2-thiourea	591–08–2	P002
Acrolein	107–02–8	P003
Aldicarb	116–06–3	P070
Aldicarb sulfone	1646–88–4	P203
Aldrin	309–00–2	P004
Allyl alcohol	107–18–6	P005
Aluminum phosphide	20859–73–8	P006
5-(Aminomethyl)-3-isoxazolol	2763–96–4	P007
4-Aminopyridine	504–24–5	P008
Ammonium picrate	131–74–8	P009
Ammonium vanadate	7803–55–6	P119
Argentate(1-), bis(cyano-C)-, potassium	506–61–6	P099
Arsenic acid H_3AsO_4	7778–39–4	P010
Arsenic oxide As_2O_3	1327–53–3	P012
Arsenic oxide As_2O_5	1303–28–2	P011
Arsenic pentoxide	1303–28–2	P011
Arsenic trioxide	1327–53–3	P012
Arsine, diethyl-	692–42–2	P038
Arsonous dichloride, phenyl-	696–28–6	P036
Aziridine	151–56–4	P054
Aziridine, 2-methyl-	75–55–8	P067
Barium cyanide	542–62–1	P013
Benzenamine, 4-chloro-	106–47–8	P024
Benzenamine, 4-nitro-	100–01–6	P077
Benzene, (chloromethyl)-	100–44–7	P028
1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-, (R)-	51–43–4	P042
Benzeneethanamine, alpha,alpha-dimethyl-	122–09–8	P046
Benzenethiol	108–98–5	P014
7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate	1563–66–2	P127
Benzoic acid, 2-hydroxy-, compd. with (3aS-cis)-1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethylpyrrolo [2,3-b] indol-5-yl methylcarbamate ester (1:1)	57–64–7	P188
2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenylbutyl)-, & salts, when present at concentrations greater than 0.3%	[1] 81–81–2	P001
Benzyl chloride	100–44–7	P028
Beryllium powder	7440–41–7	P015
Bromoacetone	598–31–2	P017
Brucine	357–57–3	P018
2-Butanone, 3,3-dimethyl-1-(methylthio)-, O-[methylamino)carbonyl] oxime	39196–18–4	P045
Calcium cyanide	592–01–8	P021
Calcium cyanide $Ca(CN)_2$	592–01–8	P021
Carbamic acid, [(dibutylamino)- thio] methyl-, 2,3-dihydro-2,2-	55285–14–8	P189

[1] Chemical Abstracts Number given for parent compound only.

Appendix 3

List of acutely hazardous materials

Description	CAS Number	EPA Number
dimethyl- 7-benzofuranyl ester		
Carbamic acid, dimethyl-, 1-[(dimethyl-amino)carbonyl]- 5-methyl-1H- pyrazol-3-yl ester	644–64–4	P191
Carbamic acid, dimethyl-, 3-methyl-1- (1-methylethyl)-1H- pyrazol-5-yl ester	119–38–0	P192
Carbamic acid, methyl-, 3-methylphenyl ester	1129–41–5	P190
Carbofuran	1563–66–2	P127
Carbon disulfide	75–15–0	P022
Carbonic dichloride	75–44–5	P095
Carbosulfan	55285–14–8	P189
Chloroacetaldehyde	107–20–0	P023
p-Chloroaniline	106–47–8	P024
1-(o-Chlorophenyl)thiourea	5344–82–1	P026
3-Chloropropionitrile	542–76–7	P027
Copper cyanide	544–92–3	P029
Copper cyanide Cu(CN)	544–92–3	P029
m-Cumenyl methylcarbamate	64–00–6	P202
Cyanides (soluble cyanide salts), not otherwise specified		P030
Cyanogen	460–19–5	P031
Cyanogen chloride	506–77–4	P033
Cyanogen chloride (CN)Cl	506–77–4	P033
2-Cyclohexyl-4,6-dinitrophenol	131–89–5	P034
Dichloromethyl ether	542–88–1	P016
Dichlorophenylarsine	696–28–6	P036
Dieldrin	60–57–1	P037
Diethylarsine	692–42–2	P038
Diethyl-p-nitrophenyl phosphate	311–45–5	P041
O,O-Diethyl O-pyrazinyl phosphorothioate	297–97–2	P040
Diisopropylfluorophosphate (DFP)	55–91–4	P043
1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa - chloro-1,4,4a,5,8,8a,-hexahydro-, (1alpha,4a lpha,4abeta,5alpha,8alpha,8abeta)-	309–00–2	P004
1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa - chloro-1,4,4a,5,8,8a-hexahydro-,(1alpha,4alpha,4abeta,5beta,8beta,8abeta)-	465–73–6	P060
2,7:3,6-Dimethanonaphth [2,3-b] oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a -octahydro-,(1aalpha,2beta,2aalpha,3beta,6beta,6aalpha,7beta, 7aalpha)-	60–57–1	P037
2,7:3,6-Dimethanonaphth [2,3-b] oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a -octahydro-, (1aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta, 7aalpha)-, & metabolites	[1] 72–20–8	P051
Dimethoate	60–51–5	P044
alpha,alpha-Dimethylphenethylamine	122–09–8	P046
Dimetilan	644–64–4	P191
4,6-Dinitro-o-cresol, & salts	[1] 534–52–1	P047
2,4-Dinitrophenol	51–28–5	P048
Dinoseb	88–85–7	P020
Diphosphoramide, octamethyl-	152–16–9	P085
Diphosphoric acid, tetraethyl ester	107–49–3	P111
Disulfoton	298–04–4	P039
Dithiobiuret	541–53–7	P049
1,3-Dithiolane-2-carboxaldehyde, 2,4-dimethyl-, O- (methylamino)-carbonyl oxime	26419–73–8	P185
Endosulfan	115–29–7	P050
Endothall	145–73–3	P088

[1] Chemical Abstracts Number given for parent compound only.

Appendix 3

List of acutely hazardous materials

Description	CAS Number	EPA Number
Endrin	72–20–8	P051
Endrin, & metabolites	[1] 72–20–8	P051
Epinephrine	51–43–4	P042
Ethanedinitrile	460–19–5	P031
Ethanimidothioc acid, 2-(dimethylamino)-N- [[(methylamino) carbonyl]oxy]-2-oxo-, methyl ester	23135–22–0	P194
Ethanimidothioic acid, N-[[(methylamino)carbonyl]oxy]-, methyl ester	16752–77–5	P066
Ethyl cyanide	107–12–0	P101
Ethyleneimine	151–56–4	P054
Famphur	52–85–7	P097
Fluorine	7782–41–4	P056
Fluoroacetamide	640–19–7	P057
Fluoroacetic acid, sodium salt	62–74–8	P058
Formetanate hydrochloride	23422–53–9	P198
Formparanate	17702–57–7	P197
Fulminic acid, mercury(2+) salt	628–86–4	P065
Heptachlor	76–44–8	P059
Hexaethyl tetraphosphate	757–58–4	P062
Hydrazinecarbothioamide	79–19–6	P116
Hydrazine, methyl-	60–34–4	P068
Hydrocyanic acid	74–90–8	P063
Hydrogen cyanide	74–90–8	P063
Hydrogen phosphide	7803–51–2	P096
Isodrin	465–73–6	P060
Isolan	119–38–0	P192
3-Isopropylphenyl N-methylcarbamate	64–00–6	P202
3(2H)-Isoxazolone, 5-(aminomethyl)-	2763–96–4	P007
Manganese, bis(dimethylcarbamodithioato-S,S')-,	15339–36–3	P196
Manganese dimethyldithiocarbamate	15339–36–3	P196
Mercury, (acetato-O)phenyl-	62–38–4	P092
Mercury fulminate	628–86–4	P065
Methanamine, N-methyl-N-nitroso-	62–75–9	P082
Methane, isocyanato-	624–83–9	P064
Methane, oxybis[chloro-	542–88–1	P016
Methane, tetranitro-	509–14–8	P112
Methanethiol, trichloro-	75–70–7	P118
Methanimidamide, N,N-dimethyl-N'-[3-[[(methylamino)-carbonyl]oxy]phenyl]-, monohydrochloride	23422–53–9	P198
Methanimidamide, N,N-dimethyl-N'-[2-methyl-4-[[(methylamino)carbonyl]oxy]phenyl]-	17702–57–7	P197
6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide	115–29–7	P050
4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a, 4,7,7a-tetrahydro-	76–44–8	P059
Methiocarb	2032–65–7	P199
Methomyl	16752–77–5	P066
Methyl hydrazine	60–34–4	P068
Methyl isocyanate	624–83–9	P064
2-Methyllactonitrile	75–86–5	P069
Methyl parathion	298–00–0	P071
Metolcarb	1129–41–5	P190
Mexacarbate	315–8–4	P128
alpha-Naphthylthiourea	86–88–4	P072
Nickel carbonyl	13463–39–3	P073

[1] Chemical Abstracts Number given for parent compound only.

Appendix 3

List of acutely hazardous materials

Description	CAS Number	EPA Number
Nickel carbonyl $Ni(CO)_4$, (T-4)-	13463–39–3	P073
Nickel cyanide	557–19–7	P074
Nickel cynaide $Ni(CN)_2$	557–19–7	P074
Nicotine, & salts	[1] 54–11–5	P075
Nitric oxide	10102–43–9	P076
p-Nitroaniline	100–01–6	P077
Nitrogen dioxide	10102–44–0	P078
Nitrogen oxide NO	10102–43–9	P076
Nitrogen oxide NO_2	10102–44–0	P078
Nitroglycerine	55–63–0	P081
N-Nitrosodimethylamine	62–75–9	P082
N-Nitrosomethylvinylamine	4549–40–0	P084
Octamethylpyrophosphoramide	152–16–9	P085
Osmium oxide OsO_4, (T-4)-	20816–12–0	P087
Osmium tetroxide	20816–12–0	P087
7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid	145–73–3	P088
Oxamyl	23135–22–0	P194
Parathion	56–38–2	P089
Phenol, 2-cyclohexyl-4,6-dinitro-	131–89–5	P034
Phenol, 2,4-dinitro-	51–28–5	P048
Phenol, 2-methyl-4,6-dinitro-, & salts	[1] 534–52–1	P047
Phenol, 2-(1-methylpropyl)-4,6-dinitro-	88–85–7	P020
Phenol, 2,4,6-trinitro-, ammonium salt	131–74–8	P009
Phenol, 4-(dimethylamino)-3,5-dimethyl-, methylcarbamate (ester)	315–18–4	P128
Phenol, (3,5-dimethyl-4-(methylthio)-, methylcarbamate	2032–65–7	P199
Phenol, 3-(1-methylethyl)-, methyl carbamate	64–00–6	P202
Phenol, 3-methyl-5-(1-methylethyl)-, methyl carbamate	2631–37–0	P201
Phenylmercury acetate	62–38–4	P092
Phenylthiourea	103–85–5	P093
Phorate	298–02–2	P094
Phosgene	75–44–5	P095
Phosphine	7803–51–2	P096
Phosphoric acid, diethyl 4-nitrophenyl ester	311–45–5	P041
Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester	298–04–4	P039
Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester	298–02–2	P094
Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester	60–51–5	P044
Phosphorofluoridic acid, bis(1-methylethyl) ester	55–91–4	P043
Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester	56–38–2	P089
Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester	297–97–2	P040
Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester	52–85–7	P097
Phosphorothioic acid, O,O,-dimethyl O-(4-nitrophenyl) ester	298–00–0	P071
Physostigmine	57–47–6	P204
Physostigmine salicylate	57–64–7	P188
Plumbane, tetraethyl-	78–00–2	P110
Potassium cyanide	151–50–8	P098
Potassium cyanide K(CN)	151–50–8	P098
Potassium silver cyanide	506–61–6	P099
Promecarb	2631–37–0	P201
Propanal, 2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl] oxime	116–06–3	P070
Propanal, 2-methyl-2-(methyl-sulfonyl)-, O-[(methylamino)carbonyl] oxime	1646–88–4	P203
Propanenitrile	107–12–0	P101

[1] Chemical Abstracts Number given for parent compound only.

Appendix 3

List of acutely hazardous materials

Description	CAS Number	EPA Number
Propanenitrile, 3-chloro-	542–76–7	P027
Propanenitrile, 2-hydroxy-2-methyl-	75–86–5	P069
1,2,3-Propanetriol, trinitrate	55–63–0	P081
2-Propanone, 1-bromo-	598–31–2	P017
Propargyl alcohol	107–19–7	P102
2-Propenal	107–02–8	P003
2-Propen-1-ol	107–18–6	P005
1,2-Propylenimine	75–55–8	P067
2-Propyn-1-ol	107–19–7	P102
4-Pyridinamine	504–24–5	P008
Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, & salts	[1] 54–11–5	P075
Pyrrolo[2,3-b]indol-5-ol, 1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethyl-, methylcarbamate (ester), (3aS-cis)-	57–47–6	P204
Selenious acid, dithallium(1+) salt	12039–52–0	P114
Selenourea	630–10–4	P103
Silver cyanide	506–64–9	P104
Silver cyanide Ag(CN)	506–64–9	P104
Sodium azide	26628–22–8	P105
Sodium cyanide	143–33–9	P106
Sodium cyanide Na(CN)	143–33–9	P106
Strychnidin-10-one, & salts	[1] 57–24–9	P108
Strychnidin-10-one, 2,3-dimethoxy-	357–57–3	P018
Strychnine, & salts	[1] 57–24–9	P108
Sulfuric acid, dithallium(1+) salt	7446–18–6	P115
Tetraethyldithiopyrophosphate	3689–24–5	P109
Tetraethyl lead	78–00–2	P110
Tetraethyl pyrophosphate	107–49–3	P111
Tetranitromethane	509–14–8	P112
Tetraphosphoric acid, hexaethyl ester	757–58–4	P062
Thallic oxide	1314–32–5	P113
Thallium oxide Tl_2O_3	1314–32–5	P113
Thallium(I) selenite	12039–52–0	P114
Thallium(I) sulfate	7446–18–6	P115
Thiodiphosphoric acid, tetraethyl ester	3689–24–5	P109
Thiofanox	39196–18–4	P045
Thioimidodicarbonic diamide $[(H_2N)C(S)]_2NH$	541–53–7	P049
Thiophenol	108–98–5	P014
Thiosemicarbazide	79–19–6	P116
Thiourea, (2-chlorophenyl)-	5344–82–1	P026
Thiourea, 1-naphthalenyl-	86–88–4	P072
Thiourea, phenyl-	103–85–5	P093
Tirpate	26419–73–8	P185
Toxaphene	8001–35–2	P123
Trichloromethanethiol	75–70–7	P118
Vanadic acid, ammonium salt	7803–55–6	P119
Vanadium oxide V_2O_5	1314–62–1	P120
Vanadium pentoxide	1314–62–1	P120
Vinylamine, N-methyl-N-nitroso-	4549–40–0	P084
Warfarin, & salts, when present at concentrations greater than 0.3%	[1] 81–81–2	P001
Zinc, bis(dimethylcarbamodithioato-S,S')-,	137–30–4	P205
Zinc cyanide	557–21–1	P121
Zinc cyanide $Zn(CN)_2$	557–21–1	P121
Zinc phosphide Zn_3P_2, when present at concentrations greater than 10%	1314–84–7	P122
Ziram	137–30–4	P205

[1] Chemical Abstracts Number given for parent compound only.