Chemical Hygiene Plan

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Grand Rapids Community College
Chemical Hygiene Plan

1. INTRODUCTION

1.1 GRAND RAPIDS COMMUNITY COLLEGE STATEMENT OF RESPONSIBILITY

It is the responsibility of Grand Rapids Community College (GRCC), as an employer, to take every reasonable precaution to provide a work environment that is free from recognizable hazards for its employees in accordance with the "general duty" clause of the Michigan Occupational, Safety and Health Act, Section 11(a). Furthermore, GRCC is required by the Michigan Occupational Safety and Health Administration (MIOSHA) Hazardous Work in Laboratories standard (the Laboratory Standard - § 408.1024 of the Michigan Compiled Laws) to ensure that the necessary work practices, procedures and policies are implemented to protect all employees working in college owned and operated laboratories from hazardous chemicals in the work area. Grand Rapids Community College and its employees have the responsibility to be well informed regarding hazardous chemicals and risks associated with using hazardous chemicals in the laboratory environment. This document is intended for the GRCC's compliance with the MIOSHA Laboratory Standard. It will serve as a Chemical Hygiene Plan for all laboratories and classrooms where hazardous materials are used.

This document will hereafter be known as the Grand Rapids Community College Chemical Hygiene Plan (GRCC-CHP).

1.2 THE MIOSHA LABORATORY STANDARD (adopted by MIOSHA January 1, 1992)

The Michigan Occupational Safety and Health Administration (MIOSHA) has determined that laboratories typically differ from industrial operations in the use and handling of hazardous chemicals. A different approach than that found in MIOSHA's substance specific health standards is warranted to protect workers. The laboratory standard applies to all laboratories that use hazardous chemicals in accordance with the definitions of laboratory use and laboratory scale provided in this document. Generally, where this standard applies it supersedes the provisions of all other standards in the MIOSHA Right-to-Know Law and the federal Occupational Safety and Health Administration (OSHA) Hazard Communication Standard 29 CFR, part 1910.1200, except the obligation to maintain employee exposures at or below the permissible exposure limits (subpart 2 of 1910.1200), prohibition of skin and eye contact where specified by any OSHA/MIOSHA standard and in other instances where the scope of hazards are not adequately addressed by this standard.

1.3 SCOPE AND APPLICATION

This document serves as the written guide for GRCC's compliance to the laboratory standard. All employees at GRCC who are engaged in the laboratory use (as defined by this document) of hazardous materials are required to comply with this document.

The primary objective of this document is to provide a general guide for handling hazardous materials in laboratories. The GRCC-CHP establishes the basic safety principles for laboratory procedures, equipment and work practices that are capable of protecting employees from physical and health hazards of hazardous materials in laboratories.

This document is intended only to highlight those safety measures necessary for achieving a safe and healthy work environment. Where the scope of hazards is not adequately addressed by this general document, specific standard operating procedures must be developed by the employee implementing the procedures and approved by their supervisors or assistant dean as appropriate. This GRCC-CHP does not, however, apply to:

1. Work involving chemicals that do not meet the conditions of the definition of laboratory use of hazardous chemicals. In such cases, the employer shall comply with all relevant specific substance standards even if such use occurs in a laboratory type setting.

2. Work involving the laboratory use of hazardous chemicals that does not have the potential for employee exposure.

1.4 HAZARDOUS MATERIAL DEFINITIONS

A.) Chemical

A hazardous chemical is defined by MIOSHA as any chemical, chemical compound, or mixture of compounds which is a physical and/or health hazard. A chemical is a **physical hazard** by MIOSHA definition if there is scientifically valid evidence that it is a flammable or combustible liquid, a compressed gas, an organic peroxide, an explosive, an oxidizer, a pyrophoric, an unstable material (reactive), or a water reactive material.

A chemical is a **health hazard** by MIOSHA definition if there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Included are allergens, embryotoxicants, carcinogens, toxic or highly toxic agents, reproductive toxicants, irritants, corrosives, sensitizers, hepatoxins (liver), nephrotoxins (kidneys), neurotoxins (nervous system), hematopoietic systems agents (blood), or agents which damage the lungs, skin, eyes or mucous membranes.

Particularly hazardous substances, by MIOSHA definition, are select carcinogens, reproductive toxicants and chemicals with a high degree of acute and chronic toxicity.

Select carcinogens are chemicals listed by MIOSHA as carcinogens, by the National Toxicology Program (NTP) as "known to be carcinogens" and by the

International Agency for Research on Cancer (IARC) as Group 1 carcinogens. Also included are chemicals or processes listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP *and* that cause statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

1. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/ml.

2. After repeated skin application of less than 300 mg/kg of body weight per week.

3. After oral dosages of less than 50 mg/kg of body weight per day.

For the current NTP report on carcinogens: http://ntp.niehs.nih.gov/

For the current list of carcinogens from OSHA: www.osha.gov (part 1990)

For the current list of carcinogens from IARC: www.iarc.fr

Reproductive toxicants are defined by MIOSHA as any chemical that affects the reproductive capabilities of males or females, including chromosomal damage (mutagenesis) and effects on fetuses (teratogenesis). Information on reproductive effects will be listed on the Safety Data Sheet (SDS).

Chemicals with a high degree of acute and chronic toxicity are not defined in the laboratory standard. Therefore, the MIOSHA Hazard Communication definition of a highly toxic chemical will be used. Chemicals with a high degree of acute toxicity are chemicals that have a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each. The LD_{50} is that dose at which a lethal response is observed in 50% of the test animals.

The following two sources have established lists of hazardous chemicals based on substantiated tests:

1. OSHA, 29 CFR 1910.1200 Subpart Z, Toxic and Hazardous Substances and Appendices A and B of OSHA 29 CFR 1910.1200 which are referenced in MIOSHA R325.70101(2)

2. American Conference of Governmental Industrial Hygienists (ACGIH), "Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment," (latest edition)

The hazard(s) of a chemical may also be listed on its container label. Additionally, if the hazard of a chemical is not evident from the container label, the SDS will list the specific hazards. Use the SDS to address chronic toxicity. For further help in determining the hazard of a chemical, contact your supervisor or assistant dean as appropriate.

B.) Biological

Biological hazards (biohazards, biohazardous materials) are exempt from coverage under the GRCC-CHP if the only hazard they pose is biological.

However, if the material also possesses physical or health hazards, then an SDS is required.

1.5 RESPONSIBILITY

1.5.1 Employee. Individual laboratory employees are responsible for their own safety. All individuals performing work with hazardous substances must accept a shared responsibility for operating in a safe manner once they have been informed about the extent of risk and safe procedures for their activities. They also have the responsibility to inform the Campus Police for reportable accidents. The supervisor, department chair or assistant dean, as appropriate, should be notified about work practices or working conditions they believe hazardous to their health or to the health of others.

1.5.2 Student. While students are not covered under the provisions of the MISHA laboratory standard, students will be made aware of chemical health and safety hazards in classroom situations and will be provided with information and equipment to protect themselves from those hazards. Instructors should provide student training at the beginning of each course in which hazardous chemicals are used, see Appendix B for Student Laboratory Safety Sheet. Specific safety instructions should be provided at the beginning of each laboratory period.

1.6 EMPLOYEE RIGHTS

It is the employee's right to receive information about the known physical and health hazards of the hazardous chemicals in their work areas and to receive adequate training to work safely with these substances. Employees have the right to work in a safe environment and inform their supervisor or Assistant Dean about potential risks in the laboratory**.**

1.7 AVAILABILITY

The GRCC-CHP must be readily available to employees and employee representatives online at www.grcc.edu, search for CHP.

1.8 ANNUAL REVIEW

The physical sciences department will review the GRCC-CHP annually from its effective date. Any changes in the CHP will be made at the risk management level. That information will be supplied to the supervisor, department chair or assistant dean, as appropriate. They are responsible for notifying their employer of any changes made in the CHP.

1.9 EMPLOYEE INFORMATION AND TRAINING

Employees must have access to information and training to ensure that they are apprised of the hazards of chemicals present in the work area. Such information must be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignment involving new exposure situations.

1.9.1 Information. Information provided to employees must include:

1. The contents of the MIOSHA Hazardous Work in laboratories standard.
2. The location and availability of the GRCC-CHP.
3. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory (available on the SDS).
4. The location and availability of known reference materials on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory, including, but not limited to, Safety Data Sheets received from the supplier and are readily available from www.grcc.edu homepage, search SDS.

1.9.2 Method of Training. General training may take the form of individual instruction, group seminars, audiovisual presentations, on-line instruction, handout material, or any combination of the above.

General awareness training provided to employees *may* include:

1. Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as visual appearance or odor of hazardous chemicals when being released, etc.).
2. General physical and health hazards of chemicals in the work area. This must include an awareness that many factors influence whether a given chemical might constitute a hazard (e.g. dose, exposure time, genetic background, developmental state, mixtures of interactions of chemicals, etc.).
3. The measures employees can take to protect themselves from these hazards, including specific procedures the College or department has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.
4. The applicable details of the GRCC CHP.

Site-specific training provided to employees or students will include:

1. Site-specific standard operating procedures.
2. Specific physical and health hazards of chemicals in the work area (available on SDSs).

1.9.3 Documentation. Employees will fill out a training certification form (see appendix A) at the time of training.

1.10 RECORD KEEPING

Campus wide training documents will be kept by the Learning Academy for Faculty and Staff. Site specific training documents will be kept by the employee's supervisor or Assistant Dean within the employee's area. Accident

records for employees should be written and retained by the Campus Police. It is recommended by this document that such records be retained for at least one year after an employee leaves a position. Ideally, training records should be retained indefinitely.

2. STANDARD OPERATING PROCEDURES

GRCC has developed generic standard operating procedures relevant to safety and health considerations when laboratory work involves the use of hazardous materials. Standard operating procedures must be provided to all affected laboratory employees. The Standard Operating Procedures in this document specify minimum regulations and recommendations.

2.1 GENERAL SAFETY PRINCIPLES

The following guidelines have been established to minimize hazards and to maintain basic safety in the laboratory.

1. Examine the known hazards associated with the materials being used. Never assume all hazards have been identified. Carefully read the label before using an unfamiliar chemical. When appropriate, review the Safety Data Sheet (SDS) for special handling information. Determine the potential hazards and use appropriate safety precautions before beginning any new operation.

2. Be familiar with the location of emergency equipment - fire alarms, fire extinguishers, emergency eyewash and shower stations and know the appropriate emergency response procedures. Avoid distracting or startling other workers when they are handling hazardous materials.

3. Use equipment and hazardous materials only for their intended purpose.

4. Always be alert to unsafe conditions and actions calling attention to them so that corrective action can be taken as quickly as possible.

2.2 HEALTH AND HYGIENE

The following practices have been established to protect laboratory employees from health risks associated with the use of hazardous materials:

1. Avoid direct contact with any hazardous materials. Know the types of protective equipment available and use the proper type for each job.

2. Confine long hair and loose clothing and always wear footwear that fully covers the feet.

3. Use appropriate safety equipment whenever exposure to gases, vapors, or aerosols is suspected and ensure exhaust facilities are working properly.

4. Wash thoroughly with soap and water after handling hazardous materials, before leaving the laboratory and before eating or drinking.

5. Replace personal protective equipment as appropriate.

6. Laboratory employees shall be familiar with the symptoms of exposure for the materials with which they work and the precautions necessary to prevent exposure.

7. Wear eye and face protection when appropriate.
8. Always inspect equipment for leaks, tears and other damage before handling a hazardous material. This includes gloves, goggles, etc.
9. Avoid tasting or smelling hazardous materials.
10. There shall be no food, drink, smoking or applying cosmetics in the laboratories.

2.3 HOUSEKEEPING

Safety follows from good housekeeping practices. Use the following guidelines to maintain orderly laboratories:

1. Keep laboratories clean and uncluttered. Clean minor spills immediately and thoroughly.
2. Do not block exits, emergency equipment or controls, or use hallways and stairways as storage areas.
3. Avoid working alone whenever possible. No students should ever be allowed to work alone in a laboratory unless supervised by an appropriate faculty member or supervisor.

2.4 CHEMICAL HANDLING

The decision to use a hazardous material should be a commitment to handle and use the materials properly from initial receipt to disposal. Each department should have a specific plan, indicate where this information is stored, and the location should be made known to department employees.

1. Always purchase the minimum amount necessary of a hazardous material.
2. Information on proper handling and disposal of hazardous materials and access to related Safety Data Sheets (SDS) should be made available to all laboratory employees prior to the use of the material.
3. Hazardous materials utilized in the laboratory must be appropriate for the laboratory's ventilation system.
4. Large, glass bottles should be stored no more than two feet from floor level.
5. Storage of materials at the lab bench, or other work areas shall be kept to a minimum.
6. Any chemical mixture shall be assumed to be as toxic as its most toxic component.
7. Substances of unknown toxicity shall be assumed to be toxic.

2.5 TRANSFERRING OF HAZARDOUS MATERIALS

When transporting hazardous materials outside the laboratory, precautions should be taken to avoid dropping or spilling chemicals. Use the following procedures:

1. Carry glass containers in specially designed bottle carriers or a leak resistant, unbreakable secondary container.

2. When transporting hazardous materials on a cart, use a cart that is suitable for the load and one that has high enough edges to contain leaks or spills.

3. When possible, transport hazardous materials in freight elevators to avoid the possibility of exposing people on passenger elevators.

2.6 STORAGE AND DISPOSAL OF HAZARDOUS WASTE

For guidelines on the storage and disposal of hazardous wastes from laboratory operations at GRCC, refer to the Grand Rapids Community College Waste Disposal Guide. Copies of this document are available from GRCC and are attached to CHP.

2.6.1 Autoclave Protocol

Basic Procedure

The following procedure is recommended by the Office of Radiation, Chemical and Biological Safety for the decontamination of biohazardous waste.

1. The following materials need to be autoclaved prior to disposal:

   - Culture and stocks of infectious agents
   - Culture dishes and related devices
   - Contaminated solid items such as paper towels, cloth and plastic pipette tips, pipettes and vials, petri dishes and gloves.

2. Items should be autoclaved in approved autoclave bags and a rigid secondary container.

3. Add one cup of water to each bag of solid waste and keep the bags OPEN--steam can not penetrate closed bags.

4. After the cycle is completed, let the bag cool for several minuets before removing it from the autoclave. Securely close orange autoclave bag.

5. Place treated autoclave bags into opaque (non see-through) black bag and close them securely before disposing. To assure that the black bag does not rupture, do not put multiple orange bags in a single black bag.

6. Only trained employees may operate the autoclave.

3. STANDARD LABORATORY SAFE HANDLING STORAGE REQUIREMENTS

3.1 HAZARD IDENTIFICATION

Identifying the specific hazard associated with a material greatly reduces chances of misuse. At the very minimum, hazardous material containers must have the material name(s) and hazard identification(s). With respect to identifying containers, storage areas and laboratory entranceways, the following conditions entail hazard identification:

1. Labels on incoming containers of hazardous materials for laboratory use are not to be removed or defaced. Labels contain information on the identity of the material(s) in the container and the hazard identification of the material(s). Incoming containers must be labeled with the date of receipt.

2. Hazardous material storage areas should be labeled per the guidelines established in Section 6 of this document.

3. Employees must have access to SDS's.

3.2 LABELING

3.2.1 Container Labels. All permanent containers of hazardous materials must be clearly and visibly labeled with the name of the material and all the hazard(s), as provided by the manufacturer. For example, acetaldehyde is flammable and a carcinogen, and must be labeled appropriately. Additionally, the subsequent guidelines shall be followed:

1. All peroxide forming chemicals must be labeled with the date the container was opened. After the recommended disposal date, test the chemical for peroxides or dispose of properly (see Appendix D for a list of peroxide forming chemicals and peroxide testing protocols).

2. Consumer products and anything available over the counter to the general public is exempt from labeling requirements as long as it has already been labeled by the manufacturer.

3. Temporary storage containers and portable containers into which hazardous materials are transferred from labeled containers are to have a temporary label identifying the chemical. The label should be affixed to or written on the container for temporary storage or transport.

4. All sample containers or prepared solutions must be labeled.

3.2.2 Waste Containers. All hazardous material waste should be segregated and labeled according to the GRCC Waste Disposal Guide. Special attention should be given to the following areas:

1. Waste containers for non-contaminated glass must be labeled (label as "Broken Glass") and kept separate from other non-contaminated waste.

2. Once a chemical has been dated and labeled as a hazardous waste, it may not be accumulated for more than 90 days.

3. For more specific information regarding hazardous wastes, reference the GRCC Waste Disposal Guide.

3.3 PROVISIONS FOR PARTICULARLY HAZARDOUS SUBSTANCES

3.3.1 Permissible Exposure Limits. The Laboratory Standard requires that employers, for laboratory uses of substances regulated by OSHA/MIOSHA occupational health standards, assure that employees' exposures do not exceed the Permissible Exposure Limits (PELs). The American Conference of Governmental Industrial Hygienists (ACGIH) has established Threshold Limit Values (TLV's) that are time weighted average (TWA) values similar to PEL's. To keep employee exposures as low as reasonably achievable, employers will be expected to uphold the lowest exposure limit.

3.3.2 Employee Exposure Determination. The CHO will arrange for employee exposure monitoring under the following circumstances:

1. Initial monitoring must be performed if there is reason to believe employee exposure levels routinely exceed the action level, or Permissible Exposure Limit (PEL).

2. Periodic monitoring must be performed when initial monitoring reveals an exposure. The employer must comply with exposure monitoring provisions of the relevant standard.

Monitoring can be terminated in accordance with the relevant standard. The CHO must notify the employee of the monitoring results within 15 working days after receipt of monitoring results. The results must be either individually distributed in writing or posted in a location accessible to all affected employees.

3.3.3 Special Considerations. The MIOSHA Laboratory Standard requires that special precautions for additional employee protection be followed for the laboratory use of **select carcinogens, reproductive toxicants and chemicals with a high degree of acute and chronic toxicity (defined in section 1.4)**.

Protection from these hazards is provided by assuring exposure to such hazards is minimized, i.e. kept under the PEL, TLV, or STEL, or eliminated. To minimize exposure, it is necessary to determine the route by which exposure may occur, whether by inhalation, absorption, injection, ingestion or a combination of exposure routes. To ensure employees do not receive exposures in excess of the PEL or TLV, hygienic standards have been established for many toxic materials. The following general hygiene standards should be observed when using select carcinogens, reproductive toxicants and chemicals with a high degree of acute and chronic toxicity.

Establish a designated area.

1. Use and store materials only in **designated areas**: a restricted access hood, or portion of a lab designated for use of highly toxic substances. Assure that all personnel with access are aware of the necessary safety precautions.

2. Label all containers, storage and use areas appropriately. Follow the guidelines established in this document.

Use proper containment devices for the protocol and material(s) being used.

1. Use a hood for procedures that may result in the generation of aerosols or vapors.

2. It is recommended that breakable containers be stored in chemical-resistant trays.

Removal of Contaminated Waste.

Follow the guidelines established in the GRCC Waste Disposal Guide.

Follow decontamination procedures prior to leaving the designated area.

1. On leaving the designated area, remove any protective apparel (place it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck.

2. Decontaminate vacuum pumps or other contaminated equipment, including glassware, before removing them from the designated area. Decontaminate the designated area before normal work is resumed.

3. Use a wet mop or a vacuum cleaner equipped with a HEPA filter to decontaminate surfaces. DO NOT DRY SWEEP SPILLED POWDERS.

4. Protect vacuum pumps against contamination with scrubbers or HEPA filters and vent effluent into the hood.

Always take extra precautions when working with particularly hazardous materials.

1. Consult the SDS for toxic properties and follow the specific precautions and procedures.

2. Guard against spills and splashes. Appropriate safety apparel, especially goggles and gloves, should be worn. All hoods or other essential engineering controls should be operating properly before work is started.

3. Notify the **Supervisor /Assistant Dean** of all incidents of exposure or spills.

3.4 PHYSICAL HAZARDS

Materials that present a physical hazard can be safely used if the specific hazard(s) are understood. If appropriate precautions are not taken, personal injury or property damage may occur. Additionally, certain chemicals cannot be safely mixed or stored with other chemicals because of the danger of violent reaction or a reaction that generates toxic gas.

When certain hazardous materials are stored or mixed together, violent reactions may occur because the materials are unsuitable for mixing, or are incompatible. Classes of incompatible materials should be segregated from each other during

storage, according to hazards of class. Use the following general guidelines for hazard class storage; flammable/combustible liquids and organic acids, flammable solids, mineral acids, caustics, oxidizers, perchloric acid, and compressed gasses.

3.4.1. Flammable/Combustible Material. The National Fire Protection Agency (NFPA) places flammable and combustible liquids in the following classes:

Flammable	**Flash Point**	**Boiling Point**
Class IA	< 73°F (22.8°C)	< 100°F (37.8°C)
Class IB	< 73°F (22.8°C)	>=100°F (37.8°C)
Class IC	>=73°F (22.8°C)& <100°F (37.8°C)	
Combustible		
Class II	>=100°F (37.8°C)&< 140°F (60°C)	
Class IIA	>=140°F (60°C)&< 200°F (93°C)	
Class IIIB	>=200°F (93°C)	

These classes give a measure of the fire risk. Appendix E lists some common flammable and combustible chemicals. Appendix E pertains to the storage of flammable and combustible materials.

When handling flammable/combustible materials, observe the following guidelines:

1. Eliminate ignition sources such as open flames, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity.

2. Store in NFPA approved flammable liquid containers or storage cabinets, in an area isolated from ignition sources or in a special storage room designed for flammable materials.

3. Ensure there is proper bonding and grounding when it is required, such as when transferring or dispensing a flammable liquid from a large container or drum. Assure bonding and grounding is checked periodically.

4. Assure appropriate fire extinguishers and/or sprinkler systems are in the area.

3.4.2 Corrosives. Corrosive materials which can react with the skin causing burns similar to thermal burns, and/or which can react with metal causing deterioration of the metal surface. See Appendix G.

1. Containers and equipment used for storage and processing of corrosive materials should be corrosion resistant.

2. Eye protection and rubber gloves should always be used when handling corrosive materials. A face shield, rubber apron, and rubber boots may also be appropriate, depending on the work performed.

3. **Never add water to acid.** When mixing concentrated acids with water, add the acid slowly to water.

4. An eyewash and safety shower must be readily accessible to areas where corrosives are used and stored. In the event of skin or eye contact with corrosives, immediately flush the area of contact with cool water for 15 minutes. Remove all affected clothing. Obtain medical help.

3.4.3 Oxidizers. Oxidizers are materials that react with other substances by gaining electrons and undergoing reduction. This reaction may result in fire or explosion. The intensity of the reaction depends on the oxidizing-reducing potential of the materials involved. See Appendix H.

1. Know the reactivity of the materials involved in the experiment or process. Ensure there are no extraneous materials in the area that could become involved in a reaction.

2. If the reaction is anticipated to be violent or explosive, use shields or other methods for isolating the materials or the process.

3.4.4 Water Reactive Materials. Water reactive materials are those that react with water to produce a flammable or toxic gas or other hazardous condition. Often a fire or explosion results. Safe handling of water reactive materials will depend on the specific material and the conditions of use and storage. Examples of water reactive chemicals include alkali metals such as lithium, sodium, and potassium; acid anhydrides, and acid chlorides.

3.4.5 Peroxidizable Chemicals (Organic Peroxides). Peroxides are materials that undergo auto-oxidation (a reaction with oxygen in the air) to form peroxides, which can explode upon impact, heat, or friction. Since these chemicals may be packaged in an air atmosphere, peroxides can form even though the container has not been opened, necessitating careful handling. See Appendix I for a list of materials that may form peroxides.

1. Date all peroxidizables upon receipt and upon opening. Dispose of or check for peroxide formation after the recommended time; 3-months or one year depending on the chemical. See Appendix I.

2. Do not open any container that has obvious solid formation around the lid.

3. It is recommended to chemically test for peroxides periodically.

4. Follow the same basic handling procedures as for flammable materials.

3.4.6. Light-Sensitive Materials. Light sensitive materials degrade in the presence of light, forming new compounds that can be hazardous or result in conditions such as pressure build-up inside a container. Examples of light sensitive materials include chloroform, tetrahydrofuran, ketones, and anhydrides. Store light-sensitive materials in amber colored bottles in a cool dark place.

3.4.7 Unstable Materials. Unstable materials can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated. Some chemicals become increasingly shock-sensitive with age. Of great concern in the laboratory is the inadvertent formation of explosive or shock-sensitive materials such as peroxides, perchlorates (from perchloric acid), picric acid and azides. A list of shock sensitive and explosive materials is provided in Appendix I.

1. Contact the Campus Police when it is suspected that the inadvertent formation of shock-sensitive materials in chemicals being stored has occurred.

2. Date all containers of explosive or shock-sensitive materials upon receipt and when opened.

3. If there is a chance of explosion, use barriers or other methods for isolating the materials or the process.

3.4.8 Cryogens. Cryogens are liquefied gases that condense oxygen from the air, create an oxygen rich atmosphere and increase potential for fire if flammable or combustible materials and a source of ignition are present. Pressure is also a hazard due to the large expansion ratio from liquid to gas, causing pressure build up in containers. Many materials become brittle at extremely low temperatures. Brief contact with materials at extremely low temperatures can cause burns similar to thermal burns. Some of the hazards associated with cryogens are fire, pressure, weakening of materials, and skin or eye burns upon contact with the liquid.

1. Equipment should be kept clean, especially when working with liquid or gaseous oxygen.

2. Mixtures of gases or fluids should be strictly controlled to prevent formation of flammable or explosive mixtures.

3. Always wear safety glasses with side shields or goggles when handling. If there is a chance of a splash or spray, a full-face protection shield, an impervious apron or coat, cuffless trousers, and high-topped shoes should be worn. Watches, rings, and other jewelry should not be worn. Gloves should be impervious and sufficiently large to be readily thrown off should a cryogen spill.

4. Containers and systems containing cryogens should have pressure relief mechanisms.

5. Containers and systems should be capable of withstanding extreme cold without becoming brittle.

3.4.9 Compressed Gases. Special systems are needed for handling materials under pressure. Cylinders pose mechanical, physical and/or health hazards, depending on the compressed gas in the cylinder.

1. Cylinders with regulators must be individually secured.

2. Only cylinders with valve protection caps securely in place may be safely gang-chained (chained in groups).

3. When storing or moving a cylinder, have the valve protection cap securely in place to protect the stem.

4. Cylinders must be secured in an upright position at all times.

5. Use suitable racks, straps, chains, or stands to support cylinders against an immovable object, such as a bench or a wall, during use and storage. Do not allow cylinders to fall or lean against one another.

6. Use an appropriate cart to move cylinders.

7. Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.

8. Oil or grease on the high-pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder. Use an oxygen approved regulator.

9. Always wear goggles when handling compressed gases.

10. Always use appropriate gauges, fittings, and materials compatible with the particular gas being handled.

4. EMERGENCY AND NON-EMERGENCY PROCEDURES

4.1. BASIC STEPS IN CASE OF A SPILL

4.1.1 Definitions of Emergency and Non Emergency Spills

Emergency Situations. Releases of hazardous substances that pose a significant threat to health and safety or that, by their very nature, require an emergency response regardless of the circumstances surrounding the release or the mitigating factors are emergency situations. The following definitions designate an emergency situation:

1. The situation is unclear to the person causing or discovering a spill.
2. The release requires evacuation of persons.
3. The release involves or poses a threat of
    a. fire, suspected fire, explosion or other imminent danger
    b. conditions that are immediately dangerous to life or health
    c. high levels of exposure to toxic substances.
4. The person(s) in the work area is uncertain they can handle the severity of the hazard with the personal protective equipment (PPE) and response equipment that has been provided and/or the exposure limit could easily be exceeded.
5. The spill is of a reactive material.

Non Emergency Situations. Conversely, releases that do not pose significant safety or health hazards to person(s) in the immediate vicinity or to the person(s) cleaning releases, do not have the potential to become emergencies within a short time frame are not emergency situations. The following situations are not emergency situations:

1. The person causing or discovering the release understands the properties and can make an informed decision as to the exposure level.
2. The laboratory instructor, laboratory technician, or trained student-workers (under supervision) can appropriately clean up the release using authorized spill kits.
3. The materials are limited in quantity, exposure potential, or toxicity and present minor safety or health hazards to persons in the immediate work area or those assigned to clean up the activity.
4. Incidental releases of hazardous substances that are routinely cleaned up by instructors, trained student employees, or trained custodians need not be considered an emergency.
5. Releases that can be safely cleaned up with the use of PPE.

4.1.2. **Spill Kits.**

Ready access to the following equipment is required in laboratories that work with hazardous materials:

1. Splash resistant goggles
2. Chemical resistant gloves
3. Plastic bags
4. The following chemical sorbents (enough for a 4 L spill)
   a. sand (organic spills)
   b. sodium hydrogen carbonate (acid spills)
   c. citric acid (base spills)
   d. zinc dust (mercury spills)
5. Small broom and dust pan

4.1.3 Procedures for Emergency Spills.

If the spill is of high toxicity or flammability, you are unsure of how to proceed, or there are more than 4 liters of chemical spilled, execute the following:

1. Call Campus Police, ext. 4911.
2. Evacuate students from the spill area and alert others in the area.
3. Isolate the spill area and close doors to the room where the spill occurred.
4. Remove ignition sources and shut down equipment.
5. If there are hazardous fumes, contact facilities for emergency shut down of HVAC units. Evacuation of the building is mandatory if chemicals or contaminants could enter the air circulation system of a building.

4.1.4 Procedures for body and eye splashes and chemical inhalation.

Attend to victims for a body splash using the following procedures:

1. If necessary, remove person(s) from spill area to fresh air only if attempts to rescue victim(s) do not present a danger to the rescuers.

2. Remove contaminated clothing, shoes, and jewelry (do not attempt to wipe the clothes) while under an emergency shower. Seconds count. Be careful not to contaminate eyes while removing clothing. It may be better to cut clothing off.

3. Flood affected area with cold water for at least 15 minutes or longer if pain persists. Try not to spread chemical on skin or eyes.

4. Contact Campus Police ASAP and assure they know the chemical(s) involved.

Attend to victims for an eye splash using the following procedures:

1. If necessary remove victim(s) from spill area to fresh air only if an attempt to rescue victim(s) does not present a danger to the rescuers.

2. Lead the victim(s) immediately to an emergency eye wash facility.

3. Hold eyelids open. Have victim rotate eyes.

4. Flush eyes for at least 15 minutes or longer if pain persists.

5. Contact Campus Police (ext. 4911) ASAP and assure that they know the chemical(s) involved.

Attend to victim of chemical inhalation using the following procedures:

1. Remove victim to fresh air.

2. If symptoms, such as a headache, nose or throat irritation, dizziness, drowsiness, or tightening of the chest, contact Campus Police, 4911.

4.1.5 Procedures for non-emergency spills (less than 4 liters).

Use the following procedures for non-emergency spills:

1. Locate the spill kit.

2. Choose the proper protective equipment. Always wear gloves and protective eyewear. If necessary, use additional protective equipment such as an apron, coveralls, boots, or respirator.

3. Confine or contain the spill.

4. Cover liquid spills with spill kit absorbent and sweep into a dustpan and place in a sealed container.

5. Sweep solid materials into a dustpan and place in a sealed container.

6. Dispose of waste as normal trash as long as substance is non-volatile, non-hazardous.

4.1.6 Mercury Spills. GRCC suggests that staff/faculty avoid the use of mercury on campus whenever possible.

In case of a small spill, i.e. a broken mercury thermometer, we can clean it up in house. For a mercury spill of more than the amount contained in a normal mercury thermometer do not clean it up. Evacuate the area and call Campus Police. **Procedures are as follows:**

1. In case of a small spill, i.e. a broken mercury thermometer, use an appropriate Mercury spill kit to clean-up the spilled mercury.

2. Do not allow foot traffic in the area until the clean up is complete.

3. Dispose of the used spill kit by placing the sealed container in your hazardous waste staging area for your department to dispose of as hazardous waste. Be certain that the package is clearly labeled Mercury.

4. If mercury (in any amount) gets into a drain do not allow anything including water to be sent down the drain cordon off the area and call Campus Police.

For a mercury spill of greater volume than the amount contained in a normal mercury thermometer do not clean it up.

1. Evacuate the area.

2. Close all access to the area and post so that no one enters.

3. If possible, without any risk of disturbing or spreading the mercury, supply fresh air ventilation.

Call Campus Police:
4010 in house phone
234-4010 by Cell, Pay, or Off Campus Phone

4.2 BASIC STEPS IN CASE OF FIRE ALARM OR FIRE

4.2.1 Fire Alarms. The following steps are basic protocol in the event of a fire alarm. These steps and exit locations should be reviewed with students.

a) When passing through a closed door, check doorframe for heat.
b) Feel the door or doorknob to the hallway with back of your hand. If it feels hot, do not open it-the fire may be on the other side of the door. If you are trapped, put a cloth or towel under the door to help prevent entry of smoke.
c) Call Campus Police, (ext.4911) stay on phone until instructed otherwise.
d) If the door is not hot, open it slowly. If the hallway is clear of smoke proceed to the nearest exit locaiton.
e) Identify people who can assist wheelchair users in getting to the "Handicapped Evacuation Areas". The "Handicapped Evacuation Area" for each building has a map marking the designated location
f) Close doors and turn off lights upon leaving the room. Evacuate the building at the nearest exit.
g) If you are with students, take your class to the designated area and wait until "All Clear" is given by the GRCC Campus Police officers.
h) Do not stand on pedestrian walkways or block exits.
i) Do not use elevators.
j) Report any known missing or injured students/staff immediately to Campus Police at ext. 4911.

4.2.2 Small Laboratory Fires. The following steps are basic protocol for handling a small laboratory fire:

1. A fire contained in a small vessel can usually be suffocated by covering the vessel with a lid.

2. If you have been trained in the use of a fire extinguisher and are confident that you can contain the fire, fight the fire from a position where you can escape.

4.2.3 Clothing/Body Fires. The following steps are basic protocol in the event of a clothing/body fire:

1. If your clothing catches on fire, drop to the floor and roll. Use a fire blanket if available.
2. If a co-worker's clothing catches on fire, knock person to the floor and role them to smother the flames. Use a fire blanket if available.
3. Use a safety shower immediately afterwards if warranted or appropriate.
4. Contact Campus Police, ext. 4119.

4.2.4 Facility Fires. The following steps are basic protocol in the event of a facility fire:

1. Activate the emergency fire alarm and alert people in area of the need to evacuate.
2. Follow steps under Section **4.2.1 Fire Alarms**.
3. Call Campus Police at ext. 4911 from a safe location.
4. Campus Police staff shall immediately notify the Crisis Management Team when a fire emergency alarm goes off.

4.3. MISCELLANEOUS EMERGENCIES

4.3.1 Gas Leakage:

1. If leakage location is identifiable, immediately shutoff at location.
2. If leakage location cannot be identified, hit the emergency shutoff.
3. Evacuate the building if leak cannot be isolated.
4. In both instances, immediately notify Campus Police, ext. 4911.

4.3.2 Accidental Ingestion of Chemicals

1. Call Campus Police, ext. 4911.
2. Do not induce vomiting unless directed to do so by medical personnel.

4.3.3 HVAC: Ventilation and Electrical

If laboratory ventilation is not functioning or there is an electrical emergency, contact **Facilities at ext. 4057**. If emergency lighting and fire alarms **ARE NOT** operable, evacuate the building after the following steps have been taken:

1. Place lids on all open containers of volatile chemicals.

2. Lower the sash on chemical fume hoods.
3. Shut down all equipment (leave cooling water and purge gases on as necessary).
4. Turn off ignition sources and gas sources.
5. Secure or isolate reactions that are underway.
6. Close all doors.
7. Take your books, coats, purse/wallet, keys, etc.

In anticipation of a power outage the following provisions have been made:

1. GRCC has emergency generators that will provide temporary lighting. The lights are primarily used for illumination to exit the facility.
2. Flashlights should be conveniently located.
3. Campus emergency numbers should be in convenient locations.

5. MEDICAL PROCEDURES

5.1 INJURY AND ACCCIDENT

Use the following procedures in the event of accident or injury to a GRCC employee (not employees through temporary services) during the performance of duties for Grand Rapids Community College. If an employee is injured on the job, he/she must:

1. Report his/her injury within 24 hours to his/her supervisor/department head or to campus police.

2. Complete an **EMPLOYEE INJURY REPORT** form. All injuries should be reported, even if medical treatment is not necessary.

3. Contact Campus Police, ext. 4911 for completion of an incident report.

4. Obtain an **Occupational Services Authorization to Treat** form prior to seeking medical treatment for an on the job injury. Only those names listed here (http://www.grcc.edu/humanresources/healthbenefits/employeeinjuryprocedures) can authorize medical treatment.

5. The employee should then proceed to one of the following facilities:

   Spectrum Health Occupational Service Clinics – (3) Locations: (Hours subject to change, call first)
   • 2750 East Beltline Drive, Ave NE, Floor-1 (Corner of East Beltline and 3 Mile Road) (616) 391-2778
   Mon-Fri - Open 8 am - 6 pm (After Hours Initial Injury Care 7-days/week until 8 pm)
   • 3350 Broadmoor SE (South of 28th St) (616) 391-2778
   Mon-Fri - Open 8 am - 6 pm (After Hours Initial Injury Care 7-days/week until 8 pm)
   • 6105 Wilson Ave SW (West Pavilion Location) (616) 391-2778
   Mon-Fri - Open 7 am - 6 pm (After Hours Initial Injury Care 7-days/week until 8 pm)

   Or After-Hours Emergent Injury Care: Blodgett Hospital Location-1840 Wealthy St SE (Adjacent to Emergency Room) (616) 391-0234

6. After treatment, the employee must return any after care instructions to his/her supervisor or Department Head for review of any restrictions. After review, supervisors are required to send all paperwork to the Benefits Office, Cook Administration Building-2nd floor at the DeVos Campus – attn. Maria Belmares Herrera

7. If an injury occurs after regularly scheduled GRCC hours and immediate medical authorization is necessary, employees must call Campus Police (x4911) or their immediate supervisor; if the injury is life threatening, injured employees should go to the nearest emergency room.

8. If treatment by a Specialist is necessary, Spectrum Health Occupational Services will call the Benefits Office (Ext. 4052) for authorization before

scheduling you with the proper physician or specialist. **Note: Medical services received from an employee's personal physician will not be paid by Grand Rapids Community College.**

NOTE: To be considered an employee, the person must be on the payroll for Grand Rapids Community College at the time of injury. If individuals are not working at the College but are contracted through temporary services, GRCC is not responsible for their treatment. Please contact the HR Benefits office (x4052) if an employee contacted through a temporary service is injured on the job. This is extremely important.

5.2 MEDICAL CONSULTATIONS AND EXAMINATIONS

GRCC must provide all employees working with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the circumstances outlined below:

1. The employee must be provided an opportunity to receive an appropriate examination when he/she develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory

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

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

4. All medical consultations and examinations must be performed by or under the direct supervision of a licensed physician and be provided without cost to the employee, without loss of pay and at a reasonable time and place.

G**RCC or the appropriate department** shall provide the following information to the physician:

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

2. A description of the conditions surrounding the exposure, including available quantitative exposure data.

3. A description of the signs and symptoms of exposure that the employee is experiencing, if any.

6. STANDARD LABORATORY FACILITY REQUIREMENTS

6.1. SIGNS AND INFORMATION

Labels and warning signs should alert employees to potentially hazardous materials and allow those unfamiliar with the laboratory surroundings to identify hazardous chemical use and storage areas, safety and emergency equipment, exits, and to aid Campus Police.

The Michigan Right-to-Know law requires that laboratories keep Safety Data Sheets (SDS's) in a systematic and consistent manner. The system adopted must provide easy access to SDS's for hazardous chemicals used in the laboratories.

Safety Data Sheets are documents containing chemical hazard identification, safe handling information, and is prepared in accordance with the OSHA Hazard Communication Standard and the Michigan Right-to-Know law. Chemical manufacturers and distributors must provide the purchasers of hazardous chemicals an appropriate SDS for each hazardous chemical/product purchased.

GRCC SDS's are located online at www.grcc.edu, search SDS; hard copies are located at in **527 Calkins Science Center**.

The following signs must be posted in appropriate places.

1. The Michigan Right-to-Know law poster, listing the location of SDS's for all hazardous chemicals used in the laboratories.
2. The emergency contact numbers are posted on the Right to Know Stations.
3. The GRCC Right to Know Committee updates policy and safety data sheets as the law states.
4. If a laboratory has 10 gallons or more of a flammable liquid, the main doorway to the lab shall have a flammable liquid sticker visibly posted on it. This is an aid to fire response personnel.

Facilities containing certain hazards must have warning signs posted at the designated area of the laboratory where the hazard exists and at the entranceway to the laboratory. Any areas placarded as such are restricted access, designated areas and have certain standards regarding training and use by employees. Such hazards include MIOSHA Class A carcinogens and radioisotopes. Other chemical hazards will be dealt with on a case-by-case basis, with consultation from the CHO.

6.2 STORAGE AREAS

Chemicals should be stored according to compatibility as designated by hazard classes. Particularly hazardous chemicals should be stored and handled with extreme care. When ordering chemicals that are unfamiliar, review the SDS

before purchase so that use and storage guidelines are understood. Assure that the following areas are labeled and chemicals are stored appropriately:

1. Carcinogens
2. Corrosives
3. Flammable Liquids
4. Flammable Solids
5. Oxidizers
6. Perchloric Acid

Additionally, storage areas for radioisotopes should be appropriately labeled. Contact the CHO for any additional information.

6.3 PERSONAL PROTECTIVE AND SAFETY EQUIPMENT

Personal protective devices and safety equipment must be provided to all employees under the appropriate circumstances and employees have the responsibility of properly using such equipment.

6.3.1 Personal Protective Equipment

Eye and skin protection equipment must be made available to all employees or visitors to laboratories where chemicals are used or stored. This equipment must be used where there is a reasonable probability of injury from hazardous chemicals that can be prevented from such equipment.

6.3.1.1 Eye Protection. Many of our laboratories, non-laboratory areas, and chemical storeroom contain hazardous or corrosive liquids that may present a chemical splash hazard that could cause eye injury. The potential for eye injury from flying debris also exists in some instances. The following section describes adequate eye protection for various situations and provides guidelines for using such protection.

MIOSHA has adopted the American National Standards Institute (ANSI) consensus standards for eye protection. All eye protective devices must be stamped with "Z87" by the manufacturer if they meet ANSI standards. If the eye protection is not marked, it may not be the most effective protection available. The following types of eye protection are available for use in the laboratory:

1. Safety glasses with side shields offer minimal eye protection against flying fragments, chips, particles, sand, and dirt.

2. Safety (impact) goggles offer adequate eye protection against flying fragments, chips, particles, sand, and dirt.

3. Chemical splash goggles have indirect venting for splash proof sides and provide adequate eye protection against chemical splashes.

4. Face shields protect the face and neck from flying particles and splashes. Face shields do not protect the eyes adequately so additional eye protection should be worn.

5. Ultra-violet (UV) light face shields provide eye protection when working with UV light sources.

Table of Eye Protection Selection Guidelines

Operation	**Eye Protection Required**
When handling potentially hazardous, corrosive, or injurious chemicals	Chemical splash goggles
Entry into laboratory or area where others are working with potentially hazardous, corrosive, or injurious chemicals	Chemical splash goggles
Transferring more than one liter quantities of corrosive chemicals	Chemical splash goggles and face shield
Working with glassware under reduced or elevated pressure or with drill presses or other similar conditions.	Safety (impact) goggles
Working with UV light sources	UV light face shield

All employees and visitors should be provided protective eye-wear whenever they enter a laboratory or chemical storeroom. Guidelines for eye protection use are outlined in the table above. Refer to the SDS for assistance in determining the injurious nature of chemicals and for specific recommendations on eye protection.

6.3.1.2 Protection of the Skin and Body. Many chemicals cause skin irritation or burns. Further, some can be absorbed through the skin, with potentially harmful effects. Therefore, efforts must be made to reduce chemical exposure to the skin and body. Skin and body protection involves the use of protective clothing to prevent chemical exposure. The SDS may provide some information on personal protective equipment recommended for a given chemical; however, the SDS often does not provide sufficient information concerning the specific type of protective clothing required.

The most basic and effective forms of protection include:

1. Shoes – shoes that cover the entire foot must always be worn when handling liquid, hazardous, and corrosive chemicals. Opened toed shoes, sandals, and clogs are forbidden in the chemistry laboratories.

2. Long pants – Long pants must be worn to protect the skin from chemical exposure. For the best protection, pants should be loose-fitting and made from a heavy material. Shorts and skirts should not be worn while working in the lab.

3. Shirts – In order to protect the skin from chemical exposure, shirts must cover the abdomen. Shirts should not have long, flowing sleeves.

4. Laboratory coats - Laboratory coats offer additional skin protection from chemical exposure.

5. Gloves – Gloves are an excellent way to prevent chemical exposure to the hands when chemicals are transferred between containers. Protective gloves should be worn when handling hazardous materials, chemicals of unknown toxicity, and corrosive materials. Choosing the appropriate hand

protection can be a challenge in a laboratory setting. Glove selection is discussed below.

In rare cases, such as when handling large quantities of strong acids or bases, acid gases, certain organic chemicals, which are classified as mutagens, or carcinogens, strong oxidizing agents, the use of specialized protective equipment that prevents skin contamination may be required. Examples of this equipment include rubber gloves, aprons, boots and protective suits.

Gloves. When handling chemicals in a laboratory, disposable latex, vinyl, or nitrile examination gloves are usually appropriate for most circumstances. When working with chemicals with high acute toxicity, working with corrosives in high concentrations, handling chemicals for extended periods of time or immersing all or part of a hand into a chemical, the appropriate glove material should be selected based on chemical compatibility. The following table outlines the major glove types and their general uses.

Glove Material	**General Uses**
Butyl	Offers the highest resistance to permeation by most gases and water vapor. Especially suitable for use with esters and ketones.
Neoprene	Provides moderate abrasion resistance but good tensile strength and heat resistance. Compatible with many acids, caustics and oils.
Nitrile	Excellent general duty glove. Provides protection from a wide variety of solvents, oils, petroleum products and some corrosives. Excellent resistance to cuts, snags, punctures and abrasions.
PVC	Provides excellent abrasion resistance and protection from most fats, acids, and petroleum hydrocarbons.
PVA	Highly impermeable to gases. Excellent protection from aromatic and chlorinated solvents. Cannot be used in water or water-based solutions.
Viton	Exceptional resistance to chlorinated and aromatic solvents. Good resistance to cuts and abrasions.
Silver Shield	Resists a wide variety of toxic and hazardous chemicals. Provides the highest level of overall chemical resistance.
Natural rubber	Provides flexibility and resistance to a wide variety of acids, caustics, salts, detergents and alcohols.

There are several factors besides glove material to consider when selecting the appropriate glove. More details on glove selection can be found in the catalogs that sell these items.

1. dexterity- Where fine dexterity is needed, consider double gloving with a less compatible material, immediately removing and replacing the outer glove if there are any signs of contamination. In some cases, such as when wearing Silver Shield gloves, it may be possible to wear a tight-fitting glove over the loose glove to increase dexterity.

2. length- Glove length should be chosen based on the depth to which the arm will be immersed or where chemical splash is likely.

3. size – Glove size may also be important. Gloves that are too tight tend to cause fatigue, while gloves which are too loose will have loose finger ends which make work more difficult.

4. degradation - Degradation is the change in one or more of the physical properties of a glove caused by contact with a chemical. Degradation typically appears as hardening, stiffening, swelling, shrinking or cracking of the glove. Gloves that show signs of degradation should be discarded.

5. breakthrough time – Breakthrough time is the elapsed time between the initial contact of the test chemical on the surface of the glove and the analytical detection of the chemical on the inside of the glove. When using mixture of chemicals, it is recommended that the glove material be selected based on the shortest breakthrough time.

6. permeation rate – The permeation rate is the rate at which the test chemical passes through the glove material once breakthrough has occurred and equilibrium is reached.

Glove Inspection, Use, and Care. The following guidelines should be observed when using protective gloves:

1. All gloves should be inspected for signs of degradation or puncture before use. Test for pinholes by blowing or trapping air inside and rolling them out.

2. Disposable gloves should be changed when there is any sign of contamination. Reusable gloves should be washed frequently if used for an extended period of time and each time they are removed.

3. While wearing gloves, be careful not to handle anything but the materials involved in the procedure. Touching equipment, phones, wastebaskets or other surfaces may cause contamination. Be aware of touching the face, hair, and clothing as well.

4. To avoid accidental skin exposure, remove the first glove by grasping the cuff and peeling the glove off the hand so that the glove is inside out. Repeat this process with the second hand, touching the inside of the glove cuff, rather than the outside. Wash hands immediately with soap and water.

Latex Gloves and Related Allergies. Latex exposure symptoms include skin rash and inflammation, respiratory irritation, asthma, and shock. The amount of exposure needed to sensitize an individual to natural rubber latex is not known, but when exposures are reduced, sensitization decreases.

NIOSH recommends the following actions to reduce exposure to latex:

1. Whenever possible, substitute another glove material.

2. If latex gloves must be used, choose reduced-protein, powder-free latex gloves.

3. Wash hands with mild soap and water after removing latex gloves.

Respirators. Use of respirators in laboratories is strongly discouraged. Respirator use is only allowed where engineering controls are not feasible or where they are being installed. Prior to using a respirator for the first time or for a new activity, employees must fill out a medical questionnaire, attend a respiratory training session, undergo a fit test and complete a respirator wearer questionnaire.

6.3.2 Safety Equipment

Safety Showers. Safety showers provide an immediate water drench of an affected person. MIOSHA has adopted the following ANSI standards for location, design and maintenance of safety showers:

1. Showers shall be located within 25 feet of areas where chemicals with a pH of <= 2.0 or >= 12.5 are used.

2. Showers shall be located within 100 feet of areas where chemicals with a pH of > 2 and < 4 or >= 9 and < 12.5 are used.

3. The location of the shower should be clearly marked, well lighted and free from obstacles, closed doorways or turns.

4. Safety showers should be checked and flushed periodically.

Eye Wash Facilities. Eye wash facilities are required in all laboratories where injurious or corrosive chemicals are used or stored and are subject to the same proximity requirements as safety showers. MIOSHA has adopted the following ANSI standards for location, design and maintenance of emergency eyewash facilities:

1. Optimally, those affected must have both hands free to hold open the eye to ensure an effective wash behind the lids. This means providing eye wash facilities that are operated by a quick release system and simultaneously drench both eyes.

2. Eye wash facilities must provide the minimum of a 15-minute water supply at no less than 0.4 gallons per minute.

3. Safety showers should be checked and flushed periodically.

6.4 VENTILATION CONTROLS

Ventilation controls are those controls intended to minimize employee exposure to hazardous chemicals by removing air contaminants from the work site. To determine ventilation requirements for a specific chemical, assess the SDS. There are two main types of ventilation controls:

1. General (Dilution) Exhaust: a room or building-wide system that brings in air from outside and ventilates within. Laboratory air must be continually replaced, preventing the increase of air concentration of toxic substances during the workday. General exhaust systems are not recommended for the use of most hazardous chemicals.

2. Local Exhaust: a ventilated, enclosed work-space intended to capture, contain and exhaust harmful or dangerous fumes, vapors and particulate matter generated by procedures conducted with hazardous chemicals.

Proper Use of Local Ventilation Systems. Once a local ventilation system is installed in a work area, it must be used properly to be effective. For use of hazardous chemicals warranting local ventilation controls, the following guidelines should be observed:

1. Conduct all operations that may generate air contaminants at or above the appropriate PEL or TLV inside a fume hood.
2. Keep all apparatus at least 6 inches back from the face of the hood and keep the slots in the hood baffle free of obstruction by apparatus or containers. Large equipment should be elevated at least two inches off the base of the fume hood, to allow for the passage of air underneath the apparatus.
3. Do not use the hood as a waste disposal mechanism except for very small quantities of volatile materials.
4. Minimize storage of chemicals or apparatus in the hood.
5. Keep the hood sash closed at all times except when the hood is in use.
6. Minimize foot traffic and other forms of potential air disturbances past the face of the hood.
7. Do not have sources of ignition inside the hood when flammable liquids or gases are present.
8. Use sash as a safety shield when boiling liquids or conducting an experiment with reactive chemicals.
9. Periodically check the airflow in the hood using a continuous monitoring device or another source of visible airflow indicator. If airflow has changed, contact GRCC Facilities for an inspection.

Ventilation Inspection. The system must be checked prior to each use to assure it is operating. **Never work with hazardous chemicals if the required ventilation system is not working**.
GRCC Facilities ensures hoods are inspected annually. After an inspection, hoods are passed or failed for use based on the following criteria:

1. The face velocity of air being drawn into the hood at maximum sash height is measured quantitatively in feet per minute (fpm) by a thermoAnemometer (a hot wire). One measurement is taken per square foot of face space and averaged. Hoods must have an average face velocity of 60-150 fpm, depending on their design, with 100 fpm being the ideal average face velocity.
2. The turbulence of the air is measured qualitatively by releasing smoke from a smoke tube. The smoke must be contained by the hood.

If the exhaust system does not pass the face velocity test and/or has excessive turbulence, it will be posted as "failed" by the inspector. The system must be repaired before hazardous chemicals can be used in the hood.

If the exhaust system does pass, the inspector will post the date of inspection and will mark the hood to indicate proper sash position for optimum hood performance. The hood sash should be set at this point for procedures that could generate toxic aerosols, gases or vapors. In general, the sash height should be set at a level where the operator is shielded to some degree from any explosions or violent reactions which could occur and where optimum air flow dynamics are achieved. If a fume hood has no markings regarding sash height or inspection dates, please contact Facilities to arrange for an inspection.

APPENDIX A

GRAND RAPIDS COMMUNITY COLLEGE PHYSICAL SCIENCE
CHEMICAL HYGIENE PLAN
AWARENESS CERTIFICATION

The Michigan Occupational Safety and Health Administration (MIOSHA) requires that all laboratory employees be made aware of the Chemical Hygiene Plan (CHP) at their place of employment.

By signing the certification form at a training session, you acknowledge that you are aware of the CHP and the policies and procedures applicable to the MIOSHA Laboratory Standard and have attended a training session on the applicable details of the CHP.

Appendix B

Basic Rules and Procedures for Working in the Laboratory Student Copy
Grand Rapids Community College- Updated 10/1/13, Effective W 14
Physical Sciences Department - Chemistry

1. Laboratory attire: Safety in the laboratory begins by coming to class properly dressed. You will not be allowed to work in the laboratory if you are not properly dressed. Missed labs due to improper dress will be assigned 0 points. Further, it is recommended that you wear old clothing to lab as it may be damaged by
exposure to chemicals. **The following rules will be strictly enforced:**

a) Approved safety goggles must properly be worn at all times. They must cover your eyes and are not to be worn on the forehead or around the neck.
b) You must wear shoes that cover the entire foot. The following are not permitted: High heeled shoes, open backed clogs, ballerina slippers, flip-flops and sandals.
c) Your abdomen and shoulders must be completely covered. Midriff type shirts, 'hipster' pants and shirts that expose the shoulders are not permitted.
d) You must wear long pants or dresses that are no more than 6 inches from the floor. Shorts, leggings and stretch pants are not permitted in the lab. Tights are not a substitute for pants.
e) Long hair must be tied back.
f) Long 'flowing' sleeves are not permitted.
g) In some cases, you may be asked to wear gloves. Inspect them for holes before use.

2. General laboratory procedures: For your safety, keep the following rules in mind when working in the laboratory.

a) Food and drinks are forbidden in the laboratory.
b) Do not work in the lab without supervision.
c) Handle and store glassware with care to avoid damage. Never work with damaged glassware.
d) Use equipment only for its designed purpose and do not attempt any unauthorized experiments.
e) Turn off any Bunsen burner at the gas source when it is not in use.
f) Avoid practical jokes or other behavior that may distract anyone else working in the lab.
g) Keep your work area clean and uncluttered.

h) Keep the walkways clear. Backpacks should be stored under your work area or at the lab entrance.

3. Working with chemicals: For your safety, keep the following rules in mind when working with chemicals. Your instructor may provide additional instructions for handling specific chemicals.

a) Do not taste or ingest any chemicals in the laboratory.
b) Do not mouth suction pipets.
c) Do not inhale fumes or vapors when working in the laboratory. Use the fume hoods when instructed.
d) Do not use flames near a flammable liquid.
e) Do not put chemicals back into their stock containers.
f) If chemicals are spilled, notify you instructor.
g) If chemicals come in contact with your skin, wash the area immediately and notify your instructor.
h) Wash your hands after completing an experiment.
i) Separate and dispose of chemical waste according to your instructor's directions.
j) Do not remove any chemicals from the laboratory.

4. First Aid: Notify your instructor immediately if any of the following incidents occur:

a) If chemicals come in contact with your eyes (flush them with water for 15 minutes).
b) If you feel nausea or dizzy.
c) If you ingest chemicals.
d) If your skin itches, burns, hurts or a rash develops (flush the area with water).

Basic Rules and Procedures for Working in the Laboratory Instructor Copy

Grand Rapids Community College
Physical Sciences Department- Chemistry

1. Laboratory attire: Safety in the laboratory begins by coming to class properly dressed. You will not be allowed to work in the laboratory if you are not properly dressed. Missed labs due to improper dress will be assigned 0 points. Further, it is recommended that you wear old clothing to lab as it may be damaged by
exposure to chemicals. **The following rules will be strictly enforced:**

a) Approved safety goggles must properly be worn at all times. They must cover your eyes and are not to be worn on the forehead or around the neck.
b) You must wear shoes that cover the entire foot. The following are not permitted: High heeled shoes, open backed clogs, ballerina slippers, flip-flops and sandals.
c) Your abdomen and shoulders must be completely covered. Midriff type shirts, 'hipster' pants and shirts that expose the shoulders are not permitted.
d) You must wear long pants or dresses that are no more than 6 inches from the floor. Shorts, leggings and stretch pants are not permitted in the lab. Tights are not a substitute for pants.
e) Long hair must be tied back.
f) Long 'flowing' sleeves are not permitted.
g) In some cases, you may be asked to wear gloves. Inspect them for holes before use.

2. General laboratory procedures: For your safety, keep the following rules in mind when working in the laboratory.

a) Food and drinks are forbidden in the laboratory.
b) Do not work in the lab without supervision.
c) Handle and store glassware with care to avoid damage. Never work with damaged glassware.
d) Use equipment only for its designed purpose and do not attempt any unauthorized experiments.
e) Turn off any Bunsen burner at the gas source when it is not in use.
f) Avoid practical jokes or other behavior that may distract anyone else working in the lab.
g) Keep your work area clean and uncluttered.
h) Keep the walkways clear. Backpacks should be stored under your work area or at the lab entrance.

3. Working with chemicals: For your safety, keep the following rules in mind when working with chemicals. Your instructor may provide additional instructions for handling specific chemicals.

a) Do not taste or ingest any chemicals in the laboratory.
b) Do not mouth suction pipets.
c) Do not inhale fumes or vapors when working in the laboratory. Use the fume hoods when instructed.
d) Do not use flames near a flammable liquid.
e) Do not put chemicals back into their stock containers.
f) If chemicals are spilled, notify you instructor.
g) If chemicals come in contact with your skin, wash the area immediately and notify your instructor.
h) Wash your hands after completing an experiment.
i) Separate and dispose of chemical waste according to your instructor's directions.
j) Do not remove any chemicals from the laboratory.

4. First Aid: Notify your instructor immediately if any of the following incidents occur:

a) If chemicals come in contact with your eyes (flush them with water for 15 minutes).
b) If you feel nausea or dizzy.
c) If you ingest chemicals.
d) If your skin itches, burns, hurts or a rash develops (flush the area with water).

_____	_____	_____	_____
Signature	Printed name	Course	Date

Appendix C

BIOLOGICAL AGENTS BY RISK GROUP

Risk Group 1 (low individual and community risk)

A biological agent that is unlikely to cause disease in healthy workers or animals.

Risk Group 2 (moderate individual risk, limited community risk)

A pathogen that can cause human or animal disease but under normal circumstances, is unlikely to be a serious hazard to healthy laboratory workers, the community, livestock, or the environment. Laboratory exposures rarely cause infection leading to serious disease; effective treatment and preventive measures are available and the risk of spread is limited.

Risk Group 2 Bacteria, Chlamydia, Mycoplasma

Bacillus cereus
Corynebacterium diphtheriae,
Escherichia coli
Mycobacteria - all species (except M. tuberculosis, and M. bovis (non-BCG strain), which are in Risk Group 3)
Pseudomonas aeruginosa
Shigella boydii, S. dysenteriae, S. flexneri, S. sonnei
Staphylococcus aureus
Streptococcus spp. (Lancefield Groups A, B,C,D,G)

Risk Group 2 Fungi
Cryptococcaceae
Candida albicans

Risk Group 3 (high individual risk, low community risk)

A pathogen that usually causes serious human or animal disease, or which can result in serious economic consequences but does not ordinarily spread by casual contact from one individual to another, or that can be treated by antimicrobial or antiparasitic agents.

Risk Group 4 (high individual risk, high community risk)

A pathogen that usually produces very serious human or animal disease, often untreatable, and may be readily transmitted from one individual to another, or from animal to human or vice-versa directly or indirectly, or by casual contact.

APPENDIX D

Classes of Peroxidizable Chemicals

A. Chemicals that form explosive levels of peroxides without concentration

Butadiene[a]	Divinylacetylene	Tetrafluoroethylene[a]	Vinylidene chloride
Chloroprene[a]	Isopropyl ether		

B. Chemicals that form explosive levels of peroxides on concentration

Acetal	Diacetylene	2-Hexanol	2-Phenylethanol
Acetaldehyde	Dicyclopentadiene	Methylacetylene	2-Propanol
Benzyl alcohol	Diethyl ether	3-Methyl-1-butanol	Tetrahydroforan
2-Butanol	Diethylene glycol dimethyl ether	Methylcyclopentane	Tetrahydronaphthalene
Cumene	(diglyme)	Methyl isobutyl ketone	Vinyl ethers
Cyclohexanol	Dioxanes	4-Methyl-2-pentanol	Other secondary alcohols
2-Cyclohexen-1-ol	Ethylene glycol dimethyl ether	2-Penten-1-ol	
Cyclohexene	(glyme)	4-Penten-1-ol	
Decahydronaphthalene	4-Heptanol	1-Phenylethanol	

C. Chemicals that may autopolymerize as a result of peroxide accumulation

Acrylic acid[b]	Chlorotrifluoroethylene	Vinyl acetate	Vinyladiene chloride
Acrylonitrile[b]	Methyl methacrylate[b]	Vinylacetylene	
Butadiene[c]	Styrene	Vinyl chloride	
Chloroprene[c]	Tetrafluoroethylene[c]	Vinylpyridine	

D. Chemicals that may form peroxides but cannot clearly be placed in sections A-C

Acrolein	tert-Butyl methyl ether	Di(1-propynyl) ether[f]	4-Methyl-2-pentanon
Allyl ether[d]	n-Butyl phenyl ether	Di(2-propynyl) ether	n-Methylphenetole
Allyl ethyl ether	n-Butyl vinyl ether	Di-n-propoxymethane[d]	2-Methyltetrahydrofu
Allyl phenyl ether	Chloroacetaldehyde diethylacetal[d]	1,2-Epoxy-3-isopropoxypropane[d]	3-Methoxy-1-butyl a
p-(n-Amyloxy)benzoyl chloride	2-Chlorobutadiene	1,2-Epoxy-3-phenoxypropane	2-Methoxyethanol
n-Amyl ether	1-(2-Chloroethoxy)-2-phen-	Ethoxyacetophenone	3-Methoxyethyl aceta
Benzyl n-butyl ether[d]	oxyethane	1-(2-Ethoxyethoxy)ethyl acetate	2-Methoxyethyl viny
Benzyl ether[d]	Chloroethylene	2-Ethoxyethyl acetate	Methoxy-1,3,5,7-cyc
Benzyl ethyl ether[d]	Chloromethyl methyl ether[e]	(2-Ethoxyethyl)-o-benzoyl	tetraene
Benzyl methyl ether	§-Chlorophenetole	benzoate	§-Methoxypropionitr
Benzyl 1-naphthyl ether[d]	o-Chlorophenetole	1-Ethoxynaphthalene	m-Nitrophenetole
1,2-Bis(2-chloroethoxy)ethane	p-Chlorophenetole	o,p-Ethoxyphenyl isocyanate	1-Octene

Bis(2-ethoxyethyl) ether	Cyclooctene[d]	1-Ethoxy-2-propyne	Oxybis(2-ethyl acetat
Bis(2-(methoxyethoxy)ethyl) ether	Cyclopropyl methyl ether	3-Ethoxyopropionitrile	Oxybis(2-ethyl benzo
Bis(2-chloroethyl) ether	Diallyl ether[d]	2-Ethylacrylaldehyde oxime	§,§-Oxydipropionitril
Bis(2-ethoxyethyl) adipate	p-Di-n-butoxybenzene	2-Ethylbutanol	1-Pentene
Bis(2-ethoxyethyl) phthalate	1,2-Dibenzyloxyethane[d]	Ethyl §-ethoxypropionate	Phenoxyacetyl chlori
Bis(2-methoxyethyl) carbonate	p-Dibenzyloxybenzene[d]	2-Ethylhexanal	Œ-Phenoxypropionyl
Bis(2-methoxyethyl) ether	1,2-Dichloroethyl ethyl ether	Ethyl vinyl ether	Phenyl o-propyl ether
Bis(2-methoxyethyl)phthalate	2,4-Dichlorophenetole	Furan p-Phenylphenetone	
Bis(2-methoxymethyl) adipate	Diethoxymethane[d]	2,5-Hexadiyn-1-ol	n-Propylether
Bis(2-n-butoxyethyl) phthalate	2,2-Diethoxypropane	4,5-Hexadien-2-yn-1-ol	n-Propyl isopropyl et
Bis(2-phenoxyethyl) ether	Diethyl ethoxymethylenemalonate	n-Hexyl ether	Sodium 8,11,14-eicos tetraenoate
Bis(4-chlorobutyl) ether	Diethyl fumarated	o,p-Iodophenetole	
Bis(chloromethyl) ether[e]	Diethyl acetal[d]Isoamyl benzyl ether[d]	Sodium ethoxyacetylide[f]	
2-Bromomethyl ethyl ether	Diethylketene[f]	Isoamyl ether[d]	Tetrahydropyran
§-Bromophenetole	m,o,p-Diethoxybenzene	Isobutyl vinyl ether	Triethylene glycol di
o-Bromophenetole	1,2-Diethoxyethane	Isophorone[d]	Triethylene glycol di
p-Bromophenetole	Dimethoxymethane[d]	p-Isopropoxypropionitrile[d]	1,3,3-Trimethoxypro
3-Bromopropyl phenyl ether	1,1-Dimethoxyethane[d]	Isopropyl 2,4,5-trichlorophenoxy-acetate	1,1,2,3-Tetrachloro-1 butadiene
1,3-Butadiyne	Dimethylketene[f]	Limonene	4-Vinyl cyclohexene
Buten-3-yne	3,3-Dimethoxypropene	1,5-p-Methadiene	Vinylenecarbonate
tert-Butyl ethyl ether	2,4-Dinitrophenetole	Methyl p-(n-amyloxy)benzoate	Vinylidene chioride[d]
	1,3-Dioxepane[d]		

1. When stored as a liquid monomer

2. Although these chemicals form peroxides, no explosions involving these monomers occur.

3. When stored in liquid form, these chemicals form explosive levels of peroxides without concentration. They may also be stored as a gas in gas cylinders. When stored as a gas, these chemicals may autopolymerize as a result of peroxide accumulation.

4. These chemicals easily form peroxides and should probably be considered under part B.

5. OSHA-regulated carcinogen

6. Extremely reactive and unstable compound.

Safe Storage Period for Peroxide Forming Chemicals

Description	Period
Unopened chemicals from manufacturer	18 months
Opened containers	
Chemicals in Part A	3 months
Chemicals in Parts B and D	12 months
Unihibited chemicals in Part C	24 hours
Inhibited chemicals in Part C	12 months[a]

[a] Do not store under inert atmosphere, oxygen required for inhibitor to function.

Sources: Kelly, Richard J., Chemical Health & Safety, American Chemical Society, **1996**, Sept, 28-36Revised 12/97

DETECTION AND INHIBITION OF PEROXIDES
BASIC PROTOCOLS

Ferrous Thiocyanate Detection Method

Ferrous thiocyanate will detect hydroperoxides with the following test:

Mix a solution of 5 ml of 1 % ferrous ammonium sulfate, 0.5 ml of 1 N sulfuric acid and 0.5 ml of 0.1 N ammonium thiocyanate (if necessary decolorize with a trace of zinc dust)

Shake with an equal quantity of the solvent to be tested

If peroxides are present, a red color will develop

Potassium Iodide Detection Method

Add 1 ml of a freshly prepared 10% solution of potassium iodide to 10 ml of ethyl ether in a 25 ml glass-stoppered cylinder of colorless glass protected from light (both components are clear)

A resulting yellow color indicates the presence of 0.005% peroxides

Inhibition of Peroxides

1. Storage and handling under an inert atmosphere is a useful precaution.
2. Addition of 0.001 % hydroquinone, diphenylamine, polyhydroxyphenols, aminophenols or arylamines may stabilize ethers and inhibit formation of peroxides.
3. Dowex-1^{R} has been reported effective for inhibiting peroxide formation in ethyl ether.
4. 100 ppm of 1-naphthol is effective for peroxide inhibition in isopropyl ether.
5. Hydroquinone is effective for peroxide inhibition in tetrahydrofuran.

6. Stannous chloride or ferrous sulfate is effective for peroxide inhibition in dioxane.

Peroxides Test Strips

These test strips are available from EM Scientific, cat. No. 10011-1 or from Lab Safety Supply, cat. No. 1162. These strips quantify peroxides up to a concentration of 25 ppm. Aldrich Chemical has a peroxide test strip, cat. No. Z10,168-0, that measures up to 100 ppm peroxide. The actual concentration at which peroxides become hazardous is not specifically stated in the literature. A number of publications use 100 ppm as a control valve for managing the material safely.

Please note that these methods are BASIC protocols. If one of these methods is performed, all safety precautions should be thoroughly researched.

Sources:

1. Furr, Keith Handbook of Lab Safety, 4th ed., CRC Press, 1995

2. Kelly, Richard J., Review of Safety Guidelines for Peroxidizable Organic Chemicals, Chemical Health & Safety, American Chemical Society, Sept./Oct. 1996.

APPENDIX E

COMMON LABORATORY FLAMMABLE AND COMBUSTIBLE CHEMICALS

Flammable and combustible chemicals are the most commonly used hazardous chemicals. The hazard of a flammable or combustible chemical is based on its flash point, and, in the case of a flammable chemical, its boiling point as well. The National Fire Protection Association (NFPA) has identified flammability classes from the flash point and boiling point data of chemicals. The following table lists some common flammable and combustible chemicals, their flash points and boiling points, and associated NFPA flammability classes:

Chemical	Flash Point		Boiling Point		NFPA Class
	° F	° C	° F	° C	
Acetaldehyde	-38	-39	69	21	IA
Dimethyl sulfide	-36	-38	99	37	IA
Ethyl ether	-49	-45	95	35	IA
Ethylene oxide	-20	-29	55	13	IA
Pentane	-57	-49	97	36	IA
Propane	-157	-105	-44	-42	IA
Benzene	12	-11	176	80	IB
Carbon disulfide	-22	-30	115	46	IB
Cyclohexane	-4	-20	179	81	IB
Ethyl alcohol	55	13	173	78	IB
n-Hexane	-7	-22	156	69	IB
Isopropyl alcohol	53	12	180	82	IB
Methyl alcohol	52	11	149	65	IB
Methyl ethyl ketone	16	-9	176	80	IB
Pyridine	68	20	239-241	116	IB
Tetrahydrofuran	6	-14	153	67	IB
Toluene	40	4	231	111	IB
Triethylamine	20	-7	193	89	IB
tert Butyl isocyanate	80	27	185-187	85-86	IC
Chlorobenzene	82	28	270	132	IC
Epichlorohydrin	88	31	239-243	115-117	IC
2-Nitropropane	75	24	248	120	IC
Xylene	81-90	27-32	280-291	138-144	IC
Acetic Acid, glacial	103	39	244	48	II
Bromobenzene	118	48	307-316	153-158	II
Formic Acid	156	69	213	101	II
Morpholine	100	38	263	128	II
Stoddard Solvent	100-140	38-60	300-400	150-200	II
Benzaldehyde	145	63	352	178	IIIA
Cyclohexanol	154	68	322	161	IIIA
Methacrylic Acid	170	77	316	158	IIIA
Nitrobenzene	190	88	412	211	IIIA
Tetrahydronaphthalene	160	71	406	208	IIIA
Benzyl Alcohol	213	101	401	205	IIIB
Caproic Acid	215	102	400	204	IIIB
Ethylene Glycol	232	111	388	198	IIIB
Phenyl Ether	239	115	498	258	IIIB
Stearic Acid	385	196	726	386	IIIB

References:
Safety Data Sheets and the National Fire Protection Agency document "NFPA 321: Classification of Flammable and Combustible Liquids, 1991 Edition."

APPENDIX F

FLAMMABLE AND COMBUSTIBLE LIQUID CONTAINMENT AND STORAGE REQUIREMENTS

Containment

Only approved containers and metal portable tanks authorized by NFPA (National Fire Protection Association) 30 shall be used to store flammable liquids.

	Flammable Class			Combustible Class	
Container	**IA**	**IB**	**IC**	**II**	**III**
Glass	1 pt*	1 qt*	1 gal	1 gal	5 gal
Metal or Approved Plastic	1 gal	5 gal	5 gal	5 gal	5 gal
Safety Cans	2 gal	5 gal	5 gal	5 gal	5 gal
Metal Drums	60 gal	60 gal	60 gal	60 gal	60 gal
Approved Metal Portable Tanks	660 gal	660 gal	660 gal	660 gal	660 gal
Polyethylene	1 gal	5 gal	5 gal	60 gal	60 gal

*Class IA and IB liquids may be stored up to one gallon in glass containers if liquid purity would be affected by storage in metal containers or if metal containers could undergo excessive corrosion by the contained liquid.

Storage

Only NFPA 45 approved amounts of flammable liquids shall be stored in laboratory units outside of flammable liquid storage rooms.

Flammable / Combustible Class	**Maximum Quantity per 100ft^2 of Laboratory Unit**	**Maximum Quantity per Laboratory Unit**	
List as Class A Lab		Unsprinklered	Sprinklered
I	20 gallons	600 gallons	1200 gallons
I, II and IIIA	40 gallons	800 gallons	1600 gallons
List as Class B Lab			
I	10 gallons	300 gallons	600 gallons
I, II and IIIA	20 gallons	400 gallons	800 gallons
List as Class C Lab			
I	4 gallons	150 gallons	300 gallons
I, II and IIIA	8 gallons	200 gallons	400 gallons

The amounts above include quantities stored in approved storage cabinets and safety cans. Allowable quantities stored outside of approved storage cabinets and safety cans are 50% of the quantities listed above.

Laboratories listed as Class A shall be considered high hazard laboratories and shall not be used as instructional laboratories.

Laboratories listed as Class B shall be considered intermediate hazard laboratories.

Laboratories listed as Class C shall be considered low hazard laboratories.

Should Class B or C laboratories be used for instructional purposes, quantities of flammable and combustible liquids shall be **50%** of those listed in the above table.

APPENDIX G

COMMON LABORATORY CORROSIVES

ORGANIC ACIDS	ORGANIC BASES	INORGANIC ACIDS
Formic Acid	Ethylenediamine	Hydrofluoric Acid
Acetic Acid (Glacial)	Ethylimine	Hydrochloric Acid
Propionic Acid	Tetramethylethylenediamine	Hydrobromic Acid
Butyric Acid	Hexamethylenediamine	Hydriotic Acid
Chloroacetic Acid	Trimethylamine aq. soln.	Sulfuric Acid
Trichloroacetic Acid	Triethylamine	Chromerge™
Acetyl Chloride	Phenylhydrazine	No-Chromix™
Acetyl Bromide	Piperazine	Chlorosulfonic Acid
Chloroacetyl Chloride	Hydroxylamine	Sulfuryl Chloride
Oxalic Acid	Tetramethylammonium Hydroxide	Bromine Pentafluoride
Propionyl Chloride		Thionyl Chloride
Propionyl Bromide	**ELEMENTS**	Tin Chloride
Acetic Anhydride	Fluorine (gas)	Tin Bromide
Methyl Chloroformate	Chlorine (gas)	Titanium Tetrachloride
Dimethyl Sulfate	Bromine (liquid)	Perchloric Acid
Chlorotrimethylsilane	Iodine (crystal)	Nitric Acid
Dichlorodimethylsilane	Phosphorus	Phosphoric Acid
Phenol		Phosphorus Trichloride
Benzoyl Chloride		Phosphorus Tribromide
Benzoyl Bromide	**INORGANIC BASES**	Phosphorus Pentachloride
Benzyl Chloride	Ammonium Hydroxide	Phosphorus Pentoxide
Benzyl Bromide	Calcium Hydroxide	
Salicylic Acid	Sodium Hydroxide	
	Potassium Hydroxide	**ACID SALTS**
	Calcium Hydride	Aluminum Trichloride
	Sodium Hydride	Antimony Trichloride
	Hydrazine	Ammonium Bifluoride
	Ammonium Sulfide	Calcium Fluoride
	Calcium Oxide	Ferric Chloride
		Sodium Bisulfate
		Sodium Fluoride

References:

The Foundations of Laboratory Safety, S.. R. Rayburn, 1990.
Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Research Council, 1981.

Improving Safety in the Chemical Laboratory, 2nd Ed., J. A. Young, 1991.
Safety Data Sheets, various chemical companies.

APPENDIX H

COMMON LABORATORY OXIDIZERS

Oxidizers react with other chemicals by giving off electrons and undergoing reduction. Uncontrolled reactions of oxidizers may result in a fire or an explosion, causing severe property damage or personal injury. Use oxidizers with extreme care and caution and follow all safe handling guidelines specified in the SDS.

Bleach
Bromates
Bromine
Butadiene
Chlorates
Chloric Acid
Chlorine
Chlorite
Chromates
Chromic Acid
Dichromates
Fluorine
Haloate
Halogens
Hydrogen Peroxide
Hypochlorites
Iodates
Mineral Acid
Nitrates
Nitric Acid
Nitrites
Nitrous oxide
Ozanates
Oxides
Oxygen
Oxygen difluoride
Ozone
Peracetic Acid
Perhaloate
Perborates
Percarbonates
Perchlorates
Perchloric Acid
Permanganates
Peroxides
Persulfate
Sodium Borate Perhydrate
Sulfuric Acid

APPENDIX I

SHOCK SENSITIVE AND EXPLOSIVE CHEMICALS

Shock sensitive refers to the susceptibility of a chemical to rapidly decompose or explode when struck, vibrated or otherwise agitated. Explosive chemicals are those chemicals which have a higher propensity to explode under a given set of circumstances than other chemicals (extreme heat, pressure, mixture with an incompatible chemical, etc.). The label and SDS will indicate if a chemical is shock sensitive or explosive . The chemicals listed below may be shock sensitive or explode under a given number of circumstances and are listed only as a guide to **some** shock sensitive or explosive chemicals. Follow these guidelines:

- Write the date received and date opened on all containers of shock sensitive chemicals. Some chemicals become increasingly shock sensitive with age.
- Unless an inhibitor was added by the manufacturer, closed containers of shock sensitive materials should be discarded after 1 year.
- Wear appropriate personal protective equipment when handling shock sensitive chemicals.

acetylene
acetylides of heavy metal
amatex
amatol
ammonal
ammonium nitrate
ammonium perchlorate
ammonium picrate
azides of heavy metals
baratol
calcium nitrate
chlorate
copper acetylide
cyanuric triazide
cyclotrimethylenetrinitramine
dinitrophenol
dinitrophenyl hydrazine
dinitrotoluene
ednatol
erythritol tetranitrate
fulminate of mercury
fulminate of silver
ethylene oxide
ethyl-tetryl
fulminating gold
fulminating mercury
fulminating platinum
fulminating silver
gelatinized nitrocellulose
guanyl
guanyl nitrsamino
guanyltetrazene
hydrazine
nitrated carbohydrate
nitrated glucoside
nitrogen triiodide
nitrogen trichloride
nitroglycerin
nitroglycide
nitroglycol
nitroguanidine
nitroparaffins
nitrourea
organic nitramines
ozonides
pentolite
perchlorates of heavy metals
peroxides
picramic acid
picramide
picratol
picric acid
picryl sulphonic acid
silver acetylide
silver azide
tetranitromethane

Mixtures:

germanium
hexanitrodiphenyamine
hexanitrostilbene
hexogen
hydrazoic acid
lead azide
lead mononitroresorcinate
lead styphnate
tetracene
tetrytol
trimethylolethane
trimonite
trinitroanisole
trinitrobenzene
trinitrobenzoic acid
trinitrocresol

mannitol hexanitrate	trinitroresorcinol
sodium picramate	tritonal
tetranitrocarbazole	urea nitrate

References: Safety Data Sheets, various chemical companies

APPENDIX J

INDUSTRIAL TOXICOLOGY - OVERVIEW

Chemical Toxicology

Toxicology is the study of the nature and action of chemical poisons.

Toxicity is the ability of a chemical molecule or compound to produce injury once it reaches a susceptible site in or on the body.

Toxicity hazard is the probability that injury will occur considering the manner in which the substance is used.

Dose-Response Relationship

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

Routes of Entry into the Body

There are four main routes by which hazardous chemicals enter the body:

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

Exposure Limits as Related to Routes of Entry

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

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

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

For a list, see the ACGIH publication "Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices." The latest editions lists both TLV's and PELs.

Types of Effects

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

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

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

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

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

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

Other Factors Affecting Toxicity

Rate of entry and route of exposure - how fast the toxic dose is delivered and by what means.

Age - can effect the capacity to repair damaged tissue.

Previous exposure - can lead to tolerance, increased sensitivity, or make no difference.

State of health, medications, physical condition, and life style - can affect the toxic response. Pre-existing disease can result in increased sensitivity.

Environmental factors - temperature and pressure, for example, can affect exposure.

Host factors - genetic predisposition and the sex of the exposed individual.

Physical Class Affects on Toxicity

When considering the toxicity of gases and vapors, the **solubility of the substance** is a key factor. Highly soluble materials like ammonia irritate the upper respiratory tract. On the other hand, relatively insoluble materials like nitrogen dioxide penetrate deep into the

lung. Fat soluble materials, like pesticides, tend to have longer residence times in the body.

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

Physiological Classifications of Toxic Materials

Irritants are materials that cause inflammation of mucous membranes with which they come in contact. Inflammation of tissue results from concentration far below those needed to cause corrosion. Examples include:

- ammonia
- hydrogen chloride
- halogens
- phosgene
- nitrogen dioxide
- arsenic trichloride
- ozone
- hydrogen fluoride
- alkaline dusts and mists
- diethyl/dimethyl sulfate
- phosphorus chlorides

Irritants can also cause changes in the mechanics of respiration and lung function. Examples include:

- sulfur dioxide
- formaldehyde
- sulfuric acid
- iodine
- acrolein
- formic acid
- acetic acid

Long term exposure to irritants can result in increased mucous secretions and chronic bronchitis.

A **primary irritant** exerts no systemic toxic action because the products formed on the tissue of the respiratory tract are non-toxic or because the irritant action is far in excess of any systemic toxic action. Example: hydrogen chloride.

A **secondary irritant's** effect on mucous membranes is over-shadowed by a systemic effect resulting from absorption. Examples include:

- hydrogen sulfide
- aromatic hydrocarbons

Exposure to a secondary irritant can result in pulmonary edema, hemorrhage, and tissue necrosis.

Corrosives are chemicals which may cause visible destruction of or irreversible alterations in living tissue by chemical action at the site of contact. Examples include:

- sulfuric and chromic acid
- sodium and potassium hydroxide

Asphyxiants have the ability to deprive tissue of oxygen.

Simple asphyxiants are inert gases that displace oxygen. Examples include:

- nitrogen
- nitrous oxide
- carbon dioxide
- hydrogen

Chemical asphyxiants render the body incapable of utilizing an adequate oxygen supply. They are toxic at very low concentrations (few ppm). Examples include:

- carbon monoxide
- hydrogen sulfide
- cyanides

Primary anesthetics have a depressant effect upon the central nervous system. Particularly the brain. Examples include:

- halogenated hydrocarbons
- alcohols

Hepatotoxic agents cause damage to the liver. Examples include:

- carbon tetrachloride
- nitrosamines
- tetrachloroethane

Nephrotoxic agents cause damage to the kidneys. Examples include:

- halogenated hydrocarbons
- uranium compounds

Neurotoxic agents damage the nervous system. The nervous system is especially sensitive to organometallic compounds and certain sulfide compounds. Examples include:

- trialkyl tin compounds
- methyl mercury
- organic phosphorus insecticides
- manganese
- tetraethyl lead
- carbon disulfide
- thallium

Hematopoietic (blood) system agents either directly affect blood cells or bone marrow. Examples include:

- nitrites

- aniline
- toluidine
- nitrobenzene
- benzene

Pulmonary tissue (lungs) agents can be toxic, through other mean than by immediate irritant action. Fibrotic changes can be caused by free crystalline silica and asbestos. Other dusts can cause a restrictive disease called pneumoconiosis. Examples include:

- coal dust
- wood dust
- cotton dust

A **teratogen** (embryo toxic or fetotoxic agent) is an agent which interferes with normal embryonic development without damage to the mother or lethal effect on the fetus. Effects are not hereditary. Examples include:

- lead
- dibromodichloropropane

A **mutagen** is a chemical agent which may react with nucleophilic structures such as DNA. Mutations can occur on the gene level (gene mutations) when, for example, one nucleotide base-pair is changed to another. Mutations can also occur on the chromosomal level (chromosomal mutations) when the number of chromosomal units or their morphological structure is altered. Examples of mutagens include most radioisotopes, barium permanganate and methyl isocyanate.

A **sensitizer** causes a substantial proportion of exposed people to develop an allergic reaction in normal tissue after repeated exposure to the chemical. The reaction may be as mild as a rash (contact dermatitis) or as serious as anaphylactic shock. Examples include:

- epoxides
- poison ivy
- chlorinated hydrocarbons
- amines
- nickel compounds
- chromium compounds
- formaldehyde
- toluene diisocyanate

TARGET ORGAN EFFECTS

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

- **Hepatotoxins (liver)**

Signs and symptoms:	jaundice, liver enlargement
Example chemicals:	carbon tetrachloride, nitrosamines, chloroform, toluene, perchloroethylene, cresol, dimethylsulfate

- **Nephrotoxins (kidney)**

Signs and symptoms:	edema, proteinuria
Example chemicals:	halogenated hydrocarbons, uranium, chloroform, mercury, dimethyl sulfate

- **Neurotoxins (nervous system)**

Signs and symptoms:	narcosis, behavioral changes, decreased muscle coordination

Example chemicals:	mercury, carbon disulfide, benzene, carbon tetrachloride, lead, mercury, nitrobenzene

· **Hematopoietic (blood) system**

Signs and symptoms:	cyanosis, loss of consciousness.
Example chemicals:	carbon monoxide, cyanides, nitrobenzene, aniline, arsenic, benzene, toluene

· **Pulmonary (lung) system**

Signs and symptoms:	cough, tightness in chest, shortness of breath.
Example chemicals:	Silica asbestos, nitrogen dioxide, ozone, hydrogen sulfide, chromium, nickel, alcohol.

· **Reproductive system (mutations and teratogenesis)**

Signs and symptoms:	birth defects, sterility.
Example chemicals:	lead, dibromodichloropropane.

· **Skin (dermal layer)**

Signs and symptoms:	defatting of skin, rashes, irritation.
Example chemicals:	ketones, chlorinated compounds, alcohols, nickel, phenol, trichloroethylene.

· **Eye or vision**

Signs and symptoms:	conjunctivitis, corneal damage.
Example chemicals:	organic solvents, acids, cresol, quinone, hydroquinone, benzyl chloride, butyl alcohol, bases.

APPENDIX K

GLOSSARY

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

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

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

Acute Exposure -- An intense exposure over a relatively short period of time.

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

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

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

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

Boiling Point -- The temperature at which the vapor pressure of a liquid equals atmospheric pressure or at which the liquid changes to a vapor. The boiling point is usually expressed in degrees Fahrenheit. If a flammable material has a low boiling point, it indicates a special fire hazard.

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

Carcinogen -- A substance that may cause cancer in animals or humans.

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

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

Chemical Hygiene Plan -- A written program developed and implemented by a department, school, or company which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting students, instructors and other personnel from the health hazards presented by the hazardous chemicals used in that particular workplace.

Chronic exposure -- A prolonged exposure occurring over a period of days, weeks, or years.

Combustible -- According to the DOT and NFPA, COMBUSTIBLE liquids are those having a flash point at or above 100deg.F (37.8deg.C), or liquids that will burn. They do not ignite as easily as flammable liquids. However, combustible liquids can be ignited under certain circumstances, and must be handled with caution. Substances such as wood, paper, etc., are termed "Ordinary Combustibles."

Compressed Gas -- A gas or mixture of gases that, in a container, will have an absolute pressure exceeding 40 psi at 70°F or 21.1°C. A gas or mixture of gases having, in a container, an absolute pressure exceeding104 psi at 130°F or 54.4°C, regardless of the pressure at 70°F. A liquid having a vapor pressure exceeding 40 psi at 100°For 37.8°C.

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

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

Cutaneous/Dermal -- Pertaining to or affecting the skin.

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

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

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

Dermatitis -- An inflammation of the skin.

Dilution Ventilation -- See GENERAL VENTILATION.

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

Dyspnea -- Shortness of breath, difficult or labored breathing.

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

EPA Number -- The number assigned to chemicals regulated by the Environmental Protection Agency (EPA).

Epidemiology -- The study of disease in human populations.

Erythema -- A reddening of the skin.

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

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

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

Flammable Liquid -- According to the DOT and NFPA a flammable liquid is one that has a flash point below 100deg.F. (See FLASH POINT).

Flammable Solid -- A solid, other than a blasting agent or explosive, that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently it creates a serious hazard.

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

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

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

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

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

Hazardous Chemicals -- Any chemical for which there is significant evidence that acute or chronic health effects may occur in exposed personnel. The term "health hazard"

includes chemicals that are carcinogens, toxins, irritants, corrosives, sensitizers or other agents that can damage the lungs, skin, eyes or mucous membranes.

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

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

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

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

Inhibitor -- A substance that is added to another to prevent or slowdown an unwanted reaction or change.

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

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

Laboratory Scale -- Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person.

Laboratory-type Hood -- A device constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory.

Laboratory Use of Hazardous Materials -- The handling or use of chemicals in which the following conditions are met: (1) Chemical manipulations are carried out on a laboratory scale. (2) Multiple chemical procedures or chemicals are used. (3) The procedures involved are not part of a production process. (4) Protective laboratory practices and equipment are available and in common use to minimize the potential for personnel exposure to hazardous chemicals.

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

Lethal Concentration$_{50}$ -- The concentration of an air contaminant **(LC_{50})** that will kill 50 percent of the test animals in a group during a single exposure.

Lethal Dose$_{50}$ -- The dose of a substance or chemical that will **(LD_{50})** kill 50 percent of the test animals in a group within the first 30 days following exposure.

Local Exhaust Ventilation (Also known as exhaust ventilation.) **--** A ventilation system that captures and removes air contaminants at the point they are being produced before they escape into the workroom air. The system consists of hoods, ductwork, a fan and possibly an air-cleaning device. Advantages of local exhaust ventilation over general ventilation include: removing the contaminant rather than diluting it; less airflow making it a more economical system over the long run; and conservation or reclamation of

valuable materials. However, the system must be properly designed with the correctly shaped and placed hoods, correctly sized fans and correctly connected duct work.

Lower Explosive Limit (LEL) (Also known as Lower Flammable Limit-LFL) -- The lowest concentration of a substance that will produce a fire or flash when an ignition source (flame, spark, etc.) is present. It is expressed in percent of vapor or gas in the air by volume. Below the LEL or LFL, the air/contaminant mixture is theoretically too "lean" to burn (See also UEL).

Melting Point -- The temperature at which a solid changes to a liquid.

MSHA -- The Mine Safety and Health Administration; a Federal agency that regulates the mining industry in the safety and health area.

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

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

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

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

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

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

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

Oxidizer -- A substance that gives up oxygen easily to stimulate combustion of organic material.

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

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

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

Physical Hazard -- A chemical that has scientifically valid evidence proving it to be a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

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

RAD -- The unit of absorbed dose equal to 100 ergs per gram or 0.01joules per kilogram of absorbing material.

Reactivity -- A substance's susceptibility to undergoing a chemical reaction or change that may result in dangerous side effects, such as explosion, burning, and corrosive or toxic emissions. The conditions that cause action, such as heat, other chemicals, and dropping, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on a SDS.

Reproductive Toxins -- Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses.

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

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

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

1. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than $10mg/ml^3$
2. After repeated skin application of less than 300 mg/kg of body weight per week
3. After oral dosages of less than 50 mg/kg of body weight per day

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

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

"Skin" -- This designation sometimes appears alongside a TLV or PEL. It refers to the possibility of absorption of the particular chemical through the skin and eyes. Thus,

protection of large surface areas of skin should be considered to prevent skin absorption so that the TLV is not invalidated.

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

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

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

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

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

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

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

Upper Explosive Limit -- Also known as Upper Flammable Limit, is the highest concentration (expressed in percent of vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present. Theoretically, above this limit the mixture is said to be too "rich" to support combustion. The difference between the LEL and the UEL constitutes the flammable range or explosive range of a substance. That is, if the LEL is1ppm and the UEL is 5 ppm, then the explosive range of the chemical is 1ppm to5ppm. (See also LEL).

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

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

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

APPENDIX L

MIOSHA HAZARDOUS WORK IN LABORATORIES STANDARD

Department of Public Health

Occupational Health Standards Commission

Hazardous Work in Laboratories

Filed with the Secretary of State on JANUARY 9, 1992.
These rules take effect 15 days after filing with the Secretary of State.

(By authority conferred on the occupational health standards commission by section 24 of Act No. 154 of the Public Acts of 1974, as amended, being 408.1024 of the Michigan Compiled Laws)

R 325-70101 Scope; effective date of subrule (2).

Rule l.

1. These rules set forth the requirements for laboratory use of hazardous chemicals. Subjects to which these rules apply include all of the following:

   (a) Exposure limits
   (b) Exposure monitoring
   (c) Written chemical hygiene plan
   (d) Employee information and training
   (e) Medical surveillance
   (f) Hazard Identification
   (g) Use of respiratory protection
   (h) Record keeping

   These rules, where they apply as specified in R 325.70102, supersede all Michigan Occupational Safety and Health act (MIOSHA) occupational health standards that govern the use of specific chemical substances, except as provided in R 325.70104, R 325.70105, and R 325.70108. Also, where they apply, these rules supersede the requirements of the Occupational Safety and Health administration (OSHA) hazard communication standard, being 29 C.F.R. 1910.1200, which is incorporated by section 14a of Act No. 154 of the Public Acts of 1974, as amended, being 408.1014a of the Michigan Compiled Laws. This subrule takes effect when an employer has developed and implemented a written chemical hygiene plan as prescribed by R 325.70106.

2. All occupational health standards that do not deal with a specific chemical substance apply to laboratory operations as do any occupational safety standards administered by the Michigan Department of Labor. Such non chemical substance standards that apply to laboratory operations include all of the following rules:

   (a) Occupation noise exposure and hearing conservation - R 325.60101 et seq.
   (b) Ionizing and non ionizing radiation - O.H. rules 2410 and 2420.
   (c) Ventilation control - O.H. rules 3101 and 3110.
   (d) Confined space entry - O.H. rules 3301 and 3302.
   (e) General respiratory protection - O.H. rule 3502.

(f) General workplace requirements - O.H. Rules 4101, 4201, and 4401.
(g) Employee medical records and trade secrets - R 325-3451 et seq.

R 325-70102 Application.

Rule 2.

1. These rules apply to all employers who have an employee or employees involved in the laboratory use of hazardous chemicals as defined in R 325.70103.

2. These rules do not apply to either of the following:

   (a) Work involving chemicals that do not meet the conditions of the definition of laboratory use of hazardous chemicals. In such cases, the employer shall comply with all relevant specific substance standards even if such use occurs in a laboratory type setting.
   (b) Work involving the laboratory use of hazardous chemicals that does not have the potential for employee exposure.

R 325.70103 Definitions.

Rule 3. As used in these rules:

(a) **"Action level"** means a concentration which is designated in established MIOSHA health standards for a specific substance, calculated as an 8-hour, time-weighted average, and which initiates certain required activities, such as exposure monitoring and medical surveillance.
(b) **"Chemical Hygiene Officer"** means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the chemical hygiene plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.
(c) **"Chemical Hygiene Plan"** means a written program which is developed and implemented by the employer, which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards presented by the hazardous chemicals used in a particular workplace, and which is in compliance with the requirements of R 325.70106.
(d) **"Director"** means the director of the Michigan Department of Public Health or his or her designee.
(e) **"Emergency"** means any occurrence, such as equipment failure, the rupture of containers, or the failure of control equipment that results in an uncontrolled release of a hazardous chemical into the workplace.
(f) **"Employee"** means a person who is assigned to work in a laboratory workplace and who may be exposed to hazardous chemicals in the course of his or her assignments.
(g) **"Hazardous chemical"** means a chemical for which there is statistically significant evidence, based on at least one study that is conducted in accordance with established scientific principles, that acute or chronic health effects may occur in employees who are exposed to the chemical. These health effects include those that result from exposure to chemicals that are any of the following:

- (i) Carcinogens.
- (ii) Toxic or highly toxic agents
- (iii) Reproductive toxins
- (iv) Irritants
- (v) Corrosives

(vi) Sensitizers
(vii) Hepatotoxins
(viii) Nephrotoxins
(ix) Neurotoxin
(x) Agents that act on the hematopoietic systems
(xi) Agents that damage the lungs, skin, eyes, or mucous membranes

Appendices A and 3 of the OSHA hazard communications standard, being 29 C.F.R. 51910.1200 and referenced in R 325.70101(2), provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of these rules.

(h) **"Laboratory"** means a facility where the laboratory use of hazardous chemicals occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non production basis.

(i) **"Laboratory-type hood"** means a work chamber which is used in a laboratory, which is enclosed on 5 sides and has a moveable sash or fixed partial closure on the remaining side, which is constructed and maintained to draw air from the laboratory and prevent or minimize the escape of air contaminants into the laboratory, and which allows chemical manipulations to be conducted in the enclosure without inserting any portion of the employee's body other than hands and arms. The term includes walk-in hoods with adjustable sashes if the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and so that employees do not work inside the enclosure during the release of airborne hazardous chemicals.

(j) **"Laboratory use of hazardous chemicals"** means the handling or use of such chemicals in which all of the following conditions are met:

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

(k) **"Medical consultation"** means a consultation that takes place between an employee and a licensed physician to determine what medical examinations or procedures, if any, are appropriate.

(l) **"Physical hazard"** means a chemical for which there is scientifically valid evidence that it is any of the following:

(i) A combustible liquid
(ii) A compressed gas
(iii) Explosive
(iv) Flammable
(v) An organic peroxide
(vi) An oxidizer
(vii) Pyrophoric
(viii) Unstable (reactive)
(ix) Water-reactive

(m) **"Production"** means the manufacturing processes that use hazardous chemicals and result in a product.

(n) **"Protective laboratory practices and equipment"** means those laboratory procedures, practices, and equipment that are accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.
(o) **"Reproductive toxins"** means chemicals that affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis).
(p) **"Select carcinogen"** means any substance that meets one or more of the criteria set forth in the definition of select carcinogen in paragraph (b) of OSHA standard 29 C.F.R. 1910.1450, which is adopted herein by reference. The cited provision of 29 C.F.R. 1910-1450 is available from the Michigan Department of Public Health, Division of Occupational Health, P.O. Box 30195, Lansing, Michigan 48909, at no cost, or from the U.S. Department of Labor, OSHA, 801 S. Waverly, Suite 306, Lansing, Michigan 48917, at no cost. The cited definition is printed as Appendix C to these rules.

R 325.70104 Permissible Exposure Limits.

Rule 4. For laboratory uses of MIOSHA-regulated substances, an employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in MIOSHA occupational health standards.

R 325.70105 Exposure monitoring.

Rule 5.

1. An employer shall measure an employee's exposure to any substance that is regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level or, in the absence of an action level, the permissible exposure limits (PEL).

2. If the initial monitoring prescribed by sub rule (1) of this rule discloses employee exposure over the action level or, in the absence of an action level, the PEL, an employer shall comply with the exposure monitoring provisions of the relevant standard.

3. Monitoring may be terminated in accordance with the relevant standard.

4. An employer shall, within 15 working days after the receipt of any monitoring results, notify an employee of these results, in writing, either individually or by posting the results in an appropriate location that is accessible to employees.

325-70106 Chemical hygiene plan.

Rule 6.

1. Where hazardous chemicals as defined by these rules are used in the workplace, an employer shall develop and carry out the provisions of a written chemical hygiene plan that provides for both of the following:

   (a) Protecting employees from health hazards that are associated with hazardous chemicals in that laboratory.
   (b) Keeping exposures below the limits specified in R 325.70104.

2. The chemical hygiene plan shall be readily available to employees, employee representatives, and upon request, to the director.

3. The chemical hygiene plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection:

   (a) Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals.
   (b) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals, including engineering controls, the use of personal protective equipment, and hygiene practices. Particular attention shall be given to the selection of control measures for chemicals that are known to be particularly hazardous.
   (c) A requirement that laboratory-type hoods and other protective equipment are functioning properly and the specific measures that shall be taken to ensure the proper and adequate performance of such equipment.
   (d) Provisions for employee information and training as prescribed in R 325-70107.
   (e) The circumstances under which a particular laboratory operation, procedures, or activity shall require prior approval from the employer or the employer's designee before implementation.
   (f) Provisions for medical consultation and medical examinations in accordance with R 325-70108.
   (g) Designation of personnel who are responsible for implementing the chemical hygiene plan, including the assignment of a chemical hygiene officer and, if appropriate, establishment of a chemical hygiene committee.
   (h) Provisions for additional employee protection for work with particularly hazardous substances, such as select carcinogens, reproductive toxins, and substances that have a high degree of acute or chronic toxicity. Specific consideration shall be given to the following provisions, which shall be included where appropriate:
      (i) The establishment of a designated area or areas that indicate the physical limits of exposure to particularly hazardous substances.
      (ii) The use of containment devices, such as laboratory-type hoods or glove boxes.
      (iii) Procedures for the safe removal of contaminated waste.
      (iv) Decontamination procedures.

4. An employer shall review and evaluate the effectiveness of the chemical hygiene plan at least annually and update it as necessary.

5. Appendix A to these rules is non mandatory, but provides guidance to assist employers in the development of a chemical hygiene plan.

R 325-70107 Employee information and training.

Rule 7.

1. An employer shall provide employees with information and training to ensure that they are apprised of and understand the hazards of chemicals present in their work areas.

2. Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and before assignments that involve new exposure situations. Refresher information and training shall be

provided by the employer to ensure that an employee is aware of the risks of exposure to hazardous chemicals.

3. Employees shall be informed of all of the following:

   (a) The contents of these rules and appendices shall be made available to employees.
   (b) The location and availability of the employer's chemical hygiene plan.
   (c) The permissible exposure limits for MIOSHA-regulated substances or the recommended exposure limits for other hazardous chemicals if there are no applicable MIOSHA rules.
   (d) Signs and symptoms associated with exposures to hazardous chemicals that are used in the laboratory.
   (e) The location and availability of known reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory, including safety data sheets (SDS) received from a chemical supplier.

4. Employee training shall include all of the following:

   (a) Methods and observations that may be used to detect the presence or release of a hazardous chemical, such as monitoring conducted by the employer, continuous monitoring devices, and the visual appearance or odor of hazardous chemicals when being released.
   (b) The physical and health hazards of chemicals in the work environment.
   (c) The measures employees can take to protect themselves from health hazards, including specific procedures that the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

5. The employee shall be trained about the applicable details of the employer's written chemical hygiene plan.

R 325-70108 Medical surveillance.

Rule 8.

1. An employer shall provide all employees who work with hazardous chemicals an opportunity to receive the following medical attention, including any follow-up examinations which the examining physician determines to be necessary:

   (a) When an employee develops signs or symptoms that are associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.
   (b) If exposure monitoring reveals an exposure level that is routinely above the action level or, in the absence of an action level, the PEL for a MIOSHA-regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.
   (c) When an event takes place in the work areas, such as a spill, leak, explosion, or other occurrence that results in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

2. All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician who is familiar with the general health effects of hazardous chemicals and sources of specific information on such effects and shall be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

3. An employer shall provide all of the following information to the physician:

   (a) The identity of the hazardous chemical or chemicals to which the employee may have been exposed.
   (b) A description of the conditions under which the exposure occurred, including quantitative exposure data, if available.
   (c) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

4. For examination or consultation that is required under this rule, an employer shall obtain a written opinion from the examining physician. The opinion shall include all of the following:

   (a) Any recommendation for further medical follow-up.
   (b) The results of the medical examination and any associated tests.
   (c) Any medical condition revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical that is found in the workplace.
   (d) A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

5. The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

R 325-70109 Hazard identification.

Rule 9.

1. With respect to labels and safety data sheets (SDS) for hazardous chemicals, both of the following provisions apply:

   (a) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.
   (b) Employers shall maintain any SDS that are received with incoming shipments of hazardous chemicals and ensure that SDS are readily accessible to laboratory employees.

2. All of the following provisions shall apply to chemical substances that are developed in the laboratory:

   (a) If the composition of the chemical substance that is produced exclusively for the laboratory's use is known, an employer shall determine if it is a hazardous chemical. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required by R 325.70107.
   (b) If the chemical produced is a by-product of unknown composition, an employer shall assume that the substance is hazardous and shall implement the provisions of R 325.70106.
   (c) If the chemical substance is produced for another user outside of a laboratory, an employer shall comply with the OSHA hazard communication standard, being 29 C.F.R. 1910.1200, which is referenced in R 325.70101.

R 325-70110 Use of respiratory protection.

Rule 10. If , after appropriate application of feasible engineering and work practice controls, the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory protection equipment. Respirators shall be selected and used in accordance with the requirements of O.H. rule 3502.

R 325.70111 Record keeping.

Rule 11.

1. An employer shall establish and maintain, for each employee, an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations, including tests or written opinions required by these rules.

2. An employer shall assure that such records are kept, transferred, and made available in accordance with the provisions of R 325.3451 et seq. and are protected from unauthorized disclosure.

R 325-70112 Compliance date for development and implementation of chemical hygiene plan.

Rule 12. Employers shall have developed and implemented a written chemical hygiene plan not more than 6 months after the effective date of these rules.

R 325.70113 Appendices.

Rule 13. Appendices A, B, C, and D to these rules are informational only and are not intended to create any additional obligations or requirements not otherwise imposed by these rules or to detract from any established obligations or requirements.

R 325-70114 Availability of rules and appendices; permission to copy.

Rule 14.

1. A copy of these rules and appendices are available at no cost from the Michigan Department of Public Health, Division of Occupational Health, 3423 North Logan/Martin Luther King, Jr. Blvd., P.O. Box 30195, Lansing, Michigan 48909.

2. Permission to copy any of these documents in full is granted by the director.

WASTE DISPOSAL GUIDE
Grand Rapids Community College

Table of Contents

A. Introduction

Excellence in research and education is of primary importance at Grand Rapids Community College. This document contains physical science department procedures for safe handling and packaging of chemical wastes.

Our goal is to provide for the storage and disposal of hazardous wastes in a safe, efficient and ecologically sound manner. We need your cooperation to meet this goal. Please abide by the guidelines set forth in this document and comply with the applicable regulatory requirements for the waste that you generate. Finally, if you handle any potentially hazardous materials, know the hazards and how to protect yourself from them.

B. Hazardous Waste Defined

Hazardous materials are substances that have hazardous characteristics such as: flammable, corrosive, reactive, toxic, radioactive, poisonous, carcinogenic or infectious.

A. Ignitable-A liquid with a flash point less than 60°C (140°F). Not a liquid capable under normal conditions of causing fire through friction, absorption of moisture or spontaneous chemical changes. An ignitable compressed gas or an oxidizer

B. Corrosive-It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5. It is a liquid and corrodes steel at a rate greater than .25 inches per year at 55°C (131°F).

C. Reactive-It is normally unstable or reacts violently with water. It forms potentially explosive mixtures with water or it generates toxic gases, vapors of fumes when mixed with water. Cyanide or sulfide wastes that generate toxic gases, vapors or fumes at pH conditions between 2 and 12.5. It is capable of detonation or explosive decomposition if subjected to strong initiation or under standard temperature and pressure. It is classified as a Department of Transportation explosive

D. Toxicity Characteristic-If an extract of the waste is found to contain certain metals, pesticides or selected organics above specified levels. If it is otherwise capable of causing environmental or health damage if improperly disposed

In a general sense, wastes that contain these materials are considered hazardous because they present a potential risk to humans and/or the environment. Hazardous waste management plans generally separate waste into three broad groups: **radioactive, chemical and biohazardous.**

Radioactive waste is classified as either low-level or high-level waste. Low-level waste is typical of that found at medical and research institutions. While high-level waste is typical of that generated at nuclear reactors. At Grand Rapids Community College a radioactive waste is any waste with detectable radioactivity that is generated from procedures involving licensed radioactive material.

Chemical waste includes discarded commercial chemical products (DCCP), and process laboratory waste. Some chemicals and chemical mixtures are hazardous wastes because they are specifically listed by the EPA. A chemical waste that is not listed by the EPA is still a hazardous waste if it has one or more of EPA's 4 hazardous characteristics: **ignitablity**, **corrosivity**, **reactivity** or **toxicity**.

C. Requirements for Chemical Waste

Labeling

Each container of hazardous waste must be labeled with the words " *Hazardous Waste*", and have a completed waste tag (or label) attached. An exception to this rule is individual small bottles of discarded commercial chemical product; however, if the discarded commercial product is not in the original container, it must also have a waste tag (or label).

Collection & Storage

Collect and store compatible wastes in strong, tight containers in a secured area that is protected from the weather, such that none can escape into the environment. Keep lids tightly secured when not in use.

Campus Police

Contact campus police at extension 4010 or 4911 in case of an emergency.

Waste Minimization

Institute methods to recycle wastes and to reduce waste volume and toxicity. Substitute nonhazardous or less toxic materials whenever possible. Purchase only the amount of chemical that is needed. Excess chemicals often become waste and any purchase savings are outweighed by disposal costs.

D. Classification of Chemical Waste

A chemical waste is considered to be a hazardous waste if it is specifically listed by the EPA as a hazardous waste or if it meets any of the four hazardous characteristics below. If a chemical waste is not on the EPA list of hazardous wastes, and does not meet any of the hazardous waste characteristics, it is a nonhazardous waste.

Hazardous Waste Characteristics

1. **Ignitable Waste**

   A liquid which has a flash point of less than 60°C (140°F) is an ignitable waste. A solid is an ignitable waste if it is capable of causing fire through friction or absorption of moisture, or can undergo spontaneous chemical change which can result in vigorous and persistent burning. A substance which is an ignitable compressed gas or oxidizer is an ignitable waste.

2. **Corrosive Waste**

   An aqueous solution which has a pH less than or equal to 2 or greater than or equal to 12.5 is a corrosive waste.

3. **Reactive Waste**

   Materials that are unstable under “normal” conditions. They can create or cause explosions, toxic fumes, or gases when heated, compressed or mixed with water.

4. **Toxic Waste**

   A waste that is harmful or fatal when ingested or absorbed.

A chemical waste can also be classified as either a process laboratory waste or a discarded commercial chemical product (DCCP). This distinction is important when manifesting and labeling. A process laboratory waste is any waste that, by virtue of some use, process or procedure, no longer meets the manufacturer's original product specifications. Examples of process laboratory wastes are chromatography effluents, diluted chemicals, reaction mixtures, etc.

A discarded commercial chemical product is the original (virgin) material, in the original container. Examples of DCCP are bottles of unused or outdated chemicals from chemical manufacturers, suppliers and vendors.

Although a chemical waste may be nonhazardous by EPA's definition, there are additional requirements for disposal at the state and local level that are beyond the scope of this manual.

E. Storage of Chemical Waste

Original containers of a hazardous material may be reused to collect waste material. For example, many solvents and acids come packaged in 1-gallon (4-liter) or smaller glass bottles that are suitable for waste collection.

Containers of hazardous waste may be stored in an area of laboratory operation near the point of generation. State and general regulations stipulate how waste generators store chemical waste and require the following

A. Any container used to store hazardous waste must be labeled with the words "hazardous waste" (regardless of its location) as soon as accumulation begins. This includes storage of chemical wastes within a laboratory.

B. Be sure that the container is compatible with the chemical waste. Use containers that are made of or lined with materials, which will not react with and are otherwise compatible with, the hazardous waste to be stored. For example, do not place hydrofluoric acid in glass. Often the original container is suitable.

C. Be sure that containers in the waste storage area do not leak. Consider the use of secondary containment, such as a tray, larger container or basin. If a leaking container is found, immediately clean up any spilled material according to established spill cleanup procedures and transfer the waste into a container that is in good condition.

D. No more than one quart of an acutely hazardous waste or 55 gallons of other hazardous wastes may be stored in the laboratory waste storage area. If this threshold quantity is reached, it must be transferred to the hazardous waste storage area. The container must bear a hazardous waste label with the accumulation date marked on the container.

E. Like any chemical storage in the laboratory or work area, be sure to segregate the containers according to the type of waste. Follow the chemical storage and segregation guidelines.

F. Waste stored near drains (floor, sink, cup sink) should have secondary containment. Secondary containers must be compatible with the waste.

F. General Labeling & Packaging Procedures

Collect small volumes of process laboratory waste in your own containers. Collect solid waste in cardboard boxes **Keep liquid and solid wastes separate**.

Attach a tag or label to each and every container of process laboratory waste. Separate wastes into the different waste categories and list the contents as halogenated organic waste, non-halogenated organic waste, aqueous mixed metals or solid waste.

Date and label each container with the words *"Hazardous Waste*". Small bottles of discarded chemical commercial products do not need to be labeled with the words "*Hazardous Waste*".

Do NOT mix incompatible materials in the same container.

Do NOT put corrosive or reactive chemicals in metal cans.

For liquids, fill containers to about 90% of container volume. **Do NOT fill containers to the top**. Make sure the caps on all bottles are secured before they are placed in the hazardous storage area.

Packaging Chemical Wastes

Place hazardous waste in sealable containers. Waste disposal cost is based on volume, not weight, therefore, whenever possible, containers should be filled, leaving headspace for expansion of the contents. Often the original container is perfectly acceptable.

If you routinely generate significant quantities of compatible solvents, bulking of waste in five gallon (20 liter) carboys. Savings to the College from this practice are substantial.

The container should not react with the waste being stored (e.g. no hydrofluoric acid in glass). Similar wastes may be mixed if the are compatible.

Chemical containers that have been rinsed with water and/or air-dried in a ventilated area can be placed in the trash or recycled. If the original contents were highly toxic, the container should be rinsed first with an appropriate solvent and the washings disposed of as hazardous waste.

G. Specific Labeling and Packaging Procedures

Ignitable Liquids and Organic Solvents

Keep halogenated wastes separate from non-halogenated solvent wastes. Separate organic solvents from aqueous solutions.

Acids, Bases, and Aqueous Solutions

Do NOT mix strong inorganic acids or oxidizers with organic compounds. Keep acids, bases or aqueous solutions containing heavy metals separate from other wastes. Avoid mixing concentrated acids and bases together in the same container.

Mercury Solutions

Keep wastes containing mercury salts separate from all other wastes.

Corrosive Materials

The following corrosive liquids shall not be mixed with any other hazardous waste under any circumstances. These liquids must be packaged in their own separate shipping container.

- Nitric acid exceeding 40 percent concentration
- Perchloric acid
- Hydrogen peroxide exceeding 52 percent strength by weight
- Nitrihydrochloric or Nitrohydrochloric acid diluted

Perchloric Acid and Perchlorates

Keep perchloric acid and perchlorate wastes separate from other wastes and in exclusive use containers.

Toxic Wastes

Separate toxic wastes from other hazardous wastes whenever possible. For example, do not mix aqueous waste containing heavy metals with wastes that do not contain heavy metals. **This is especially true for wastes containing mercury**.

Severe Toxicity Wastes

Keep severe toxicity wastes separate from other wastes whenever possible.

Broken Mercury Thermometers

Collect elemental mercury and glass from broken thermometers in an impermeable, sealed container. A wide mouth polyethylene or glass jar with a screw top cap works well. Label the container as *"broken thermometer and elemental mercury".*

Contaminated Debris from Laboratories

This includes debris contaminated with hazardous chemicals. Whether this material is a hazardous waste depends on how it is generated, the contaminants and the concentration of contaminants. If the debris contains any of the constituents classified as hazardous waste, it is a hazardous waste. If it comes from the cleanup of a hazardous material spill it is a hazardous waste. If it is neither of these, it is a nonhazardous waste and may be disposed of in the dumpster.

In some cases it is not prudent to dispose of nonhazardous waste into the dumpster. For example phenol (poison) contaminated solid debris is best disposed of by incineration. In general, any waste contaminated with trace levels of a poison or carcinogen should be collected for incineration.

Chemical Compatibility

Accidental mixing of one hazardous waste with another may result in a vigorous and dangerous chemical reaction. Generation of toxic gases, heat, possible overflow or rupturing of receptacles, fire and even explosions are possible consequences of such reactions.

H. Disposal of Unknowns

Chemical wastes with no identification (unknowns) present a particularly dangerous threat, due to their unknown composition and characteristics. Under no circumstances should an unknown waste be placed in a container with properly labeled wastes.