CHEMICAL HYGIENE PLAN

THE WYSS INSTITUTE
FOR
BIOLOGICALLY INSPIRED ENGINEERING

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June 2011

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LIST OF ABBREVIATIONS AND ACRONYMS

BFD	Boston Fire Department
CFR	Code of Federal Regulations
CHO	Chemical Hygiene Officer
CHP	Chemical Hygiene Plan
EH&S	environmental health and safety
LD_{50}	median lethal dose
mg/kg	milligrams per kilograms
MSDS	material safety data sheet
NFPA	National Fire Protection Association
OSHA	U.S. Occupational Safety and Health Administration
PEL	permissible exposure limit
PI	Principal Investigator
PPE	personal protective equipment
ppm	parts per million
SAA	satellite accumulation area
SOP	standard operating procedures
STEL	short term exposure limit
TLV	threshold limit value
TWA	time weighted average
Wyss Institute	Wyss Institute for Biologically Inspired Engineering at Harvard University

1.0 POLICY AND PURPOSE

1.1 POLICY

It is the policy of the Wyss Institute for Biologically Inspired Engineering at Harvard University (Wyss Institute) to provide a safe and healthy workplace in compliance with the Occupational Safety and Health Act of 1970 and with regulations of the Department of Labor, including 29 Code of Federal Regulations (CFR) 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*. The full U.S. Occupational Safety and Health Administration (OSHA) standard can be found on the following link: http://www.osha.gov/comp-links.html.

1.2 PURPOSE

This document presents the Chemical Hygiene Plan (CHP) required by the above mentioned regulations. The purpose of the CHP is to describe proper practices, procedures, equipment, and facilities for employees, students, visitors, or other persons working in the laboratory areas of the Wyss Institute to protect them from potential health hazards presented by chemicals used in the laboratory workplace and to keep exposures below specified limits. It is the responsibility of administration, research, and supervisory personnel to know and to follow the provisions of this plan. The Chemical Hygiene Officer (CHO) is responsible for developing, implementing, monitoring, and updating the plan annually. Affected departments are all those maintaining laboratories that contain and use hazardous chemicals, as defined by the regulations.

2.0 RESPONSIBILITY, AUTHORITY, AND RESOURCES

2.1 CHEMICAL HYGIENE OFFICER

The CHO has the responsibility for overseeing the safety and health of the employees conducting work in Wyss Institute laboratories and the visitors to the Wyss Institute. The CHO will provide assistance to the Principal Investigators (PIs) in assigning responsibilities. The CHO for the Wyss Institute is Christopher Neal, who can be reached at 617-432-7222 or cneal@eheinc.com, and is typically on-site Thursdays.

2.1.1 Requirements—The OSHA *Occupational Exposure to Hazardous Chemicals in the Laboratory* or *Laboratory Standard* requires the designation of a CHO.

2.1.2 Definition—The CHO is an employee designated by the employer, who is qualified by training or experience to *provide technical guidance* in the development and implementation of the written CHP.

2.1.3 Duties—The CHO should assist each responsible PI in the facility to accomplish the following (where feasible):

- Work with the PI to develop a CHP with appropriate Standard Operating Procedures (SOPs) and to implement the plan at the individual laboratory level.
- Work with the PI to monitor safe procurement, use, storage, and disposal of hazardous chemicals.
- Assist the responsible PI with required safety audits and necessary documentation therein (which includes documentation of training).
- Advise the PI concerning adequate facilities and procedures under the current regulations.
- Seek ways to improve the Chemical Hygiene Program.
- In addition, the CHO should be fully familiar with the contents of the OSHA Regulation 29 CFR 1910.1450, *Occupational Exposures to Hazardous Chemicals in Laboratories*.

2.1.4 Resources—The CHO may call upon the Radiation Safety Officer, Department Administrators, and PIs to provide specific information concerning the laboratories.

2.2 INSTITUTE ADMINISTRATORS AND PRINCIPAL INVESTIGATORS

Wyss Institute Administrators and PIs should ensure that all safety policies and procedures outlined in the CHP are followed by laboratory personnel and that all staff under their direction is trained in safe work practices appropriate to their areas. PIs or their designees should ensure that the following duties are performed:

- Prior to conducting experiments, notify the CHO if you will be working with hazardous chemicals to ensure proper procedures are in place prior to working with hazardous chemicals.
- Assure that work is conducted in accordance with the CHP.
- Identify the location of work areas where toxic substances and potential carcinogens will be used and maintain an inventory of these substances.
- Obtain, review, and approve SOPs detailing all aspects of proposed research activities that involve hazardous agents.
- Prepare SOPs for use of test/experimental substances when this use involves alternate procedures not specified in these guidelines. The SOP shall include a description of the alternate procedures and an assessment of alternate controls that will be used.
- Define hazardous operations, designate safe practices, and select protective equipment.
- Ensure that program and support staff receives instructions and training in safe work practices, use of personal protective equipment, and in procedures for dealing with accidents involving toxic substances.
- Ensure that employees fully understand the training received.
- Ensure that all personnel obtain the medical examinations and protective equipment necessary for the safe performance of their job.

- Monitor the safety performance of the staff to ensure that the required safety practices and techniques are being employed.
- Coordinate with the Wyss Institute EH&S Office for workplace evaluations that include air samples, swipes, or other tests to determine the amount and nature of airborne and/or surface contamination. The Wyss Institute EH&S Office will inform employees of the results and use data to aid in the evaluation and maintenance of appropriate laboratory conditions.
- Assist the Wyss Institute EH&S Office and the Radiation Safety Office when appropriate.
- Periodically monitor and audit compliance status. Conduct formal laboratory inspections to ensure compliance with existing laboratory SOPs.
- Prepare emergency procedures for dealing with accidents that may result in the unexpected exposure of personnel or the environment to a toxic substance.
- Investigate accidents and report them to the CHO and/or the Wyss Institute EH&S Office. Include recommendations for procedures that will minimize the occurrence of a similar accident.
- Report incidents to the CHO that cause: (1) personnel to be seriously exposed to hazardous chemicals or materials, such as may occur from accidental skin penetration, ingestion, or probable inhalation of a chemical, or (2) constitute a danger of environmental contamination.
- Ensure that action is taken to correct work practices and conditions that may result in the release of toxic chemicals.
- Properly dispose of unwanted and/or hazardous chemicals and other hazardous materials.
- Document and maintain compliance with all local, state, and federal regulatory requirements. (The Wyss Institute EH&S Office will provide periodic updates.)
- Make copies of the approved safety plan available to the program and support staff.
- The PI or Institute Administrator must appoint a representative to the Wyss Institute Safety Committee, which meets on a quarterly basis.

2.3 STAFF MEMBERS, VOLUNTEERS, AND STUDENTS

Staff members, as defined by the CHP, are those staff under the direction of the PI or Institute Administrator, as defined by the Plan. Staff not under the direction of the PI or Institute Administrator, but who are in an area under their direction, is also subject to the CHP, including SOPs, in effect in that area. Non-employees, such as volunteers and visiting scientists, are equally subject to the plan, as described below.

The primary responsibility of the employee is to follow the procedures in the CHP and all SOPs. These include the following:

- Understand and follow all laboratory SOPs.
- Understand all training received.
- Understand the function and proper use of all personal protective equipment. Wear personal protective equipment when mandated or necessary.
- Report, in writing, any significant problems arising from the implementation of the SOPs.
- Report all facts pertaining to every accident that results in the exposure to toxic chemicals and any action or condition that may exist that could result in any accident.
- Contact the Institute Administrator, the PI, the CHO, or the Wyss Institute EH&S Office if any of the above procedures is not clearly understood.

2.4 ENVIRONMENTAL HEALTH AND SAFETY OFFICE STAFF

The primary function of the Wyss Institute EH&S Office Staff is to assist the CHO in the safe operation of all aspects of the Wyss Institute facility.

The Wyss Institute EH&S Office serves a variety of other functions. These include:

- Expert advice and consultation on safety issues.
- Evaluate hazards and provide hazard toxicity information.
- Advice regarding proper protective equipment and protective measures.
- Assist in obtaining the proper gloves for laboratory operations.
- Hazardous waste disposal.
- Safety training.

- Laboratory safety inspections.
- Liaison with regulatory agencies on the local, state, and federal levels, as well as non-regulatory accrediting groups.

3.0 CHEMICAL HYGIENE PLAN

3.1 DEVELOPMENT, IMPLEMENTATION, AND UPDATE

The CHO oversees the preparation of the CHP, specifically the SOPs for the laboratory. The CHO is responsible (per OSHA regulation) for ensuring that the plan meets the requirements set forth in the 29 CFR 1910.1450 and is fully implemented.

The CHO is responsible for ensuring that the CHP is reviewed on an annual basis and updated as necessary to accommodate changes in OSHA standard 29 CFR 1910.1450, Wyss Institute procedures, and personnel policy. In addition, the CHO will ensure that the CHP update includes procedures regarding new hazards and new processes as they are introduced.

The CHO will ensure that the CHP and updates are distributed or made available to those affected by the changes.

3.2 IDENTIFICATION AND CLASSIFICATION OF HAZARDOUS CHEMICALS

All Wyss Institute laboratories must submit an inventory of their hazardous chemicals to the EH&S Office on an annual basis as part of the Boston Fire Department's Emergency Signage (National Fire Protection Association [NFPA] Diamond) program. Based on these lists, the Wyss Institute EH&S Office provides laboratory contacts with appropriately labeled NFPA Diamonds for placement at entrance doors into the laboratories (see Appendix A).

Hazardous chemicals can be easily classified into generic categories (e.g., corrosive, reactive, flammable, toxic, etc.) and are labeled on the primary container as such. The definitions associated with these generic categories can be found at the following link: http://www.osha.gov/SLTC/hazardcommunications/index.html.

Alternate means of classifying and identifying hazardous chemicals include the following:

- Lists of known or suspect human carcinogens, prepared by the International Agency for Research on Cancer and the National Toxicology Program, are available through the Wyss Institute EH&S Office.

- The NFPA has categorized a wide variety of chemicals found in industrial settings. This list is available through the Wyss Institute EH&S Office.

- Material safety data sheets (MSDSs) are available via the internet from manufacturer's websites as well as searchable databases and the Wyss Institute's website. Each person working in the laboratory must be familiar with how to access MSDSs for chemicals used in the area prior to working in the area.

- When the human or animal median lethal dose (LD_{50}) for any given substance is less than 50 milligrams per kilogram (mg/kg) or if the permissible exposure limit (PEL) is less than 10 parts per million (ppm), and if the substance is not on the list in Appendix B,[1] then the CHO and PI or Institute Administrator or designee will have to develop a specific standard operating procedure for this chemical.

- Manufacturers and manufacturers' associations have valuable information. See Appendix C for a list of Chemical Information Resources.

3.3 SELECTION OF REQUIRED CONTROL METHODS AND AUTHORITY FOR CHEMICAL USE

MSDSs for many chemicals used in the laboratories indicate recommended limits (e.g., threshold limit value or TLV), OSHA-mandated limits (e.g., PEL, short-term exposure limit [STEL], and action limit), or both, as exposure guidelines.

When such limits are stated, they will be used in the laboratories by the CHO and the Wyss Institute EH&S Office staff to assist in determining the safety precautions and control measures necessary when handling toxic materials.

A chemical fume hood certified by the Wyss Institute EH&S Office must be used when the following occurs:

- When working with a compound that has a reported TLV or PEL less than 50 ppm.

[1] For these compounds, a copy of the MSDS is sent to and filed in the Wyss Institute EH&S Office. The PI is required to fill out a form outlining special precautions to be taken when this extremely hazardous substance is used (see Appendix B).

- If the LD_{50} is less than 500 mg/kg or the median inhalation dose, LC_{50}, is less than 200 ppm.[2]
- When working with or handling toxic or malodorous materials (e.g., 2-mercaptoethanol) with moderate or high vapor pressure.

3.4 SPECIAL PROVISIONS FOR PARTICULARLY HAZARDOUS SUBSTANCES (CARCINOGENS, REPRODUCTIVE TOXINS, AND ACUTELY AND EXTREMELY TOXIC CHEMICALS)

The procedures described in this section must be followed when performing laboratory work with greater than 10 mg of any carcinogen, reproductive toxin, substance with a high degree of acute toxicity, or chemical whose toxic properties are unknown.

These substances must be handled, used and stored only in designated areas of restricted access. Appropriate areas include chemical fume hoods, glove boxes, designated portions of a laboratory, or an entire laboratory if it is specifically dedicated for that purpose.[3] A designated area must be clearly posted with signs warning that a specific, extremely hazardous material is in use and that only those trained to work with it are allowed to enter the area while procedures using it are ongoing. The boundaries of the designated area must be clearly defined.

The smallest amount of a chemical that is required by a procedure should be used, purchased, and stored. Whenever possible, material should be ordered in amounts equal to that required in a given procedure to avoid unnecessary weighing out of the material.

Spill procedures must be developed and posted in the designated area. Staff should be familiar with and have available materials that will inactivate the chemical.

Long-sleeved clothing and gloves known to be impermeable to the material must be worn whenever working in designated areas. Because decontamination of jewelry may

[2] These values should be used if a TLV or PEL is not available for the substance in question.

[3] A designated area may be posted with a removable sign if work with extremely hazardous agents is not continuous in the laboratory.

be difficult, it is recommended that jewelry not be worn when working in a designated area.

The designated area must be decontaminated when work is completed. Contact the Wyss Institute EH&S Office for more information.

Liquid wastes must be put into screw-top containers that are compatible with the chemical. The container must be labeled with the words, *Hazardous Waste*, the chemical name, the type of hazard (toxic, ignitable, corrosive, or reactive), and dated only when full. Hazardous waste labels are available from the Wyss Institute EH&S Office. Hazardous waste must be removed from the lab within three days after filling the container.

3.5 ELIMINATION OR SUBSTITUTION

The first step in evaluating the safety of a new experiment, process, or operation is to investigate the possibility of eliminating hazardous materials or substituting with a less hazardous material.[4] When selecting alternate products, care must be taken that one hazard is not being substituted for another.

The particular process, experiment, or operation may also be modified to reduce the quantity of the hazardous material(s) necessary or limit the potential emission release rate or exposure time.[5] The use of a secondary containment device, such as a pan, can also be helpful in preventing or minimizing the effects of chemical spills. The EH&S Office should be consulted for advice.

[4] As an example, instead of using an organic solvent or chromic acid-based material for washing glassware, one should substitute an aqueous-based detergent. Aromatic compounds (i.e., benzene) and chlorinated hydrocarbons (i.e., methylene chloride) in some experiments should be replaced with aliphatic compounds or non-chlorinated hydrocarbons.

[5] For example, the use of micro scale techniques may be applicable in measuring boiling points of a material. Another example is the substitution of closed systems for open vessels.

3.6 ENCLOSURE, ISOLATION, AND REGULATED AREAS

3.6.1 Designated Areas

Reducing the potential for exposure to particularly hazardous chemicals is achieved by restricting the use of the material to a designated area equipped with the proper control devices. This designated area can be a glove box, fume hood, bench, or an entire laboratory depending on the manipulations required. Hazardous substances are stored, used, and prepared for disposal only in designated areas. The designated area is identified by signs to alert others of the presence of a particularly hazardous material. For example:

Over balance area: **CAUTION: ACRYLAMIDE BALANCE**

On glove box: **CAUTION: AFLATOXIN IN USE**

Biohazard signs are also available from the Wyss Institute EH&S Office. Refer to the Wyss Institute Biosafety Manual for more information regarding biological safety.

In addition to establishing the physical boundaries that define the designated area, procedures used in a designated area have special provisions. These include storage, use of protective equipment, containment, equipment disposal, and decontamination procedures.

3.7 EDUCATION AND TRAINING

The CHO or appointed individual(s) shall provide information and training concerning the handling of hazardous chemicals in the laboratory. The Wyss Institute EH&S Office staff is available to assist in developing and implementing procedure-specific training for laboratories with particular needs.

Employees shall be informed of the presence of hazardous chemicals when assigned to a work area and prior to new exposure situations. This information must include the following:

- Contents of the OSHA *Laboratory Standard*.
- Applicable details and location of the CHP.
- Emergency and personal protective equipment training.
- Physical and chemical properties of hazardous substances used in the workplace.
- Proper handling of hazardous chemicals to minimize exposure.
- Signs and symptoms of exposure associated with hazardous chemicals used in the workplace.
- Availability of reference material, including MSDSs.

Training should be provided immediately for new employees in the affected work area and annually thereafter for all personnel. The name of each person trained shall be recorded together with the training contents, date, and the trainer in the Wyss Institute EH&S Office.

It is the responsibility of the Institute Administrator and the PI to assure that all staff members complete the required training sessions. Further, if English is not the primary language spoken by a staff member, the Institute Administrator should ensure that an interpreter accompanies the non-English speaking staff.

3.8 GENERAL WORK PRACTICES AND STANDARD OPERATING PROCEDURES FOR CHEMICALS OR CLASSES OF CHEMICALS

Before developing general work practices and standard operating procedures, it is important to consult the MSDS for the chemical. The following are general guidelines for responding to an incident.

3.8.1 General Work Practices—Spills

1. **Eye Contact:** Eyes should be promptly flushed with water for 15 minutes. Medical help should be sought immediately after flushing.

2. **Skin Contact:** Contaminated clothing should be removed as quickly as possible and the affected area flushed with water for 15 minutes. Medical attention should be sought immediately after flushing.

3. **Clean up with no injury:** If no one is injured, the clean up of the spill should begin immediately. For assistance or advice, call the Wyss Institute EH&S Office.

4. **Clean up with injury:** If someone is injured, that person should seek medical assistance immediately. Clean up should be initiated by someone other than the injured person. For assistance or advice, contact the Wyss Institute EH&S Office.

3.8.2 General Work Practices—Avoidance of Routine Exposure

1. Work should be conducted in a chemical fume hood whenever possible.
2. Smelling chemicals to determine their identity should be avoided.
3. **Never** place your head inside of a chemical fume hood to check on an experiment.
4. Inspect gloves before use.[6]
5. Release of toxic chemicals (including dry ice) in cold or warm rooms must be avoided, these rooms contain recirculated atmospheres.
6. Exhaust of an apparatus (e.g., vacuum pumps) that may discharge toxic chemicals should be vented into a fume hood or filter.
7. When transporting hazardous chemicals, use one or more of the following:
   a. Carts designed to prevent bottles from spilling
   b. Secondary containment
   c. Bottle carriers

3.8.3 General Work Practices—Choice of Chemicals

1. Less toxic substances should be substituted in place of more toxic ones wherever possible.
2. Only those amounts necessary for immediate work should be ordered.

3.8.4 General Work Practices—Personal Hygiene

1. No eating (including chewing gum), drinking, smoking, or applying cosmetics is allowed. The use of contact lenses in the laboratory should be avoided.

2. Mouth pipetting of **any** substance is prohibited.

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6 Up to 5% of all new and unused gloves have holes or tears in them.

3. Hands must always be washed before leaving the laboratory. Solvents must never be used to wash hands.

4. Laboratory coats and safety glasses should be worn in the laboratory whenever there is a potential for exposure to infectious, chemical, or radioactive hazards. Appropriate gloves must be worn when handling chemicals. Refer to Appendix D, "Effective Use of Gloves." This equipment should not be worn in cafeterias, bathrooms, and conference areas to avoid cross contamination.

3.8.5 General Work Practices—Appropriate Storage of Chemicals

1. Incompatible chemicals must be segregated (see Appendix E for Chemical Storage Guidelines).
2. Glass bottles must not be stored on high shelves or on the floor.
3. Chemicals should be stored in containers with which they are compatible.
4. All bottles must be labeled with the correct chemical name in English and using no abbreviations. Bottles should be dated upon receipt and again upon opening.

3.8.6 General Work Practices—Procedures for Flammable Chemicals

1. General Use and Handling

    a. Flammable liquids are defined as those liquids with a flash point of 140 degrees Fahrenheit (°F) or less and having an absolute vapor pressure of not more than 40 pounds per square inch at 100 °F. Some examples commonly found at the Wyss Institute are acetone, ethanol, isopropyl alcohol, and diethyl ether. All flammable liquids should be handled carefully.

    b. Flammable substances should be handled only in areas free of ignition sources (e.g., away from electric ovens, burner flames, and hot surfaces).

    c. Flammable substances should never be heated using an open flame. Heating mantles, oil baths, safety hot plates, and steam baths should be used. When heating either by steam bath or hot plate, use a filter or distilling flask as a receiver. Such distillations must be carried out in a fume hood.

d. Smoking is not permitted within the Wyss Institute.

e. Boiling chips or glass beads are helpful in distilling or evaporating flammable substances to prevent superheating and bumping.

f. Ground cylinders or equipment when transferring flammables from one container to another. Contact the Wyss Institute EH&S Office, if there are questions about proper grounding.

2. Storage

a. Bottles of volatile liquids should not be stored near heat sources or in direct sunlight.

b. Quantities of flammable solvents stored in the laboratory should be kept to a minimum. The Boston Fire Department limits storage based on the type of liquid, the floor, where the solvents are stored, and the size of the laboratory (control area). Contact the Wyss Institute EH&S Office regarding the limit for your control area.

c. Whenever possible, flammable liquids including spray and squeeze bottles should be stored in approved storage cabinets. Flammable liquids must never be stored on the floor.

d. Adequate ventilation must be provided where flammable liquids are used.

e. When flammable liquids are stored in a refrigerator, it must be a *Laboratory-Safe* Refrigerator (as defined in NFPA 45). These are approved for storing flammable liquids and have all electrical equipment mounted on the outside surface of the refrigerator.

f. Flammable liquids must not be stored with chemicals that are considered to be incompatible with them (e.g., oxidizers, oxidizing acids, etc.).

3.8.7 General Work Practices—Procedures for Reactive Chemicals

Reactive materials include oxidizers, organic peroxides, explosives, air sensitive, shock sensitive, temperature sensitive, and those ranked 3 or 4 for instability by the NFPA (Appendix F). These materials are known as unstable materials by the Boston Fire Department. Each laboratory is responsible for disposing of unstable materials prior to them becoming potentially explosive.

For peroxide-forming chemicals (e.g., diethyl ether, tetrahydrofuran), containers should be dated upon opening and disposed of as hazardous waste by the expiration date or within six months, whichever is sooner.

All reactive materials must be handled with caution, personal protective equipment must be used, and, where possible, work should be done in a chemical fume hood.

3.8.8 General Work Practices—Procedures for Corrosive Chemicals

1. Extreme care must be exercised in handling and pouring corrosive materials. This includes: approved gloves, a laboratory coat, and safety glasses.
2. Acids and similar chemicals should not be stored above lab bench level.
3. Corrosive materials should not be heated or handled in large, fragile containers (e.g., four-liter beakers) without providing a secondary containment to catch the contents in case of breakage.
4. Porcelain dishes should not be used as cleaning baths.
5. Strong alkalis should not be stored next to strong acids.
6. Inorganic acids and organic acids should be segregated from each other.
7. If strong acids or alkalis come in contact with skin or clothing, affected parts should be washed quickly and thoroughly with large quantities of water. If such materials are splashed in the eyes, they should be flushed thoroughly with a continuous stream of cold water for at least 15 minutes. In either case, medical attention should be sought immediately.

3.8.9 Special Procedures: Work with Formaldehyde

The OSHA formaldehyde standard 29 CFR 1910.1048, *Occupational Exposure to Formaldehyde,* states that the eight-hour PEL time-weighted average (TWA) for people working with formaldehyde is 0.75 ppm. The STEL TWA for 15-minute exposure is 2.0 ppm.

The Hazard Warning for formaldehyde, including labeling requirements, falls under the OSHA *Hazard Communication Standard*. If formaldehyde is to be used by any individual in the laboratory, all staff should be informed of the health hazards of formaldehyde upon initial orientation to the work site.

3.9 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) is designed to prevent personal injury. Examples of PPE include safety glasses or goggles, face shields, safety shields, gloves, rubber aprons, laboratory coats, and protective creams. It is the responsibility of the Institute Administrator and/or PI to ensure that laboratory staff is using necessary safety equipment.

The type and level of equipment can be determined with the aid of the CHO and the Wyss Institute EH&S Office. Use of PPE should only be considered after exercising all options for reducing the hazards. If in doubt about the potential danger of an experiment or activity, all available safety devices should be employed. Information on such devices can be obtained from the Wyss Institute EH&S Office upon request.

3.9.1 Respirators

Required use of a respirator is the responsibility of the Institute Administrator, the PI (or their designee), the CHO, and the Wyss Institute EH&S Office. The provisions of the employee's home institution's Respiratory Protection Program must be followed when respiratory protection is required.

All staff must follow these basic elements:

- Less hazardous materials should be substituted for more hazardous materials.

- Laboratory fume hoods or other engineering controls should be employed to control exposure.
- If items 1 and 2 above have been considered but added protection is still deemed necessary, respirator type shall be selected on the basis of type of chemical exposure, level of exposure, and user medical examination.
- Selection of a respirator type must be performed in consultation with the Wyss Institute EH&S Office.
- A medical clearance is required for each employee before a respirator is used routinely. A medical opinion can be obtained through the host institution's Occupational/Employee Health Services.
- Appropriate fit testing and training shall be performed under the direction of the host institution for all negative pressure respirators before use.
- The respirator user must regularly maintain and clean the respirator.
- The respirator user must perform a negative and positive pressure check before each use.

3.9.2 Eye Protection

Eye protection must be worn in the laboratory whenever there is a potential for eye contact with liquids and/or particulates. If a person wears prescription glasses, then (s)he must wear prescription safety glasses or safety glasses or goggles that fit over the prescription glasses. The type of eye protection to be used shall be stated in the SOPs for the laboratory.

Goggles are recommended when working with volatile substances that irritate the eyes, as well as, for protection against irritating dusts or spattering or splashing of hazardous materials. It is also advisable to wear a safety shield when distilling at high temperatures, under reduced pressures, or when distilling corrosive liquids. Safety glasses and goggles have only a limited application and do not offer full protection against all hazards. For particularly dangerous operations, full-face shields of an approved type are to be worn in addition to the eye protection discussed above.

3.9.3 Protective Clothing

The use of protective clothing, including gloves, shall be determined by the Wyss Institute EH&S Office. When working with a potential hazardous material, protective clothing is required.

- Protective clothing is chosen, with the aid of the Wyss Institute EH&S Office, on the basis of the chemical exposure and medical condition of the user.
- Contaminated protective clothing must be disposed of properly.
- Open-toed shoes or sandals shall not be worn in the laboratory.
- Skin should not be exposed when working with hazardous materials.
- Contaminated laboratory coats shall not be worn.

NOTE: Laboratory coats should not be worn in common areas
(Cafeterias, bathrooms, kitchen areas, outside, conference rooms, break rooms, etc.)

3.9.4 Protective Gloves

When handling toxic or hazardous chemicals, protective gloves are required. To protect against accidental spills or contamination, workers should refer to glove manufacturers' glove charts and the National Institute for Occupational Safety and Health database to select a glove appropriate for use with the reagent in question (see Appendix D for glove selection). There is no glove currently available that will protect against all chemicals for all types of tasks. If the gloves become contaminated, they should be removed and discarded as hazardous waste as soon as possible.

Staff members must remove at least one glove before leaving the immediate work site to prevent contamination of public areas (e.g., doorknobs, light switches, telephones, etc.).
Latex Alert: Latex (i.e., several protein antigens) has been shown to be a sensitizer. In order to best protect workers from becoming sensitized, powdered latex exam gloves are PROHIBITED in the Wyss Institute laboratories. Powder-free latex gloves may be used where appropriate.

NOTE: Latex gloves do not protect against every hazardous material.

3.9.5 Other Personal Protective Equipment

Other personal protective equipment shall be used as needed.

Safety shields are recommended for use whenever solvent or vacuum distillations are being run in glass equipment or whenever large glass vessels are subjected to a vacuum. Safety shields should also be used during reactions involving unknown characteristics or that contain toxic materials.

3.10 VENTILATION, FUME HOODS, AND PROPER OPERATIONS

Local exhaust ventilation is the primary method used to control inhalation exposures to hazardous substances. Other types of local exhaust include vented enclosures for large pieces of equipment or chemical storage and snorkel types of exhaust for capturing contaminants near the point of release.

A laboratory fume hood should be used when working with hazardous substances. A properly operating and correctly used fume hood will control the vapors released from volatile liquids, as well as unpropelled dusts and mists.

Do not make any modifications to hoods or ductwork without first consulting the Wyss Institute EH&S Office.

A fume hood should not be used for large pieces of equipment unless the fume hood will be dedicated for this use since it will change airflow patterns and render the fume hood unsafe for other uses. It is generally more effective to install a specially designed enclosure for large equipment so that the hood can be used for its intended purpose. A fume hood should not be used for chemical or other miscellaneous storage, this also restricts airflow. Chemicals should be stored in a sealed (following NFPA 45 requirements) chemical storage cabinet. All freestanding cabinets should have bungs in place and the doors should close properly.

The Wyss Institute EH&S Office oversees the fume hood program. Before you begin using a fume hood, check to see that the hood is labeled appropriately if being used for work with particularly hazardous chemicals and that it has been certified within the last

year. If a fume hood requires certification or if you have questions regarding fume hood operation, contact the Wyss Institute EH&S Office.

Some of the basic guidelines for working safely in a chemical fume hood include the following:

- Work at least six inches behind the sash.
- If it is necessary to store materials in a fume hood, they should be elevated so that air can pass under them.
- Never put your head (or face) inside an operating fume hood to check on an experiment.
- Work with the sash in the lowest position possible. The sash will act as a barrier and provide containment should a problem arise with the reaction.
- Do not clutter the hood with bottles or equipment. Only materials actively in use should be in the fume hood.
- Clean the grille along the bottom slot of the back of the hood regularly so it does not become clogged with paper and dirt.
- Do not dismantle or modify the physical structure of the hood or exhaust system in any way without first consulting the Wyss Institute EH&S Office.
- Report any suspected hood malfunctions to the Wyss Institute EH&S Office.

If a person decides to use a ventilating engineering control besides a chemical fume hood, then (s)he needs to notify the Wyss Institute EH&S Office prior to purchasing or installing the equipment.

3.11 HOUSEKEEPING

It is essential for both safety and efficiency that the facilities be kept neat and orderly. Floors, shelves, and benches should be free from dirt and unnecessary apparatus and tools. Equipment should never obstruct exits, passages, or fire extinguishers, etc.

Care should be exercised when disposing of materials. Flammable or toxic materials should be collected for disposal as hazardous waste and, therefore, should not be placed in the regular waste stream.

General guidelines for good housekeeping include the following:

- Never block access to emergency equipment, showers, eyewashes, and exits.
- Label all chemical containers with the identity of the contents and list the appropriate hazards.
- All work areas should be kept clear of clutter.
- All aisles, hallways, and stairs must be kept clear.
- All chemicals should be returned to their proper storage area at the end of the day.
- Liquid wastes should be kept in spill-proof containers and stored off the floor in an appropriate storage area.
- ALWAYS BE PREPARED FOR SPILLS. Small spills should be cleaned up promptly using the spill kits located in the hallways. All clean up materials must be collected for disposal as hazardous waste.

3.12 SIGNS AND LABELS AND MATERIAL SAFETY DATA SHEETS

3.12.1 Emergency Signage

The Boston Fire Department (BFD) requires that each laboratory have appropriate signage to indicate the level of the hazard with respect to the chemicals stored in the laboratory. This signage takes the form of a diamond (NFPA 704 diamond), which is comprised of four smaller diamonds. Each smaller diamond is color-coded to represent a specific hazard classification: blue for health hazards, red for flammability hazards, yellow for reactivity hazards, and white for special classes of hazards. For more information on NFPA diamonds, refer to Appendix A.

Each small diamond contains a number from 0 to 4. A hazard level of 0 on the NFPA diamond represents no hazard while a hazard level of 4 on the NFPA diamond represents the highest hazard in that category. Fires and other emergencies may be dealt with more effectively and safely if the BFD is informed of the level of hazards in a specific area. The names and emergency phone numbers of the current Institute Administrator or PI responsible for each laboratory area, including shared spaces, should also be posted. Laboratories are responsible for keeping their contact information current.

Signs are reviewed annually by the Wyss Institute EH&S Office and are based upon the chemical inventories received from the laboratories. It is extremely important that contact names and chemicals are kept current. The BFD may choose not to enter a laboratory if the information provided appears to be out-of-date.

3.12.2 Other Signs

- Radioactive or biohazardous substances used in laboratories require the posting of special signs.
- *Eye Protection Required* signs are recommended at entrances to laboratories using acids and corrosive chemicals. Safety glasses for visitors must be provided.
- Signs indicating the location of fire blankets, eyewash units, safety showers, fire extinguishers, and other safety devices are required.
- Entrances to laboratories, storage areas, and associated facilities must have signs as necessary to warn emergency personnel and custodians of unusual or severe hazards.[7]

3.12.3 Chemical Container Labeling

All containers must be labeled with the chemical contents. The labels must be in English and have no abbreviations on them. Chemicals received from outside vendors or from internal stockrooms must have labels indicating the name, along with other physical and chemical data. Toxicity warning signs or symbols should be prominently visible on the labels.

All chemical containers that have been decanted from an original container must be labeled with the chemical name, the primary hazard(s), the name of the responsible person, their PI, and the date. The Wyss Institute EH&S Office can be contacted for further information regarding labels for this purpose.

[7] Examples of severe or unusual hazards that may require signs are unstable chemicals, toxic or carcinogenic materials, water reactive chemicals, and radioactive materials.

All chemical waste containers must be labeled with the words *Hazardous Waste*, the full chemical name(s), the type of hazard (i.e., toxic, ignitable, corrosive, or reactive), the responsible person, and the date the container became full. Labels are available from the Wyss Institute EH&S Office. Labeling must be provided for chemicals synthesized in the laboratory or prepared by other processes, such as distillation or extraction. For information about obtaining hazard labels, please contact the Wyss Institute EH&S Office.

Chemicals developed in the laboratory must be assumed to be toxic if no data on toxicity are available. Suitable handling procedures must be prepared and implemented, including training of users in controls necessary to handle a material safely. If the substance is produced for another user outside of the laboratory, a MSDS and labels must be prepared and provided to such users in accordance with the OSHA *Hazard Communication* standard 29 CFR 1910.1200.

For information on the labeling of biohazardous materials, as required by the OSHA *Bloodborne Pathogen* standard 29 CFR 1910.1030, refer to Appendix G.

3.12.4 Material Safety Data Sheets

MSDSs are bulletins prepared by manufacturers to summarize the health and safety information associated with their products. The manufacturer or supplier should provide MSDSs for each chemical. A file of MSDSs should be maintained in the laboratory and must be accessible to any staff member or visiting professional. MSDSs may also be obtained online from manufacturer's websites, searchable MSDS database websites such as http://hazard.com/msds, the Wyss Institute website, or the Wyss Institute EH&S Office website.

The following information is required by OSHA to be included in all MSDSs:

- Product identity
- Reactivity hazards
- Hazardous ingredients
- Spill clean-up
- Physical/chemical properties

- Protective equipment
- Fire and explosion hazards
- Special precautions
- Health hazards

A user's guide to MSDSs can be found in Appendix H. Consult with the Wyss Institute EH&S Office to apply this general information to your work situation.

3.13 MONITORING AND EMPLOYEE ASSESSMENT

The Wyss Institute EH&S Office will perform exposure monitoring, when appropriate, in accordance with Paragraph (d) of OSHA 29 CFR 1910.1450. Other qualified consulting service providers may be employed by the Wyss Institute EH&S Office to conduct such monitoring. All monitoring results will be kept on file in the Wyss Institute EH&S Office. A report summarizing the results of the exposure monitoring will be provided to the EH&S contact for the laboratory and made available to the person who participated in the exposure monitoring.

3.13.1 Staff Exposure Determination

- **Initial monitoring** will be performed if there is reason to believe that those exposure levels for a substance could routinely exceed the action level (or PEL in the absence of an action level).

- **Periodic monitoring** will be performed **if** the initial monitoring performed discloses employee exposure over the action level (or PEL in the absence of an action level). The employee's institution shall immediately comply with the exposure monitoring provisions of the relevant standard.

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

- Within 15 working days after the receipt of any monitoring results, the employees will be notified in writing of these results either individually or by posting the results in an appropriate location accessible to employees.

Anyone with a reason to believe that exposure levels for a substance routinely exceed the action level, or PEL in the absence of an action level, may request that the Wyss Institute EH&S Office initiate the monitoring process.

It will be the responsibility of the CHO to ensure that periodic monitoring requirements are satisfied, when necessary.

The EH&S Office and the CHO will maintain records in accordance with the record-keeping requirements of OSHA 29 CFR 1910.1450.

Individual hospitals shall establish and maintain, for each employee, an accurate record of any measurements taken to monitor employee exposures and any medical consultation and/or examinations including tests or written opinions required by this standard. The individual hospitals shall ensure that such records are kept, transferred, and made available in accordance with OSHA 29 CFR 1910.20.

Records from monitoring done by other qualified services must be maintained by the CHO and the Wyss Institute EH&S Office.

3.14 WASTE DISPOSAL

Every effort should be made to dispose of hazardous waste in a proper, safe, and efficient manner. It is the responsibility of the individual creating the waste to properly identify and handle waste chemicals within the Wyss Institute facility.

The Wyss Institute EH&S Office maintains a “Main Accumulation Area” for the storage of chemical hazardous wastes transported from the laboratories.

The Wyss Institute EH&S Office maintains Satellite Accumulation Areas (SAAs) in the laboratories for the storage of chemical hazardous waste. Contact the Wyss Institute EH&S Office for information regarding the establishment of an SAA. The following guidelines must be followed at all SAAs.

- Once a waste container has been filled in the laboratory, it must be transported to the main accumulation area within three days.

- Waste chemicals stored in containers of one gallon or larger sizes shall be **break-resistant** whenever possible.

- Waste chemicals stored in breakable containers of one gallon or larger sizes shall be kept in **approved secondary containers**.
  - Break-resistant shall mean a container made of metal, plastic, plastic-coated glass or metal overpacks of glass.
  - An approved secondary container is a bottle carrier made of rubber, metal, or plastic with carrying handle(s) which is of large enough volume to hold the contents of the chemical container. Rubber or plastic should be used for acids/alkalines, and metal, rubber, or plastic for organic solvents.

- Wastes must be packaged and placed in containers in a manner that will allow them to be transported without the danger of spillage, explosion, or hazardous vapors escaping. Wastes that have not been properly packaged and identified will not be accepted for disposal.

3.14.1 Unknown Waste Chemicals

Every effort should be made by the Institute Administrator or PI to identify unknown waste. It is the responsibility of the Institute to identify all chemicals. The Institute Administrator or PI may need to question laboratory personnel, students, and volunteers, or send a sample to an analytical laboratory, to ascertain the contents of unknown wastes. All charges associated with the identification of an unknown waste will be paid by the laboratory/institution. Laboratory personnel must be constantly reminded to identify and label all wastes and project products. If unknown waste has been discovered and cannot be identified, immediately contact the Wyss Institute EH&S Office.

NOTE: Never mark a container "UNKNOWN".
Label unknown waste streams with the words "Pending Analysis," and immediately alert the EH&S Office.

3.14.2 Transportation

All hazardous waste will be collected from the laboratories and transported to the Main Accumulation Area by a representative of the Wyss Institute EH&S office.

3.14.3 Guidelines for Waste Reduction/Management

Procedures for waste disposal should be prepared **before** beginning a project. Waste must be labeled properly. Each Wyss Institute platform, group, or researcher must properly identify waste materials prior to disposal; inadvertent mixing of incompatible materials could have serious consequences.

Waste minimization is very important to protect the environment and also to reduce the disposal costs charged to the laboratory. The following suggestions should be considered in an effort to minimize the amount of waste generated by the laboratory.

- Order only and store the amount of material needed for the project or experiment. The BFD has severe restrictions on flammable liquid storage in laboratories.
- Use only the amount of material that is needed for conclusive results.
- Date containers upon receipt and again upon initial opening.
- Before disposing of unwanted, unopened, or uncontaminated chemicals, check with others at the Wyss Institute who may be able to use them.
- On termination of a research project, all unused chemicals to be kept by the laboratory shall be labeled and dated. All chemicals for disposal must be in proper containers and labeled with the words *Hazardous Waste*, the chemical name, type of hazard (toxic, ignitable, corrosive, or reactive), and the date.

3.14.4 Types of Chemicals and their Disposal

Regulations prohibit the discharge of most organic solvents into the sewer system. Small amounts of water-soluble, non-flammable materials may be discharged down the drain. The Wyss Institute EH&S Office must be consulted to determine which chemicals can be disposed in this manner.

Chemical Class	Disposal
Organic solvents	✓ Paced in suitable containers that prevent vapors or liquids from escaping. ✓ Tightly cap ✓ Prominently label containers ✓ Disposed as hazardous waste
Mixtures of organic solvents	✓ If compatible they can be combined in one container ✓ Container must have estimated percentages of each solvent in the mixture.
Ether (diethyl) in cans	✓ Do not move it over a year beyond the expiration date or beyond six months from the date of opening ✓ The EH&S Office must be contacted immediately.
Acids and alkaline solutions	✓ Concentrated acids and caustics must be treated as hazardous waste ✓ Store in tightly capped and labeled containers
Inorganic and organic solids	✓ If in original containers may be sent to the Wyss Institute hazardous waste room.
Mercury	✓ Contact the Wyss Institute EH&S Office to dispose of mercury containing equipment. ✓ Put broken mercury thermometers into a jar or secondary container. ✓ Clean-up materials from a mercury spill may be placed in a container, labeled, and sent to the hazardous waste accumulation area. ✓ Mercury-containing compounds must be disposed through the hazardous waste room.
Cyanide compounds, arsenic, lead, and heavy metal wastes	✓ Place in bottles or containers ✓ Seal tightly ✓ Label, and send to the hazardous waste accumulation area
Waste oil (e.g., vacuum pump oil or lubricating oils)	✓ Collect in one-gallon containers or less ✓ Dispose of as hazardous waste

The Wyss Institute EH&S Office may be consulted if there is any question concerning the toxicity or packaging of any toxic wastes.

3.14.5 Other Types of Wastes—Special Procedures Required

- **Gas cylinders** are to be returned to the proper vendor. Some small “lecture bottles” are of the non-returnable type and become a disposal problem when empty or near empty with a residual amount of gas. When ordering gases in lecture bottle size, be sure to order the gases in a returnable cylinder.

- **Controlled drugs** to be disposed of as waste **must not be sent to the waste accumulation area**. The handling, records, and disposal of controlled drugs are the responsibility of the Institute and must be conducted within Drug Enforcement Agency regulations.

- **Biological waste and physically dangerous waste (sharps) must be placed in proper containers.** Contact the Wyss Institute EH&S Office for proper disposal procedures.

3.15 MEDICAL SURVEILLANCE

Medical consultations/examinations are coordinated for Wyss Institute staff through the employee's institutional Occupational/Employee Health Services and the EH&S Office under the following circumstances:

- Whenever a staff member develops signs or symptoms potentially associated with a hazardous chemical to which the staff member may have been exposed in the laboratory.

- Where exposure monitoring reveals an exposure level routinely above OSHA's action level or permissible exposure limit for an OSHA-regulated substance requiring such medical monitoring and medical surveillance.

- Whenever an event occurs, such as a chemical spill, leak, or explosion that results in the likelihood of a hazardous exposure. First aid issues are handled by the Employee's Occupational/Employee Health Services during business hours or through the Emergency Room during off-hours.

- Whenever a staff member is exposed to blood or visibly bloody fluids by a needle-stick, open cut, or splash to the face.

3.16 EXPOSURE REPORTING

Staff who believe they have had an exposure should contact the CHO or the Wyss Institute EH&S Office for evaluation.

If employees exhibit adverse health effects, they should report immediately to the Emergency Room of the closest hospital. The Wyss Institute EH&S Office will evaluate the situation and conduct air sampling, if necessary, to determine actual exposures. The results of all hazard evaluations and any air sampling data will be available to all

occupants of the affected areas. The CHO or the Wyss Institute EH&S Office can be contacted directly for information. In addition, the results of any personal air sampling will be given to the individual and kept on file in the Wyss Institute EH&S Office.

3.17 EMERGENCY SITUATIONS

Emergencies that may occur in a laboratory include fire, explosion, chemical spill or release, or medical or other health threatening accidents. General procedures to be followed in any emergency are found in the Emergency Action Plan.

3.18 EMERGENCY EQUIPMENT

In any emergency, it is critical that all staff members are familiar with the use and location of emergency equipment. These include fire extinguishers, fire alarms, safety showers, and eyewash stations.

All emergency equipment is on a preventive maintenance schedule. Fire alarms are tested periodically and extinguishers are inspected monthly by the building management entity. Safety showers on a quarterly basis and eyewash stations on a monthly basis are tested by the Wyss Institute EH&S Office.

3.19 OVERSIGHT, ANNUAL REVIEW, RECORDKEEPING, COMPLIANCE, AND ENFORCEMENT

The **Wyss Institute EH&S Office** is responsible for establishing and maintaining records for employee training, employee and environmental monitoring, and quantity of chemicals stored in the workplace. In practice, the CHO may assist with this work.

The **Principal Investigator and Institute Administrator** enforce the CHP by making sure that the chemical hygiene rules are known and followed. The CHO advises and assists in this work and helps with documentation.

The **Chemical Hygiene Officer** will assist with chemical hygiene and housekeeping inspections. When there are significant changes in existing policies or work practices, an inspection will be conducted soon after the new process is implemented.

The **Wyss Institute EH&S Office** assists the CHO in the inspection process and in all related matters.

The **Chemical Hygiene Officer** annually reviews and updates the CHP.

4.0 INSTITUTE PLATFORM STANDARD OPERATING PROCEDURES

Each Institute Platform inserts their individual Standard Operating Procedures in this section, if applicable.

APPENDIX A

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) SIGNAGE

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) LABELING SYSTEM

Signage based on the NFPA labeling system has been posted at the entrances to all laboratories and laboratory related facilities at Peptimmune. Also, many chemical manufacturers include the NFPA rating system in the labeling of chemical containers. The following is an example of the NFPA labeling system.

FIRE HAZARD (RED)

0—will not burn

1—will ignite if preheated

2—will ignite if moderately heated

3—will ignite at most ambient conditions

4—burns readily at ambient conditions

HEALTH HAZARD (BLUE)

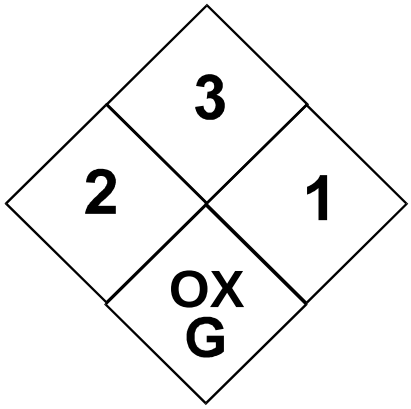
0—no more than ordinary combustibles in a fire

1—slightly hazardous

2—hazardous

3—extreme danger

4—deadly



REACTIVITY (YELLOW)

0—stable and not reactive with water

1—unstable if heated

2—violent chemical change

3—shock and heat may detonate

4—may detonate

SPECIFIC HAZARD

OX—oxidizer

ACID—acid

ALK—alkali

COR—corrosive

~~W~~ —use no water

G—gas cylinder

LN2—liquid nitrogen

APPENDIX B

LIST OF CARCINOGENS, TERATOGENS, EXTRAORDINARILY HAZARDOUS SUBSTANCES IN THE WYSS INSTITUTE CHEMICAL INVENTORY

LIST OF CARCINOGENS, TERATOGENS, EXTRAORDINARILY HAZARDOUS SUBSTANCES IN THE WYSS INSTITUTE CHEMICAL INVENTORY

LIST OF CARCINOGENS, TERATOGENS, EXTRAORDINARILY HAZARDOUS SUBSTANCES

Chemical Name	CAS #	Alternate Name	OSHA	IARC	NTP
Acrylic acid	000079-10-7	Acrylic acid		3	
Benzidine	000092-87-5	Benzidine	X	1	1
Cadmium chloride	010108-64-2	Cadmium chloride			1
Cadmium compounds	007440-43-9	Cadmium compounds		1	1
Chloramphenicol	000056-75-7	Chloramphenicol		2A	
Chloroform	000067-66-3	Chloroform		2B	2
Cholesterol	000057-88-5	Cholesterol		3	
1,4-Dioxane	000123-91-1	Dioxane		2B	2
Hydrochloric acid	007647-01-0	Hydrochloric acid		3	
Mineral oil	008012-95-1	Mineral oil			1
Orange G	001936-15-8	Orange G		3	
Phenol	000108-95-2	Phenol		3	
Polyvinyl pyrrolidone	009003-39-8	Polyvinyl pyrrolidone		3	
Pyridine	000110-86-1	Pyridine		3	
Rhodamine B	000081-88-9	Rhodamine B		3	
Toluene	000108-88-3	Toluene		3	
Trichloroacetic acid	000076-03-9	Trichloroacetic acid		3	
Trypan blue	000072-57-1	Trypan blue		2B	

OSHA U.S. Occupational Safety and Health Administration

IARC International Agency for Research on Cancer

NTP National Toxicology Program, U.S. Department of Health and Human Services

APPENDIX C

CHEMICAL INFORMATION RESOURCES

CHEMICAL INFORMATION RESOURCES

Laboratory workers requiring health and safety information regarding substances they plan to use or are using, may obtain this information from the following sources:

- Container label
- Wyss Institute for Biologically Inspired Engineering EH&S Office, Department Administrator or Principal Investigator
- Material Safety Data Sheet (obtained from the chemical manufacturer)
- Manufacturer's technical service department
- American Chemical Society (516) 877-4138
  Chemical Health and Safety Division
  Chemistry Department
  Adelphi University
  Garden City, NY 11570
- American Petroleum Institute (202) 682-8000
  1220 L Street, NW
  Washington, DC 20005
- Chemical Manufacturers Association (703) 741-5000
  1300 Wilson Blvd.
  Arlington, VA 22209
- Compressed Gas Association, Inc. (703) 412-0900
  1725 Jefferson Davis Highway, Suite 1004
  Arlington, VA 22202-4102
- U.S. Department of Labor
  Occupational Safety and Health Administration (OSHA) (202) 219-7075
  Health Standards
  Attention: Adam Finkel, Director
  Room N3718
  200 Constitution Avenue, NW
  Washington, DC 20210
- Region l OSHA Department (617) 565-7164
  133 Portland Street, First Floor
  Boston, MA 02114
- Massachusetts Department of Labor and Industries
  1001 Watertown Street, Second Floor
  West Newton, MA 02165
  Division of Occupational Hygiene (617) 969-7178
  Right-To-Know Law Coordinator (617) 727-3982

- Massachusetts Department of Public Health
  Bureau of Environmental Health Assessment (617) 624-5757
  250 Washington Street, Seventh Floor
  Boston, MA 02108

- Massachusetts Department of Environmental Protection (617) 292-5568
  One Winter Street
  Boston, MA 02108
  Regional Department (617) 932-7600
  10 Commerce Way
  Woburn, MA 01801

The Wyss Institute EH&S Office is available to all staff.

APPENDIX D

EFFECTIVE USE OF GLOVES

EFFECTIVE USE OF GLOVES

REASONS FOR WEARING GLOVES

The hands are the part of the body most likely to come into contact with chemicals. Skin contact can result in dermatitis that is caused by a chemical or allergic irritation of the skin. In addition, some chemicals penetrate the skin and can cause illness in other parts of the body. Wearing gloves protects workers from skin irritation and other effects of chemical exposure.

CHOOSING THE RIGHT GLOVES

Material safety data sheets detail appropriate gloves for use with each chemical. In addition, chemical compatibility charts for specific glove materials can be obtained from the glove manufacturer. The chart at the end of this appendix is an example of a compatibility chart. In addition, the National Institute for Occupational Safety and Health (NIOSH) offers the following database for chemical compatibility with various materials:
http://www.cdc.gov/niosh/ncpc/ncpc2.html
Choosing the proper gloves includes selecting the right thickness, heavy gloves for more protection and light gloves for delicate work.

EFFECTIVE USE OF GLOVES

Improper removal of gloves can be a source of contamination. The procedure, which works for thin gloves that may have to be changed often, is as follows.

1. Using the fingers of one gloved hand, pinch the material of the other glove at the base of the palm and peel off the glove.
2. Continue to hold the glove.
3. With the ungloved hand, reach about an inch under the other glove on the palm side of the wrist, pinch, and peel off the other glove.
4. Both gloves have now been removed without skin contact and the contaminated sides of the gloves are facing in.
5. Gloves used with highly toxic materials should be disposed as hazardous waste before leaving the work area.

Studies have shown that up to 5% of new gloves have holes in them. Substances leaking through gloves are held in contact with skin, increasing absorption into the body. Gloves that have been improperly selected or have holes in them can sometimes be worse than no gloves at all. Gloves used for dangerous chemicals can be tested for leaks by filling them with air and immersing them in water. This should not be done with PVA laminated gloves, since they may not be water-resistant. If certain types of gloves consistently leak, the manufacturer should be notified.

CHEMICAL RESISTANCE CHART

The degree of protection required on a given job is known only by you. This chemical resistance or permeation chart developed by our laboratory or from data published by manufacturers of resins, rubber or polymers can only serve as a guide.

Degradation or permeation will occur at some time depending on the degree of exposure. You must determine this by testing. That is why we offer our Performance Rated Order (PRO) Program. Ask your distributor for complete details.

CHEMICAL	NITRILE	NATURAL RUBBER	PVC	NEOPRENE
Acetaldehyde	F	F	F	E
Acetic Acid	G	G	G	E
Acetone	P	G	P	G
Acrylonitrile	P	F	P	P
Aluminum Chloride	E	E	E	E
Ammonium Fluoride 40%	E	E	E	E
Ammonium Hydroxide	F	G	E	E
Amyl Acetate	P	F	P	NR
Amyl Alcohol	G	G	–	E
Aniline	P	P	G	G
Animal Fats	E	P	G	E
Aqua Regia	F	G	G	G
Battery Acid	S	G	E	E
Benzaldehyde	P	F	F	NR
Benzene	F	P	P	NR
Benzyl Alcohol	P	P	–	E
Benzyl Chloride	P	P	–	P
Butane	E	P	P	E
Butyl Acetate	P	P	P	NR
Butyl Alcohol	E	E	G	E
Butyl Cellosolve*	E	E	–	E
Butyraldehyde	P	P	G	–
Calcium Hypochlorite	G	G	–	F
Carbolic Acid	P	P	–	F
Carbon Disulfide	G	NR	NR	NR
Carbon Tetrachloride	G	P	P	NR
Castor Oil	E	E	F	E
Cellosolve* Acetate	F	G	–	F
Cellosolve* Solvent	G	E	–	E
Chlorine (dry)	P	P	–	F
Chlorine (wet)	F	F	–	NR
Chloroacetone	P	P	–	G
Chlorobenzene	P	P	P	NR
Chloroform	P	P	P	NR
Chloromethylene	P	NR	NR	NR
Chlorothene* VG	F	NR	P	NR
Chromic Acid	P	P	G	NR
Citric Acid	E	E	E	E
Cottonseed Oil	E	P	G	G
Creosote	G	P	G	F
Cutting Oil	E	F	F	E
Cyclohexane	E	P	F	NR
Cyclohexanol	G	P	F	E
Diacetone Alcohol	P	P	P	G
Dibenzyl	P	P	–	NR
Dibutyl Phthalate	P	P	–	F
Diethylamine	F	F	F	P
Di-Isobutyl Ketone	P	G	P	P
Di-Isocyanate	G	P	F	P
Dimethyl Formamide	F	P	P	G
Dimethyl Sulfoxide, DMSO	E	E	F	E
Dioxane	P	P	P	NR
Dyestuff	S	E	E	E
Electroless Copper (MacDermid 9048)	E	E	E	E

Select the coating with the highest rating in the Physical Properties Chart on the right, then check the Chemical Resistance Charts below.

Key to chart:

E	Excellent
G	Good
F	Fair
P	Poor
Blank (–)	Insufficient data
NR	Not recommended

CHEMICAL	NITRILE	NATURAL RUBBER	PVC	NEOPRENE
Electroless Nickel (MacDermid V60/61)	E	E	E	E
Epoxy Resins	E	E	E	E
Ethyl Acetate	P	P	P	E
Ethyl Alcohol	E	E	G	E
Ethyl Ether	F	P	P	E
Ethyl Formate	P	P	P	G
Ethylene Dichloride	P	P	P	NR
Ethylene Glycol	E	E	E	E
Ethylene Trichloride	P	P	–	NR
Fluorine	F	F	–	NR
Formaldehyde	F	F	G	E
Formic Acid 90%	F	E	E	E
Freon TF	E	NR	NR	G
Furfural	P	P	P	G
Gasoline	E	P	P	NR
Glycerin	E	E	F	E
Hexane	E	P	F	E
Hydraulic Fluid-Petroleum Base	E	P	G	G
Hydraulic Fluid-Ester Base	P	P	P	NR
Hydrazine 65%	E	G	E	E
Hydrobromic Acid	P	E	–	–
Hydrochloric Acid 38%	G	G	G	E
Hydrochloric Acid 10%	E	E	E	E
Hydrofluoric Acid 48%	F	F	F	E
Hydrogen Peroxide 30%	F	F	F	E
Hydroquinone	F	G	F	E
Insecticides	S	E	E	E
Isobutyl Alcohol	G	E	G	E
Iso-Octane	E	P	P	E
Isopropyl Alcohol	G	E	G	E
Kerosene	E	P	F	E
Lacquer Thinner	G	NR	F	F
Lactic Acid	E	E	G	E
Lard	E	P	–	F
Lauric Acid 36%/EtOH	E	G	F	E
Linoleic Acid	E	P	G	E
Linseed Oil	E	P	F	E
Lubricating Oils (Petroleum)	E	P	–	G
Maleic Acid	P	P	G	E
Methyl Acetate	P	P	–	G
Methyl Alcohol	E	E	E	E
Methyl Bromide	G	F	P	NR
Methyl Cellosolve	F	P	–	E
Methylene Chloride	P	P	P	NR
Methyl Ethyl Ketone (M.E.K.)	P	G	P	P
Methyl Formate	P	P	–	NR
Methyl Isobutyl Ketone	P	F	F	NR
Methylamine	F	F	F	E
Methyl Methacrylate	P	P	F	NR
Mineral Oil	E	P	F	G
Mineral Spirits, Rule 66	E	NR	F	G
Monoethanolamine	P	G	G	E
Morpholine	P	F	G	P
Muriatic Acid	G	G	G	G

PHYSICAL PROPERTIES	NITRILE	NATURAL RUBBER	PVC	NEOPRENE
Abrasion Resistance	E	G	G	G
Cut Resistance	E	E	P	E
Puncture (snag) Resistance	E	E	G	E
Flexibility	E	E	G	G
Heat Resistance	G	F	P	G
Ozone Resistance	F	P	E	E
Tensile Strength	E	E	F	E
Dry Grip	E	E	E	E
Wet Grip	G	E	E	F

NOTE: Products in these categories vary in capabilities. Laboratory tests are necessary for specific recommendations.

CHEMICAL	NITRILE	NATURAL RUBBER	PVC	NEOPRENE
Naptha	E	P	P	G
Nitric Acid – Concentrated 70%	P	P	F	G
Nitric Acid – Diluted 10%	F	F	G	E
Nitric Acid – Red Fuming	P	P	P	NR
Nitric Acid – White Fuming	NR	NR	P	NR
Nitrobenzene	F	P	P	NR
Nitromethane	P	G	P	G
Nitropropane 95.5%	NR	E	NR	G
Octyl Alcohol	G	G	F	E
Oleic Acid	F	P	F	E
Olive Oil	E	P	F	G
Oxalic Acid	G	G	G	E
PCB's	F	P	P	–
Paint Remover	G	F	P	F
Palmitic Acid Saturated	G	G	G	E
Pentane	E	P	NR	E
Perchloric Acid 60%	P	P	P	E
Perchloroethylene	F	P	P	NR
Peuta	E	F	E	G
Phenol	P	P	G	E
Phosphoric Acid	G	G	P	E
Pickling Solution	P	P	G	F
Picric Acid	G	G	G	E
Pine Oil	G	P	F	P
Plating Solutions – Chrome	E	G	E	–
Potassium Hydroxide 50%	G	G	E	E
Printing Ink	E	G	F	E
Propane	E	P	F	E
Propyl Acetate	P	P	F	P
Propyl Alcohol	E	E	G	E
Propylene Oxide	P	P	–	NR
Rubber Solvent	E	NR	NR	G
Silicon Etch	NR	NR	F	G
Skydrol 500	P	P	P	NR
Sodium Hydroxide 50%	G	E	E	E
Sodium Hypochlorite	G	G	–	G
Soybean Oil	E	P	–	E
Stearic Acid	G	G	G	G
Stoddard Solvent	E	P	F	E
Styrene	P	P	P	NR
Sulfuric Acid (diluted)	G	G	G	G
Sulfuric Acid (conc.) 95%	P	P	F	F
Tannic Acid 65%	E	E	E	E
Tetrahydrofuran	P	P	P	NR
Toluene	F	P	P	NR
Toluene Di-Isocyanate	P	P	P	NR
Trichlorethylene	F	P	P	NR
Triethanol Amine	F	G	G	E
Trinitrotoluene	P	P	F	G
Tung Oil	E	P	F	E
Turbine Oil	G	P	P	G
Turpentine	E	P	F	NR
Vegetable Oil	E	P	F	E
Vinyl Chloride	–	–	–	NR
Xylene	F	P	P	NR

Chlorothene® is a registered trademark of the Dow Chemical Corp.

Cellosolve® is a registered trademark of the Union Carbide Corp.

APPENDIX E

CHEMICAL STORAGE GUIDELINES

CHEMICAL STORAGE GUIDELINES

The following information is designed to aid in proper chemical storage in the Wyss Institute for Biologically Inspired Engineering (Wyss Institute) laboratories. Chemicals are to be stored according to the following hazard classes. Storing all classes together alphabetically is prohibited. Chemicals may be organized alphabetically once they are segregated according to hazard class.

Oxidizers: Incompatible with **flammables** and organics.
Common Oxidizers—Ammonium persulfate, silver nitrate, silver nitrite, hydrogen peroxide, potassium permanganate, sodium dichromate.

Toxic: Poisons
Common Toxics—Arsenic compounds, cyanides, osmium tetroxide, formaldehyde, formalin, naphthalene, chloroform, acrylamide.

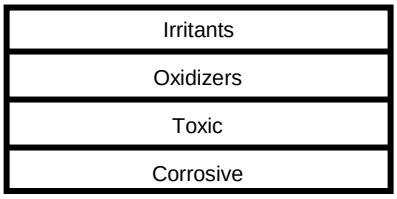
Flammables: Incompatible with **oxidizers**. Ignitable/flammable chemicals must be stored in a **flammable cabinet**. Flammable chemicals requiring refrigeration must be stored in a refrigerator rated for flammable storage.
Common Flammables—Ethanol, methanol, acetone, benzene, ethyl acetate, butanol, alcohols, furans, toluene, Sigmacote, TEMED, paraformaldehyde (flammable solid)

Corrosive: Three kinds of Corrosives: **Bases, Organic Acids, and Inorganic Acids.** All 3 of these corrosives have this pictogram; however, must be separated from each other.
Common Bases—sodium hydroxide, potassium hydroxide, developer.
Common Organic Acids—acetic acid, glacial acetic acid, phenol, formic acid.
Common Inorganic Acids—sulfuric acid, hydrochloric acid, perchloric acid, nitric acid, chromic acid.

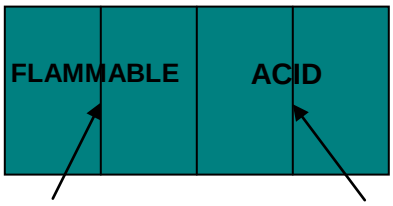
Irritants: chemicals producing irritation. Often, the majority of chemicals in a dry chemical storage area in Wyss Institute laboratories.

Common Irritants—Sodium carbonate, sodium bicarbonate, Trizma, putrescine, antifoam.

Chemical Storage Shelving



Chemical Fume Hood



Flammable

Corrosive Storage: Segregate inorganic acids, organic acids, and bases.

APPENDIX F

LIST OF UNSTABLE CHEMICALS

LIST OF UNSTABLE CHEMICALS

Chemical	DOT Class	Reason for D003	Comments
Acetone Cyanohydrin	6.1	4	Reacts with water to form toxic gas
Acetyl Chloride	3	2, 4	Reacts violently with water or alcohol, flammable
Acetyl Bromide	8	2, 4	Reacts violently with water or alcohol
Acrolein (uninhibited)	6.1	1	Polymerizes readily, dangerous fire risk
Allyl Chloroformate	6.1, 3, 8	4	Reacts with water to form toxic gas
Allyl Trichlorosilane	3	4	Reacts with water to form toxic gas
Aluminum (powder)	4.3	2	Reacts with water
Aluminum Alkyl (Triethylaluminum)	4.2, 4.3	1, 2	Powder or dust will ignite spontaneously. Reacts with water
Aluminum Borohydride	4.2, 4,3	1, 2	Powder or dust will ignite spontaneously. Reacts with water
Aluminum Bromide	8	2	Reacts with water
Aluminum Calcium Hydride	4.3	1, 2	Flammable in contact with water alcohols; spontaneous ignition in moist air.
Aluminum Carbide	4.3	1, 2	Dangerous fire risk in contact with water; off gas is methane
Aluminum Chloride	8	4	Reacts with water to form toxic gas
Aluminum ferrosilicon powder	4.3, 6.1	2	Reacts violently with water
Aluminum Hydride	4.3	2	Reacts violently with water
Aluminum Iodide	4.3	2	Reacts violently with water
Aluminum Phosphide	4.3, 6.1	4	Reacts with water to form toxic gas
Aluminum Silicon (powder)	4.3	2	Reacts with water
Aluminum Sulfide	4.3	4, 5	Decomposes in moist air to hydrogen sulfide.
Ammonium Bisulfide (ammonium sulfide)	8, 6.1, 3	5	Forms toxic fumes with pH of between 2-12.5
Anisoyl Chloride	8	4	Reacts with water to form toxic gas
Antimony Pentachloride	8	1	Fumes in moist air, reacts strongly with organics
Antimony Pentafluoride	8, 6.1	2, 3	Reacts with water, forms potentially explosive mixtures with water
Antimony Tribromide	6.1	4	Reacts with water to form toxic gas
Arsenic Trichloride		4	Fumes in moist air
Arsenic Trifluoride	6.1	4	Fumes in moist air
Barium Hydride	4.3	4	Reacts with water to form hydrogen gas
Barium Powder	4.3	2	Reacts violently with water
Barium Sulfide	4.2, 8	4	Reacts with water to form toxic gas
Benzene Sulfonyl Chloride	8	4	Reacts with water to form toxic gas
Benzotrichloride	8	4	Reacts with water to form toxic gas
Benzoyl Bromide	8	4	Reacts with water to form toxic gas
Benzoyi Chloride	6.1, 8	4.	Reacts with water to form toxic gas
Benzoyl Fluoride	8	4	Reacts with water to form toxic gas
Benzoyl Iodide	8	4	Reacts with water to form toxic gas
Benzyl Chloride	6.1	4	Generates toxic gasses in water
Benzyl Chloroformate	8	4	Heat forms phosgene gas·
Boron Phosphide	4.3	4	Evolves toxic fumes with water, ignites at 390F
Boron Powder	4.2	1	Ignites in air, reacts with metals, explodes with hydrogen iodide
Boron Tribromide	8, 6.1	4	May explode when heated, forming liquid
Boron Trichloride	2.3, 8	4	Fumes are corrosive and toxic
Boron Triflouride	8, 3	2, 4	Very reactive, decomposes violently with water

Chemical	DOT Class	Reason for D003	Comments
Boron Trifluoride Dimethyl Etherate	4.3, 8, 3	2	Reacts violently with water
Bromoacetvl Bromide	8	4	Reacts with water to form toxic gas
Bromobenzene Sulfonyl Chloride	8	4	Reacts with water to form toxic gas
Bromotrimethyl Silane	3, 8	4	Reacts with water to form toxic gas
Butylithium	4.2	2	Ignites in moist air
Calcium Carbide	4.3		
Calcium Cyanamide	4.3	4, 2	Fire risk with moisture, generates ammonia when wet
Calcium Dithionite	4.2	1	Will ignite spontaneously
Calcium Hydride	4.3	2	Reacts with water
Calcium Magnanese Silicon	4.3	2	Reacts violently with water
Calcium Metal	4.3	2	Reacts with water
Calcium Phosphide	4.3, 6.1	2	Generates toxic fumes with water
Calcium Silicide	4.3	2	Reacts with water
Calcium Sulfide	4.3	4, 5	Decomposes in moist air to hydrogen sulfide
Carbon, Activated	4.2	1	Powder or dust will ignite spontaneously
Cerium Metal	4.3	2	Explosive when heated
Cesium Metal	4.3	2	Unstable, reacts with water, explosive when heated
Cesium Peroxide	5.1	2	Reacts with water, explosive when heated
Cesium Phosphide	4.3	2	Reacts with water, explosive when heated
Chlorine Triflouride	2.3, 5.1, 8		
Chlorophexyl Trichlorosilane	3, 8	4·	Reacts with water to form toxic gas
Chloromethyl Silane	3, 8	4	Reacts with water to form toxic gas
Chlorophenyl Trichlorosilane	3, 8	4	Reacts with water to form toxic gas
Chlorosulfonic Acid	8, 6.1		Reacts with water to form toxic gas
Chlorosulfuric Acid	8	4	Reacts with water to form toxic gas
Chlorotriethyl Silane	3, 8	4	Reacts with water to form toxic gas
Chlorotrimethyl Silane	3, 8	4	
Chromyl Chloride (Chromium oxychloride)	8	4	Reacts with water to form toxic gas
Copper Phosphide	1, 4	1	Spontaneously flammable, Reacts with water to from phosphine
Copra	4.2	1	Will ignite spontaneously
Cotton	4.2	1	Will ignite spontaneously
Cupric Sulfide	4.3	4, 5	Decomposes in moist air to hydrogen sulfide
Cyanogen Chloride	6.1	4, 5	Forms toxic fumes with pH of between 2-12.5 and with water
Cyclohexyl Trichlorosilane	3, 8	4	Reacts with water to form toxic gas
Dibutyl Aluminum Hydride	4.3		
Dichloro Phenyl Trichlorosilane	8	4	Reacts with water to form toxic gas
Dichloroacetyl Chloride	8	2, 4	Reactive
Dichlorodiethyl Sulfide			Vapor is extremely poisonous
Dichlorodimethyl Silane	3, 8	4	Reacts with water to form toxic gas
Diethyl Aluminum Chloride	4.3	1, 2	Reacts with water, explosive at room temperature
Diethyldichlorosilane	3, 8	4	Reacts with water to form toxic gas
Diethylzinc	4.2, 4.3	1, 2	Will ignite spontaneously and reacts with water
Diodoacetylene		6	Sensitive to impact, crushing, or heating
Disopropyl Fluorophosphate	6.1	4	Reacts with water to form toxic gas (HF)
Dimethyl, Diethoxysilane	3, 8	4	Reacts with water to form toxic gas
Dimethyl Dimethoxysilane	3, 8	4	Reacts with water to form toxic gas
Dimethyldichlorosilane	3, 8	4	Reacts with water to form toxic gas (HCl)
Dimethylzinc	4.2, 4.3	1, 2	Will ignite spontaneously and reacts with water

Chemical	DOT Class	Reason for D003	Comments
Diphenyldichlorosilane	3, 8	4	Generates toxic gas with water
Dodecyltrichlorosilane	8	4	Generates toxic gas with water
Ethyl Phosphonous Dichloride, Anhydrous	6.1, 4.2	1	Will ignite spontaneously
Ethyldichlorosilane	4.3, 8.3	2	Reacts violently with water
Ferrosilicon	4.3, 6.1	2, 4	Flammable and evolves gas with moisture
Ferrous Phosphide	4.3	4	Generates toxic gas with water
Fibers, or Fabrics of Animal or Vegetable, or Synthetic	4.2	1	Will ignite spontaneously
Fish Meal, Stabilized or Fish Scrap, Stabilized	4.2	1	Will ignite spontaneously
Fluorophosphoric Acid	8	2	Reacts with water
Fluosulfonic Acid	4.3	2, 4	Reacts violently with water
Gun Powder			
Hafinum Powder, dry	4.2	1	Powder or dust will ignite spontaneously
Hexadecyltrichlorosilane	4.3	2, 4	Reacts violently with water
Hexyltrichlorosilane	4.3	2, 4	Reacts violently with water and generates a toxic gas
Hydrazlne	8	4	Capable of detonating if heated
Hydrocyanic Acid, Hydrogen Cyanide	6.1, 3	1, 4	Will ignite spontaneously, reacts with water to form toxic gas
Hydroaen Sulfide	2.3, 2.1	2	Reacts with water
Hydroxylamine	3, 8	1	Will ignite spontaneously
Iodine Pentafluoride	5.1, 6.1, 8	2	Violently reacts with water
Iron (powder)			
Iron Oxide, Spent	4.2	1	Will ignite spontaneously
Isobutyl Chloroformate	3, 8	4	Reacts with water to form toxic gas
Isobutyryl Chloride	8	4	Reacts with water to form toxic gas
Isopropyl Magnesium Chloride	4.3	2	Violently reacts with Water
Lanthanum Powder	4.2	1, 2	Can detonate readily at room temperature
Lithium	4.3	1, 2	Powder or dust will ignite spontaneously. Reacts with water
Lithium Aluminum Deuteride	4.2	2	Reacts violently to water and evolves hydrogen gas
Lithium Aluminum Hydride	4.3	2	Reacts violently to water and evolves hydrogen gas
Lithium Aluminum Hydride Ethereal	4.3	2	Reacts with water
Lithium Amide	4.3	2	Reacts violently to water
Lithium Borohydride	4.3	2	Reacts violently to water
Lithium Ferrosilicon	4.3	2	Reacts violently to water
Lithium Hydride	4.3	2	Reacts violently to water
Lithium Methoxide	4.3	2, 4	Reacts violently to water
Lithium Nitride	4.3	2	Reacts violently to water
Lithium Silicon	4.3	2	Reacts violently to water
Magnesium Aluminum Phosphide	4.3, 6.1	2	Reacts violently with water
Magnesium Amide	4.2	1, 4	Normally unstable at room temp. without detonating. Mixed with water forms toxic gas
Magnesium Diamide	4.2	1	Will ignite spontaneously
Magnesium Diphenyl	4.2	1	Will ignite spontaneously
Magnesium Phosphide	4.3, 6.1	4	Reacts with water to form toxic gas (Phosphine)
Magnesium Powder	4.3	2	Reacts violently with water
Magnesium Silicide	4.3	2	Reacts violently with water
Methyl (Trimethoxy) Silane			
Maneb	4.3	2	Reacts violently with water

Chemical	DOT Class	Reason for D003	Comments
Methyl Aluminum Sesquibromide	4.3	1, 2	Powder or dust will ignite spontaneously. Reacts with water
Methyl Chlorosilane	3,8	4	Generates toxic gas with water
Methyl Dichlorosilane	4.3, 8.3	2	Reacts violently with water
Methyl Ethyl Ketone Peroxide	5.2		
Methyl Hydrazine			
Methyl Lithium	4.2	1, 2	Normally unstable, undergoes violent change without detonating, reacts violently with water
Methyl Magnesium Bromide	4.3	2	Reacts violently with water
Methyl Magnesium Chloride	4.3	2	Reacts violently with water
Methyl Magnesium Iodide	4.3	2	Violently reacts with water
Methyl Phenyl Dichlorosilane	3, 8	4	Reacts with water to form toxic gas
Methyl Phosphonous Dichloride	6.1, 4.2	1	Will ignite spontaneously
Methyl Sufonyl Chloride	8	4	Reacts with water to form toxic gas
Methyl Trichlorosilane	3, 8	4	When mixed with water releases toxic gas
Magnesium Hydride	4.3	2	Reacts violently with water
Nickel Carbonyl (Nickel Tetracarbonyn	6.1, 3	6	Capable of exploding when heated
Niobuim Chloride	8	4	Generates toxic gas when mixed with water
Nitrocellulose	3 or 1	6	Capable of exploding when subjected to a strong initiating source
Nitroglycerin	3 or 1 or 4.1	6	Capable of exploding when heated
Nonyl Trichlorosilane	3, 8	4	When mixed with water releases a toxic gas
O-Chloro Benzoyl Chloride	8		
Octadecylsllane	3, 8	4	Reacts with water to form toxic gas
Octadecyltrichlorosilane	8	4	Reacts with water to form toxic gas
Octadecyltrichlorosilane	3, 8	4	When mixed with water releases a toxic gas
Octanoyl Chloride	8	2	Reacts with water
Octyl Trichlorosilane	3, 8	4	When mixed with water releases a toxic gas
Oxalyl Chloride	8	2	Reacts with water
Pentaborane	4.2, 6.1	1	Will ignite spontaneously
Phenyl Lithium	4.2	1, 4	Normally unstable and readily capable of detonating at room temp. Mixed with water emits toxic gas
Phenyl Magnesium Bromide	4.3	2	Reacts violently with water
Phenyl Magnesium Chloride	4.3	2	Reacts with water
Phenyl Trichlorosilane	3, 8	4	When mixed with water releases a toxic gas
Phenylmethyl Sulfonyl Flouride·	8	4	Generates toxic gas with water
Phosgene	2.3, 8	4	Reacts with water to form toxic gas
Phosphabicyclononanes or Cyclooctadiene Phosphines	4.2	1	Will ignite spontaneously
Phosphine	2.3, 2.1		
Phosphorous Oxychloride	8	4	When mixed with water releases a toxic gas
Phosohorous Pentabromide	8	4	When mixed with water releases a toxic gas
Phosphorous Pentachloride	8	4	When mixed with water releases a toxic gas
Phosphorous Pentasulfide	4.1	5	When mixed with water or exposed to pH 2-12.5 emits toxic fumes. Capable of detonating at standard temp.
Phosphorous Pentoxide	8	4	When mixed with water releases a toxic gas
Phosphorous Sulfide	4.1	5	Forms toxic gas when exposed to pH of 2-12.5
Phosphorous Tribromide	8	4	When mixed with water emits toxic gas
Phosphorous Trichloride	6.1	4	When mixed with water emits toxic gas
Phosphorous Trifluoride	2.1	4	When mixed with water releases a toxic gas
Phosphorus Amorphous Red	4.1	4	Reacts with water to form toxic gas
Phosphorus Heptasulfide	8	5	Sulfide that when exposed to pH between 2 and 12.5 releases toxic fumes

Chemical	DOT Class	Reason for D003	Comments
Phosphorus Oxvbromide	8	4	When mixed with water releases a toxic gas
Phosphorus Pentaflouride	2.3	4	When mixed with water releases a toxic gas
Phosphorus Sesquisulfide	4.1	6, 5	Capable of detonating if subjected to initiation source
Phosphorus Triiodide	8	4	When mixed with water emits toxic gas
Phosphorus White	4.2, 6.1	1	Will ignite spontaneously
Phosphorus Yellow in water	4.2, 6.1	1	Will ignite spontaneously
Platinum/Lithium Alloy	4.3	2	Violently reacts with water.
p-Nitrosodimethylaniline	4.2	1	Will ignite spontaneously
Potassium	4.3	2	Reacts violently with water
Potasshim Borohydride	4.3	2	Reacts violently with water
Potassium Dithionite	4.2	1	Will ignite spontaneously
Potassium Hydride	4.3	2	Reacts violently with water
Potassium Peroxide	5.1	2	Violently reacts with water
Potassium Phosphide	4.3, 6.1	2	Reacts violently with water
Potassium Sulfide	4.2	1	Will ignite spontaneously
Propionyl Chloride	3, 8	4	Generates toxic gas with water
Propyl Magnesium Bromide	4.3	2	Reacts with water
Propyl Methyl Dichlorosilane	8	4	Reacts with water to form toxic gas
Pronvl Trichlorosilane	3, 8	4	Generates toxic gas with water
Pyrosulfuryl Chloride	8	4	Reacts with water
Raney Nickel	4.2	1	Unstable
Red Phosphorus	4.1	2	Reacts violently with water
Rubidium	4.3	2	Reacts with water
Seed Cake	4.2	1	Will ignite spontaneously
Silicon Chloride (Silicon Tetrachloride)	8	4	Reacts with water to form toxic gas
Silicon Tetrabromide	8	4	Reacts with water to form toxic gas
Sodium	4.3	2	Reacts violently with water
Sodium Aluminum Hydride	4.3	2	Reacts violently with water
Sodium Amide	4.3	2	Reacts violently with water
Sodium Borohydride	4.3	4	Reacts violently with water to form toxic gas
Sodium Cyanoborohydride	4.3	4	Reacts violently with water to form toxic gas
Sodium Dithionite	4.2	1	Will ignite spontaneously
Sodium Ethoxide (Ethylate)	4.3	2	Reacts violently with water
Sodium Hydride	4.3	2	Reacts violently with water
Sodium Hydrogen Acetylide	4.3	2	Reacts violently with water
Sodium Hydrosulfite	4.3	2	Reacts violently with water
Sodium Methylate	4.2, 8	1, 2	Will ignite spontaneously, Reacts violently with water
Sodium Peroxide	5.1	2	Reacts violently with water
Sodium Phosphide	4.3	2	Reacts with water
Sodium Potassium Alloy	4.2, 4.3	2	Reacts with water, explosive at room temperature
Sodium Sulfide	4.2 or 8	5	Forms toxic fumes with pH between 2-12.5
Sodium Trimethoxy Borohydride	4.3	2	Reacts with water
Stannic Bromide	8	4	Fumes in moist air
Stannic Chloride	8	4	Fumes in moist air
Stannic Phosphide	4.3, 6.1	4	Reacts with water
Strontium Metal	4.3	4	Reacts with water
Strontium Phosphide	4.3, 6.1	4	Reacts with water to form toxic gas
Succinyl Chloride	8	4	Reacts with water to form toxic gas
Sulfur Dichloride	8	2	Reacts violently with water
Sulfur Monochloride	8	2	Reacts violently with water
Sulfur Trioxide	8, 6.1	4	Reacts with water to form toxic gas
Sulfuryl Chloride	8, 6.1	2	Reacts violently with water
Tert-Butyl Hypochlorite	4.2, 8	1	Will ignite spontaneously

Chemical	DOT Class	Reason for D003	Comments
Tetrachlorosilane	8	2	Reacts violently with water
Tetramethylsiiane	3	2	Reacts violently with water
Textile Waste, Wet	4.2	1	Will ignite spontaneously
Thionyl Bromide	8	4	Reacts with water to form toxic gas
Thionyl Chloride	8	4	Reacts with water to form toxic gas
Thiourea Dioxide	4.2	1	Will ignite spontaneously
Titanium Disulfide	4.2	1	Will ignite spontaneously
Titanium powder(dry)	4.2	1	Will ignite spontaneously
Titanium Tetrabromide	8, 6.1	4	Reacts with water to form toxic gas
Titanium Tetrachloride	8, 6.1	4	Reacts with water to form toxic gas
Titanium Trichloride	4.2, 8	4	Reacts with water to form toxic gas
Trichlorosilane	4.3, 3, 8	2	Reacts violently with water
Triethyl Aluminum	4.3	2	Reacts violently with water
Triethyl Borane	4.3	4	Reacts with water to form toxic gas
Trimethyl Borate	3	4	Reacts with water to form toxic gas
Trimethylchlorosilane	3	4	Reacts with water to form toxic gas
Vanadium Oxytrichloride	8	4	Reacts with water to form toxic gas
Vinyl Magnesiurn Bromide	4.3	2	Reacts violently with water
Vinyl Magnesium Chloride	4.3	2	Reacts violently with water
Vinyl Trlchlorosilane	3,8	4	Reacts with water to form toxic gas
White Phosohorous	4.2, 6.1	1	Will ignite spontaneously
Wool Waste. Wet	4.2	1	Will ignite spontaneously
Xanthates	4.2	1	Will ignite spontaneously
Zinc Ash	4.3	2	Reacts violently with water
Zinc Dust	4.2	1	Unstable at room temp.
Zinc Phosphide	4.3, 6.1	2	Reacts violently with water
Zirconium Hydride	4.2	1	Powder or dust will ignite spontaneously
Zirconium Powder	4.2	6	Flammable, explosive, should be kept in water

U.S. Department of Transportation (DOT) Class (49 CFR 173)
Class 1 Explosives
Class 2 Gases
2.1 Flammable Gases
2.2 Non-Flammable Gases
2.3 Poisonous Or Toxic
Class 3 Flammable Liquid
Class 4 Flammable Solids
4.1 Flammable Solid
4.2 Spontaneously Combustible Material
4.3 Dangerous When Wet
Class 5 Oxidizing Substances; Organic Peroxides
5.1 Oxidizer
5.2 Organic Peroxide
Class 6 Poisonous (Toxic) And Infectious Substances
6.1 Poisonous (Toxic) Material
6.2 Infectious Substance
Class 8 Corrosives

Hazardous Waste Number D003
U.S. Environmental Protection Agency, Characteristic of reactivity (40 CFR 261.23)

APPENDIX G

BIOHAZARD LABELING GUIDELINES

BIOHAZARD LABELING GUIDELINES

The following minimum instructions and/or guidelines are to be used in implementing the labeling or color coding requirements set forth by the OSHA *Bloodborne Pathogens Standard*.

Warning labels must be predominantly fluorescent orange or orange-red against contrasting background colors and contain the Biohazard Symbol and the word *biohazard*.

Item	Biohazard Label	Red Container	See Exemptions
Regulated waste container (sharps and/or non-sharps)	**X**	**X**	
Reusable contaminated sharps Container (i.e., surgical tools in soaking tray)	**X**	**X**	
Refrigerators, freezers, centrifuges, etc. holding blood or other potentially infectious materials	**X**		
Specimens and regulated wastes shipped from the laboratories to other facilities for service or disposal	**X**	**X**	
Contaminated Laundry	**X**	**X**	**X**
Contaminated laundry sent to another facility that does not use Standard Precautions	**X**	**X**	
Containers used to store, transport, or ship blood	**X**	**X**	
Individual specimen containers of blood or other potentially infectious material that remains within the lab	**X**	**X**	**X**
Blood or blood products for clinical use			**X**
Contaminated equipment that needs service (i.e., dialysis equipment or suction device)	**X** (on the contaminated portion)		

BIOHAZARD LABELING EXEMPTIONS

As a general rule, further labels are not required under the following circumstances.

1. Blood, blood components, or products labeled as to contents and released for transfusion or other clinical use.

2. Red bags or red containers are used instead.

3. Individual containers of blood or other potentially infectious material (OPIM) placed within a labeled container for shipping, storage, transport, or disposal.

4. Regulated wastes that have been decontaminated.

5. Specimen containers retained within a facility that observes Standard Precautions (i.e., the Wyss Institute).

6. Alternate labeling or color-coding for contaminated laundry containers within a facility that observes Standard Precautions (i.e., the Wyss Institute).

7. For drawn blood or during lab procedures on blood samples, individual containers of blood or OPIM do not require labels **provided** the larger containers into which they are placed for storage, transport, shipment, or disposal are labeled (i.e., test tube racks, trays, or holders).

APPENDIX H

USER'S GUIDE TO MATERIAL SAFETY DATA SHEETS

USER'S GUIDE TO MATERIAL SAFETY DATA SHEETS

Material safety data sheets (MSDSs) are prepared by manufacturers to summarize the health and safety information about their products.

TO OBTAIN MSDSs

- Consult the manufacturer's website, or a searchable online MSDS database such as http://hazard.com/msds.
- Ask your Department Administrator, Principal Investigator, or Chemical Hygiene Officer for the location of the MSDS file.
- Contact the Wyss Institute EH&S Office.
- Call the manufacturer.

Listed below is the most important information that OSHA requires on MSDSs. For assistance with interpreting and applying this information, consult with the Wyss Institute EH&S Office.

COMPONENTS OF AN MSDS

Identity

- Trade name used on the label and inventory list.
- Manufacturer's name, address, and emergency telephone number.
- Preparation and revision dates.

Hazardous Ingredients

- CHEMICAL and COMMON NAMES of all the hazardous components
- MAXIMUM OCCUPATIONAL LIMITS OF EXPOSURE

OSHA PEL: Permissible exposure limit (PEL)—eight-hour time-weighted average (TWA); this is an upper limit, enforceable by law, above which no worker can be exposed.

OSHA STEL: 15 – 60 minutes, a regulatory upper short-term exposure limit (STEL).

ACGIH TLV: Eight-hour TWA; usually equal to or lower than the PEL, but a recommended upper limit only; also more current in terms of toxicological data.

These are not proven safe levels of exposure. If the exposure limit is not listed, do not assume that a chemical is safe. Contact the EH&S Office.

- PERCENTAGE OF THE MIXTURE (optional). The percentages do not usually add up to 100%, since only the hazardous ingredients have to be listed. This is NOT a trade secret recipe.

Physical/Chemical Characteristics

- VAPOR PRESSURE—a measure of a liquid's tendency to evaporate.
- VAPOR DENSITY—a vapor or gas that is lighter or heavier than air.
- APPEARANCE AND ODOR—depending upon your senses to detect or identify hazardous materials can be very dangerous.

The EH&S Office considers these properties as well as how you work with a hazardous material to evaluate the risk.

Fire and Explosion Hazard Data

- FLASH POINT—the lowest temperature at which a liquid gives off enough vapors, which when mixed with air, can be easily ignited by a spark. The lower the flash point, the greater the risk of fire or explosion. Remember that it is the vapors that burn, not the liquid.

Reactivity Data

- Reactivity, in this context, is the tendency for a material to chemically change or breakdown and to become more dangerous. Precautions include:

  - CONDITIONS TO AVOID—such as light or heat.
  - MATERIALS TO AVOID—for example, sodium and water will react vigorously to generate hydrogen, creating a fire hazard.

Health Hazard Data

- If you need health hazard information that is not on an MSDS, contact the Wyss Institute EH&S Office.
- ROUTES OF ENTRY—how a hazardous material can enter your body (e.g., inhalation, skin absorption, and ingestion).
- SHORT-TERM HEALTH EFFECTS (ACUTE)—symptoms may be felt immediately after the first brief contact (e.g., burns, watery eyes, sore throat).
- LONG-TERM HEALTH EFFECTS (CHRONIC)—symptoms may be felt after repeated contact with the same hazardous material over a long period of time.
- REFERENCES that list a chemical as a carcinogen or potential carcinogen.
- SIGNS AND SYMPTOMS OF EXPOSURE.
- MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE.
- EMERGENCY AND FIRST AID PROCEDURES.

If you are concerned about a chemical exposure you may have had, notify the Wyss Institute EH&S Office.

Precautions for Safe Handling and Use

- SPILL AND LEAK PROCEDURES—The Wyss Institute EH&S Office can advise you on specific procedures and provide protective equipment.
- WASTE DISPOSAL—Contact the Wyss Institute EH&S Office for information on the disposal of a particular chemical. To schedule a pick up of hazardous waste, send an e-mail to clschemicals@bidmc.harvard.edu with the chemical name(s), quantity, and exact location of the waste.

Control Measures

- The Wyss Institute EH&S Office can answer specific questions regarding ventilation and personal protective equipment for normal working conditions and emergencies. Suitable control measures are based on how a material is used.