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IMPORTANT PHONE NUMBERS

(McLean #’s are 617-855-xxxx)

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SECURITY 2121
FACILITIES 2621
RESEARCH ADMINISTRATION 2922
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CHAIR, LAB SAFETY SUBCOMMITTEE (MCLEAN: DONA WONG) 2042
INFECTION CONTROL (MCLEAN: PAULA BOLTON) 3258
OCCUPATIONAL HEALTH (MCLEAN: BETH O’NEIL) 2438
BIOLOGICAL SAFETY (MGH: ANNE SALLEE) 617-724-4579
PARTNER’S INSTITUTIONAL BIOSAFETY COMMITTEE 617-732-8330
PIBC: TED MYATT)
RADIATION SAFETY (MGH) 617-726-5128
ENVIRONMENTAL HEALTH AND SAFETY (MGH) 617-726-2425

FOR IMMEDIATE ADVICE ABOUT ANY CHEMICAL EXPOSURE:

MASSACHUSETTS POISON CENTER 800-222-1222
617-232-2120

TRIUMVIRATE ENVIRONMENTAL 800-966-9282
1.0 POLICY AND PURPOSE

Laboratory safety is the responsibility of every individual working in, or proximal to, the clinical or research laboratories located on the McLean Hospital Campus. This includes principal investigators, research fellows, residents, research assistants, students and volunteers and other staff, who may have to enter these facilities, e.g. members of Plant and Operations, Building Services, Shipping and Receiving.

The policy of McLean Hospital (as represented by the McLean Corporation and the Office of the President) is to provide a safe and healthy workplace in compliance with the Occupational Safety and Health Act of 1970 and regulations of the Department of Labor including the Occupational Safety and Health Administration (OSHA) Lab Standard 29CFR1910.1450 “Occupational Exposure to Hazardous Chemicals in Laboratories”. The Lab Standard is designed to enhance the safety of laboratory personnel through better information and work practices. As laboratory personnel, you already know that your technical skills are critical to your work. Knowing the hazards of the substances you work with and safe work practices is just as important. The key requirements of the Lab Standard that you should be aware of are as follows:

- You must have access to the Chemical Hygiene Plan.
- Material Safety Data Sheets (MSDS) must be available to you.
- You must be informed of the hazardous chemicals present in your laboratory and the operations in which they are involved.
- You must receive adequate training in working with hazardous chemicals.
- Chemical containers and chemical waste must be labeled properly.
- You must know how to detect the presence or release of a hazardous chemical.
- You must be provided with personal protective equipment (safety glasses, gloves, lab coat, for example).
- You must be provided with engineering controls (fume hood, for example).
- You must receive training in the proper procedures for responding to emergencies.
- You are entitled to a medical consultation, whenever there is an event, such as a spill or leak that increases your risk of chemical exposure.

If there is reason to believe that the airborne concentration of a hazardous chemical may exceed established exposure limits, air monitoring may be required.

- You must be notified of the results of any air monitoring conducted.
- You are entitled to a copy of established exposure limits for hazardous chemicals.
- You are entitled to a complete copy of the OSHA Lab Standard.

The full standard is provided in Appendix A.
2.0 ROLES AND RESPONSIBILITIES
The McLean Hospital Board of Trustees authorizes the Safety and Maintenance Committee to develop and institute Safety Procedures and Policies that ensure the safety of all.

2.1 Administration
The Administration of McLean Hospital accepts responsibility for the safety program’s leadership, effectiveness, and continuous program review and improvement.

2.2 Environmental, Health and Safety Department (EH&S)
The primary responsibility of the Environmental, Health and Safety Department is to provide technical support and guidance to laboratory and hospital personnel for the development and management of environmental, health and safety programs. McLean Hospital’s EH&S Department includes:

2.2.1 Hospital Safety Officer
The HSO is appointed by the President and Psychiatrist-in-Chief to implement and coordinate an effective and comprehensive safety program, with specific duties that include data collection, hazard surveillance and assessment, development of policies and procedures, implementation of training programs, technical support, and program assessment and improvement. The HSO reports to the Safety and Maintenance Committee at least every committee meeting. The HSO is empowered by the Administration to intervene whenever circumstances exist that result in an unsafe condition.

2.2.2 Lab Safety Subcommittee (LSSC)
The LSSC is a subcommittee of the Safety and Maintenance Committee, devoted specifically to laboratory safety. The Chair of the LSSC is a PI with extensive laboratory experience, and members of the LSSC are chosen from labs across McLean Hospital such that the entire range of research and safety issues is represented. The LSSC is responsible for:

- Development and evaluation of safety procedures.
- Laboratory inspection and audits.
- Training and information dissemination.
- Hazard and exposure assessments.
- Accident investigation.
- Oversight and approval of “sharps” exemptions

2.2.3 Lab Safety Officer
The LSO is appointed by the Sr. Vice President for Research Administration to promote and maintain a safe work environment in accordance with all applicable federal, state and local regulations. The LSO serves as a member of the LSSC and works closely with its Chair and the hospital’s Safety & Maintenance Committee to develop lab safety policy.
In particular, the LSO is responsible for:

- Responding to concerns and emergencies
- Providing a degree of "safety enforcement" of exposure control policies and procedures developed by the LSSC relating to chemicals and hazardous materials, hazardous wastes, environmental compliance, and lab safety.
- Overseeing laboratory safety training activities.
- Ensuring that emergency response supplies are readily available.
- Maintaining and updating lab emergency signage as needed
- Updating manuals and emergency procedures in conjunction with the LSSC and the Safety & Maintenance Committee.
- Acting as Chair of the Institutional Biosafety Committee and coordinating with Partner’s IBC and the Belmont Board of Health for annual safety inspections.
- Oversight of First Responder Operational Level (FROL) training and respirator fit testing.
- Management of Standard Operation Procedures (SOPs) for the use of hazardous chemicals at McLean.

2.3 Department Heads/Principal Investigators

The Department Heads and PIs are responsible for safety management in their laboratories, and they accept responsibility for the actions of employees, the performance of equipment, and safe operations within their labs.

To assist PIs provide adequate safety measures, training materials, including a template Lab Safety packet is available at:

https://research.mclean.harvard.edu/safety/Training.php

PIs or lab managers should use the Lab Safety packet provided as a template to create their own lab-specific training module. Documentation of appropriate lab-specific training should be maintained for all new hires and current lab staff.

Department Heads and PIs must ensure that:

- Laboratory personnel have adequate knowledge and information to recognize and control chemical hazards in the laboratory.
- Hazardous operations are defined and safe practices and protective equipment are designated and provided.
- Safe work practices, personal protective equipment and engineering controls are used to reduce the potential for exposure to hazardous chemicals.
- Laboratory personnel are informed of the potential hazards of the chemicals they use and are trained in safe
laboratory practices, controls and emergency procedures.

- Laboratory personnel are informed of the signs and symptoms associated with exposures to hazardous chemicals used in their laboratory.
- Chemical waste is managed properly.
- Action is taken to correct work practices and conditions that may result in the release of hazardous chemicals.
- Personnel are trained in the safe use and disposal of particularly hazardous substances in the laboratory, following written and approved SOPs.
- Laboratory operations are supervised to ensure that Lab Safety Policies and Procedures are being followed.
- Compliance with Lab Safety Policies and Procedures is maintained and documented.

### 2.3.1 Research Program Department Heads

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<td><a href="mailto:wilson_woo@hms.harvard.edu">wilson_woo@hms.harvard.edu</a></td>
<td>Cellular Neuropathology</td>
<td>MRC-303E</td>
</tr>
<tr>
<td>Zanarini, Mary</td>
<td><a href="mailto:zanarini@mclean.harvard.edu">zanarini@mclean.harvard.edu</a></td>
<td>Laboratory for the Study of Adult Development</td>
<td>SERV-122</td>
</tr>
</tbody>
</table>


### 2.4 Employees

Employees are responsible for cooperating with all aspects of safety management, including compliance with all safety
rules and regulations and continuously practicing with safety in mind. Employees must report unsafe conditions promptly to their supervisor, Lab Safety Officer, or Chair of the Lab Safety Subcommittee, and must complete annual safety training.

**TRAINING**

- ALL staff at McLean Hospital will be required to complete the following mandatory annual trainings via the HealthStream system ([www.partners.org/healthstream](http://www.partners.org/healthstream)):
  - Infection Control
  - Fire Safety
  - Corporate Compliance

  In addition, ALL staff that work in a laboratory environment will be required to complete Laboratory Safety training through HealthStream.

### 2.5 First Responders Operational Level (FROLs)

FROLs are individuals who respond to releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of protecting nearby persons, property, or the environment from the effects of the release. They are trained to respond in a defensive fashion without actually trying to stop the release. Their function is to contain the release from a safe distance, keep it from spreading, and prevent exposures.

FROLs must have 8 hours of training and annual re-training (4 hr) for certification to provide them with sufficient knowledge/experience in basic hazard and risk assessment techniques, selection of proper personal protective equipment, basic hazardous materials terms, basic control and containment procedures, basic decontamination procedures, and relevant standard operating procedures.

McLean maintains approximately 10 FROLs, spread throughout Mailman Research Center, Oaks, and the Neuroimaging Center. Basic Training is conducted on an annual basis.

Researchers should contact a FROL for any hazardous chemical-related issue.

For a current list of FROLs, see:

[https://research.mclean.harvard.edu/safety/Labpersonnel.php](https://research.mclean.harvard.edu/safety/Labpersonnel.php)

### 3.0 LABORATORY EMERGENCY PROCEDURES & ADMINISTRATIVE PROTOCOLS

#### 3.1 Fire

3.1.1 **Fire Emergency Instructions**
IF YOU HEAR THE FIRE ALARM:

1. Evacuate Building
2. Proceed to previously determined group meeting spot
3. Keep Vicinity of Building Clear

IF YOU DISCOVER FIRE OR SMOKE:

In the event there is a fire in the lab, remember the word RACE, which stands for the following:

R = Rescue: Rescue anyone in immediate harm's way;

A = Alarm: Sound the alarm as follows:

1. Verbally by shouting “FIRE” and the room number.
2. Electronically by activating the nearest fire alarm pull station. (Note: Anyone hearing the word “FIRE” or seeing flames should immediately activate the nearest fire alarm pull station.)
3. After sounding the alarm electronically, call x2222 to report the incident. When calling, stay on the line to answer any questions the operator may have about the incident provided it is safe to do so.
4. During a fire alarm, do NOT use elevators.

C = Contain: Contain the fire by closing all doors, windows, sashes on fume and/or bio-hoods, flammable liquids storage cabinets, etc.

E = Extinguish/Evacuate: Extinguish the fire if it is small enough to do so safely.

Smother the flames or use a nearby fire extinguisher.

For clothing fire, “STOP, DROP AND ROLL”.

Fires require “fuel, oxygen and heat”. These comprise the “fire triangle”. There are different types of fires depending upon the material ignited (“fuel”). Fire officials have designated “fire classifications” based on the type of fuel. The four (4) classes or types of fires are as follows:

1. Class A These are fires involving ordinary combustibles, such as paper, wood, cloth. They are called ordinary, because they are found everywhere.
2. Class B These are fires involving some type of flammable liquid, such as grease, alcohol, acetone, gasoline, etc.
3. Class C These are fire involving energized electrical equipment, such as computers, copiers, motors, etc
4. Class D These are fires involving some type of flammable metal, such as magnesium and sodium.
Just as there are different types of fires, there are different types of fire extinguishers. Each type of extinguisher is designed to handle a different type of fire. The different types of fire extinguishers are as follows:

1. **Class A** This type of fire extinguisher is designed for Class A fires only. It uses water to extinguish the fire, which makes it unacceptable for use on a Class, B, C or D fire. (Note: This type of extinguisher is usually readily identifiable by its distinct silver canister.)

2. **Class BC** This type of fire extinguisher is designed for use on either a Class B or C fires. It uses either Dry Chemicals (sodium or potassium bicarbonate) or Carbon Dioxide gas to extinguish the fire. It does not work on Class A fires, so it has to be used in tandem with another extinguisher type, usually one with water in it that’s designed specifically for Class A fires. The BC type extinguisher is found in most labs. It is not approved for use on Class D fires because CO₂ will react with the flammable metals.

3. **Class ABC** This type of extinguisher is designed for use on Class A, B & C fires. It is also commonly found in the MRC. It uses powder to extinguish a fire, creating a mess when discharged. Therefore, this type of extinguisher is not usually used in labs or other areas of hospital where expensive electrical equipment is in use, such as computer, scientific equipment and MRI scanners.

4. **Class D** This type of extinguisher is designed for use on Class D fires only.

**Using a fire extinguisher:** The way to remember how to use a fire extinguisher is with the word **PASS**:

- **P** = Pull the locking pin;
- **A** = Aim the hose at the base of the fire;
- **S** = Squeeze the handle; and
- **S** = Sweep from side to side at the fire base until the extinguisher is empty.

However, you should only try to fight a fire if it is safe to do so.

**Evacuate** the floor in accordance with the lab’s fire plan and proceed to predetermined location (e.g. deMarneffe foyer) so the Belmont Fire Department and McLean Security can determine if all personnel are accounted for.

(**Note:** If anyone is unable to leave the floor, the Lab Safety Officer (or Incident Commander) should report this situation to fire officials so they can take appropriate action.)

Finally, do not go back into the building and/or lab until told to do so by a fire official. **The Fire alarm is not over until the fire department gives the “all clear.”**

**3.1.2 LABORATORY FIRE ADMINISTRATIVE PROTOCOL**

**PURPOSE**

To provide for the safe and rapid evacuation of occupied areas during a suspected, or actual fire.

**SCOPE**

The following people will be notified by Security:

Clinical Nursing Supervisor          Director of Nursing
RESPONSIBILITIES

Nursing: Upon alarm activation, the primary responsibility of the Nursing staff will be to monitor and assess the need for medical assistance in the emergency situation.

Security Services: Upon alarm activation, Security will dispatch at least three officers and the shift supervisor to assist in the emergency. Prior to the arrival of the Belmont Fire Department, Security personnel will have primary responsibility to ensure the safe evacuation and accounting for occupants of the building. After the arrival of the Fire Department, Security will provide assistance as directed by the Fire Department and provide crowd control if necessary.

Communication Services: Primary responsibility will be to provide support and equipment, upon request by Security, and direct the Belmont Fire Department to the emergency site. The operators will relay pertinent information pertaining to building identification number, name, zone, and area number as well as emphasizing program name (i.e., Mailman Research Center, ADARC, Psychology Laboratories, Imaging, etc.) and will assist Security in coordinating the response by other McLean personnel.

Support Services: Building Services (UNICCO), Dietary (Morrison), and Plant & Operations Department will provide services as requested by Nursing Administration.

Research Staff: The Principal Investigator from the research area where the fire originated or a staff member from that department, should identify themselves to Security and provide an assessment of the degree of danger inherent to the situation. For example, are radioactive materials involved, are quantities of flammable solvents stored in the area, is high voltage equipment running in the area, etc. Security should relay the information accurately to the firefighters on the scene, and the research staff should remain available to supply additional information to the firefighters if requested.

3.2 Medical Emergency

3.2.1 Medical Emergency

If you are at the scene of any medical emergency:

1. CALL 2-2-2-2 for any situation requiring immediate medical attention.
2. Provide the following information:
   - Type of emergency and any injuries;
   - Injured person’s location, if applicable;
• Your name, location and telephone number;
• Remain on line until dispatcher disconnects the call.

3. Check for hazards before entering location where emergency occurred.
4. Initiate lifesaving measures if required and you are trained to do so.

CPR "CODE CALL" PROCEDURE (USED ONLY FOR CARDIAC/RESPIRATORY ARREST)

1. Recognize resuscitation emergency
2. Dial 2-2-2-2 and state: - CODE CALL
   - LOCATION
   - IDENTIFY YOURSELF
3. Qualified staff should initiate basic CPR (initiate CPR before calling 2-2-2-2 if child/infant).
4. Assign research staff member to building entrance to direct medical help to site.
5. Code Cart and Emergency Drug Box will be brought to site by Security staff.
6. Senior medical person on site (Emergency Medical Technician, Paramedic, Medical staff) will assume responsibility and supervision upon arrival.

General Guidelines

1. Senior medical person at site directs CPR.
2. Record of medications and resuscitation procedure is to be taped to patient.
3. Transfer by ambulance to the nearest appropriate acute care facility in accordance with DPH Regulations governing ambulance procedures.
4. MDCC must accompany patient in ambulance if paramedics are not available and continue CPR as indicated. Nurse may go if indicated.
5. Defibrillator accompanies patient if not available in ambulance and is returned to McLean Hospital by the Medical Clinic Internist.

• Do not move injured persons unless there is an immediate danger of further harm.
• Keep injured person warm.
• Remain with victim until medical assistance arrives.

PERSONAL CONTAMINATION (CHEMICAL, BIOLOGICAL, RADIOLOGICAL) ON SKIN:

1. Remove any contaminated clothing, jewelry, etc.
2. Wash skin thoroughly with water using a drench hose, emergency shower or faucet.
3. Take care not to break the skin.
4. Flush mucous membranes with water.
5. For biological, blood, or radiological exposure, use soap and water.
   Report radiation contamination to the MGH Radiation Safety Office at 617-726-5128.
6. Occupational Health or MDOC will determine if medical attention required. Have MSDS or other source of contaminant information available.
7. Report the injury to your supervisor and complete an Accident Report Form as directed by Occupational Health.

**IN EYE:**

1. Wash eye thoroughly with water using an emergency eyewash, if available.
2. Forcibly hold eyes open to ensure effective wash behind both eyelids for at least 15 minutes.
3. Occupational Health or MDOC will determine if medical attention required. Have MSDS or other source of contaminant information available.
4. Report radiation contamination to the MGH Radiation Safety Office at 617-726-5128
5. Report injury to your supervisor and complete an Accident Report Form as directed by Occupational Health.

**MINOR INJURY, NEEDLESTICK, CONTAMINATED SHARPS**

1. Briefly bleed wound and then wash the affected body part with soap and water for at least 15 minutes.
2. Cover injured area with clean gauze.
3. Contact Occupational Health or MDOC. Bring or send an MSDS or other source of information about the contaminant. Occupational Health Nurse or MDOC will determine if medical follow-up is required.
4. If the needlestick involves radiological materials, report exposure to the Radiation Safety Office at 617-726-5128.
5. Report incident to your supervisor and complete an Accident Report Form as directed by Occupational Health.

**CUTS AND ABRASIONS**

1. Wash area with soap and water for 1–2 minutes.
2. Cover injured area with clean gauze.
3. Contact Occupational Health or MDOC.
4. Report injury to your supervisor and complete accident report as directed by Occupational Health.

**REPORT ALL ON-THE-JOB INJURIES AND ILLNESSES TO YOUR SUPERVISOR AND OCCUPATIONAL HEALTH.**

An Accident Report Form should be available from Occupational Health. Fill out the appropriate sections of the Accident Report Form within 24 hours of the injury or illness and give it to your supervisor to complete his/her sections. If you need assistance, contact Occupational Health or your supervisor.
3.2.2 Medical Emergency Administrative Protocol

Purpose

To ensure that appropriate medical care is available at all times to research personnel on the Hospital's grounds.

Scope

This policy applies to McLean Hospital Principal Investigators, Research Staff, Safety and Security personnel, the Occupational Health Nurse, and the Medical Doctor On Call (DOC).

Procedure

1. A triage team is deployed to the site of all medical emergencies. This team consists of the Medical Doctor On Call (DOC), Psychiatrist On Call (PDOC) if appropriate, Medical Clinic Nurses (8:00 a.m. to 4:00 p.m., Monday through Friday), the Administrative Nursing Supervisor and/or other staff nurses as deployable.

2. Security will report to the site with emergency medical care support equipment including defibrillator, intubation equipment and emergency pharmaceuticals.

3. Radio communications between Security at the site and the Administrative Nursing Supervisor in the office will be maintained to secure additional help, supplies and ambulances.

4. The MDOC will administer definitive on-site treatment for the medical emergency. Personnel with unstable medical problems will be transferred to the nearest appropriate acute care facility in accordance with DPH Regulations governing ambulance procedures.

5. The Emergency Medical Care Committee reviews the specific content of each emergency medical service. This information is used in an interdisciplinary format to generate recommendations for change and continuous quality improvement.

3.3 Chemical Spill

3.3.1 Chemical Spill Procedure

The hazards posed by a chemical spill can range from minor to extremely hazardous. Deciding what those hazards are depends on the knowledge and experience of the user, the size of the spill, and the context in which it is spilled (e.g. open lab vs closed lab, near a heat source, etc.). Good lab practice enables researchers to make sound judgments when it comes to dealing with a chemical spill.

Minor Spill

Does the spill involve a small amount of a chemical (<1 L) with known properties that do not pose any immediate threat? This is a minor spill that should be contained and cleaned up by the user with the help of First Responders (FROLs) if needed, using the following procedures:

- Contain the spill.
- Decontaminate any exposed personnel.
- Warn others in the vicinity.
- Identify the material and consult the MSDS.
• Obtain spill response cleanup material from spill kit and clean the affected area.
• Dispose of hazardous waste in SAA and/or MAA
• Log spill and cleanup procedures in chemical spill kit log book
• Inform PI

**NO ONE SHOULD CLEAN UP A SPILL BY HIM/HERSELF WITHOUT AT LEAST ONE OTHER PERSON PRESENT**

Once the spilled material has been cleaned, place all absorbent material and personal protective equipment used in the spill response in a plastic bag or container. Label the container with a Hazardous Waste Label listing the chemical spilled and the contaminated debris. The containerized material can then be placed in your Satellite Accumulation Area or brought down to the Main Accumulation Area.

**MAJOR SPILL**

Does the spill result in injury? Is the spill large (>1 L)? Does the spilled chemical pose an immediate threat (flammable, toxic, etc)? Are you at all unsure of any of the above? Are you unsure of the proper cleanup procedure? This is considered a major spill that requires the following actions:

1. Evacuate and secure the area (lock doors or assure guarding of entrance into the area).
2. The discoverer, or an individual designated by the discoverer, reports the spill:
   a. CALL: **EMERGENCY x2222**
   b. The caller gives his/her
      - Name
      - Location of spill
      - Extension from which he/she is calling
      - Name of chemical if known
      - Approximate quantity
      - Intentions to proceed with clean up or to wait for help from Lab Safety Officer and FROLs.
   c. Security initiates Safety Chain by calling:
      - Security Supervisor
      - Hospital Safety Officer
      - Laboratory Safety Officer
      - First Responders (FROLs)
      - Research Administration
      - Occupational Health
3. The caller returns to the entrance of the spill area (or safest location proximal to spill) to assist in clean up
and/or to wait for assistance.

4. Once the reporting step is completed or underway, trained personnel (e.g. outside agent like Triumvirate) may clean-up spills.

5. The discoverer of the spill must also report the spill to the Principal Investigator or to his/her alternate as soon as practical either before, during or immediately after clean up.

ONLY PERSONNEL WHO HAVE RECEIVED TRAINING IN CHEMICAL SPILL IDENTIFICATION, EVALUATION AND CONTAINMENT MAY CLEAN UP SPILLS. FOR CLEAN UP OF HIGHLY TOXIC CHEMICALS OR WHEN THE LEVEL OF HAZARD IS UNCERTAIN, AN OUTSIDE CONSULTANT (TRIUMVIRATE) WILL BE CONTACTED TO HANDLE CLEAN UP.

3.3.2 Accidents Involving Radioactive Materials

The MGH Radiation Safety Office (617-726-5128) shall be notified immediately of any accident involving possible body contamination or ingestion of radioactivity by personnel, over-exposure to radiation, contamination of equipment, spread of contamination, or difficulty in cleaning up a contaminated area. The MGH Radiation Safety Office must be notified immediately in the event of loss of radionucleotides.

Radioactive Spills

All spills of radioactive material must be contained and cleaned up promptly. The responsibility for cleaning or for calling for experienced help rests on the individuals working in the area involved and responsible for the spill.

Under no circumstances should any untrained person attempt to examine or clean up any spill of radioactivematerial. The clean up technique should be planned with the same care that is used in, for example, the bacteriological handling of virulent organisms. Fans or ventilating apparatus should not be turned on in an attempt to blow the radionucleotide or its decay products away. Such maneuvers will only disseminate the radioactive material. Also, if a radionucleotide is blown out of a building, air currents might carry finely divided material into nearby windows or air-intake ducts. Proper precautions taken immediately will minimize radiation hazards and reduce financial losses.

The following procedures will be followed:

1. Major Spills

Major spills should be reported to the MGH Radiation Safety Office (617-726-5128) immediately. A major spill is defined as a spill that meets any of the following conditions:

1. Involves an injury
2. Results in personal contamination, ingestion, or inhalation of radioactive material
3. Is expected to result in significant exposure to an individual
4. Occurs in or spreads to an unrestricted (non-posted) area (includes liquids, solids, and vapors)
5. Is likely to result in closure of a lab or a major area of a lab for more than 24 hr.

If a major spill occurs, follow this procedure:

a. If a person is injured, medical treatment comes first. Remove individual from contaminated area if
possible.
b. Notify all persons not involved in the spill to vacate the room at once
c. If hands are protected from contamination (i.e. gloves) right the container of spilled liquid.
d. Cover spill, quickly evacuate room, close doors.
e. Remove contaminated shoes and clothing at door.
f. Call \texttt{x2222} and Radiation Safety Office (\texttt{617-726-5128}).
g. Take immediate steps to decontaminate involved personnel.
h. Clean up of the spill should be supervised by the Radiation Safety Office.

2. Minor Spills

Minor spills are those not defined as major spills.

a. Notify all persons in the room or area at once.
b. Monitor potentially contaminated staff. Do not allow staff to leave the area until monitoring is complete.
c. Only trained staff should handle spills.
d. Confine the spill immediately.
e. Determine extent of spill using survey meters and wipe tests.
f. Put on protective gloves and drop absorbent paper on a liquid spill.
g. Decontaminate, starting at the edge of the spill and working inward. Use a monitor to check the progress of the work.
h. Monitor all persons involved in the spill and the clean up.

3.3.3 \textbf{CHEMICAL SPILL ADMINISTRATIVE PROTOCOL}

\textbf{PURPOSE}

To assure that McLean Hospital personnel handle chemical spill response in the most safe, effective and efficient manner.

\textbf{SCOPE}

This policy applies to McLean Hospital's Safety and Security personnel, Principal Investigators, Department Managers, Laboratory workers, and Chemical Spill Response Team Members.

\textbf{RESPONSIBILITIES}

1. The Principal Investigator or Department Manager communicates the chemical spill policy to his/her people and takes reasonable measures to prevent chemical spills in his/her area(s).

2. Laboratory workers maintain a safe work environment and are familiar with
emergency response procedures in the event of a spill.

3. Security coordinates the notification of appropriate personnel (Lab Safety Officer and FROLs) to assist in cleanup and follow-up.

4. The Hospital and Laboratory Safety Officers recommend cleanup measures, coordinate cleanup and investigate spill incidents.

5. Personnel trained in hazardous material cleanup (e.g. FROLs, Triumvirate) will be contacted to handle all but minor chemical spills.

PROCEDURE

1. (a) When Security receives notification of a chemical spill, the Security Officer obtains the following information from the caller:
   a. Name of caller
   b. Location of spill
   c. Description of injury(ies), fire(s), or other complications:
      *Name
      *Nature of injury or problem
      *Location of injured person(s), fire, problem
   d. Chemical involved, if known
   e. Approximate quantity of chemical
   f. Need for help in cleanup

   (b) If there is a fire, Security notifies the Belmont Fire Department of the fire's location and of the name(s) of the chemical(s) involved.

   (c) If someone is injured, Security calls the ambulance and gives the location of the injured person(s), the nature of the injury(ies) and the name of the chemical(s) involved.

2. The Security Officer who receives the original call notifies the Security Supervisor. The Security Supervisor assures that the following people are contacted:
   a. Hospital Safety Officer
   b. Laboratory Safety Officer & Response Team (e.g. FROLs)
   c. Security Manager
   d. Principal Investigator responsible for the area of the spill
   e. Department Head / Administrator on Call
   f. Assistant Director for Research Operations
g. Senior Vice President/Research
h. Senior Vice President/Operations
i. Occupational Health (provide name of chemical and estimate of injuries, if known)
j. Chief of Internal Medicine

k. Triumvirate-#1-800-366-9282 (as directed by the Safety Officer)
l. Director of Media Relations

3. The Safety Officer and FROLs evaluate the chemical spill incident and participate in the cleanup of minor spills.

4. If the spill has occurred in a public area, the quantity spilled is one gallon or greater, or Security assistance is indicated, the Security Supervisor sends a Security Officer to the area of the spill. The officer will manage crowds and maintain boundary conditions in a manner that will minimize both patient and staff concerns. Only personnel wearing appropriate personal protective equipment shall be allowed in the area of the spill.

5. In the event of a minor spill (<1 L), only lab personnel who are trained in chemical identification, evaluation, and containment can clean up the spill. Lab personnel are always encouraged to contact a FROL for assistance.

6. In the event of a major spill (>1 L, or high hazard), only personnel trained in emergency response can clean up the spill. For McLean, this means an outside team of responders (e.g. Triumvirate).

7. As practical, after or during spill cleanup, the Security Manager or the Safety Officer shall notify the Administrator On Call of the action taken to clean up the spill.

8. Other than the Fire Department or the ambulance, the Safety Officer shall obtain approval from the Administrator On Call or Media Relations before contacting or responding to outside agencies (i.e. the press).

9. After cleanup of a spill of one liter or more, or when the events dictate, the Safety Officer will investigate the incident and prepare a report which contains recommendations to prevent reoccurrence.

3.5 Emergency Signage for Laboratories

A copy of this notice should be placed on ALL doors to lab areas:

In case of EMERGENCY
in this room

contact

NAME ____________________________ PHONE _____________

NAME ____________________________ PHONE _____________

NAME ____________________________ PHONE _____________

REPORT ALL EMERGENCIES

DIAL 2222

4.0 FIRST AID PROCEDURES

MEDICAL ASSISTANCE

Medical assistance should be administered under medical supervision at the Occupational Health Clinic, in Room 136 on the first floor of the Service Building (inside Human Resources Department Rm 131), at x2438 (9a.m to 4:30p.m. Mon-Tues, Thurs-Fri, 7:30am to 2:30p.m. Wed). During off-hours, when the clinic is closed, call Security at X2121. In case of Emergency, call x2222.

FIRST AID
The following first aid procedures should be administered immediately before intervention of medical personnel.

**Eye Contamination:** (Chemical or other Foreign Material in Eye)

**DO --** Immediately hold eyelids open and wash eyes with gentle stream of running water without delay. Continue washing at least 15 minutes. Call x2222.

Eye washes are located at sinks in laboratories. These need to be checked by a designated lab member on a regular basis. Malfunctions should be reported to Facilities for immediate correction.

**DO NOT --** Use other eyewashes or ointments.

**Chemical Exposure:**

**DO --** Immediately flush with water using sink or safety shower as needed. Apply stream of water while removing contaminated clothing. Place cleanest available material over burned area. Call x2222.

**DO NOT --** Apply ointments or other substances to extensive burns.

**Shock:**

**Recognition** -- Cold or clammy skin with beads of perspiration on the forehead and palms of hands -- Pale face -- Complaint by the victim of a chilled feeling, or even shaking chills -- Frequently, nausea or vomiting - Shallow breathing.

**DO --** Correct the cause of shock if possible. Keep victim lying down with airway open. If vomiting, turn victim's head to the side so that the neck is arched. Elevate victim's legs and keep the head lower than the trunk of the body if possible. Keep victim warm and give fluids if victim is able to swallow. Call x2222.

**DO NOT --** Do not give fluids if the victim is unconscious, semi-conscious, or if abdominal injury is suspected.

**Poisoning:**

**Signs indicating poisoning:** Odor of poison on breath, discoloration of lips and mouth, pain or burning sensation in throat. Unconsciousness, confusion, or sudden illness. Any or all of the above in presence of open containers of poison.

**DO --** Call x2222.

**Maintaining Breathing:**

There is need for help in respiration when breathing movements stop or when lips, tongue, and fingernails become blue. When in doubt, begin artificial respiration. No harm can result from its use and delay may cost the victim's life.

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**5.0 General Laboratory Safety Precautions**

Laboratory procedures involve many potential hazards. For your safety and that of your colleagues, be aware of these
hazards and learn how to minimize them. Attend required safety trainings and renew annual safety training through HealthStream. Get more information from more experienced personnel or members of the safety subcommittee if you have any doubts about the safety of a procedure. Always walk through hallways and laboratories. Use this Laboratory Safety manual and familiarize yourself with safety resources:

- McLean Hospital Research intranet
  https://research.mclean.harvard.edu/index.php
- MGH Environmental Health & Safety
  http://intranet.massgeneral.org/ehs/ehs_home.htm
- Harvard University Environmental Health & Safety – Lab Safety
  http://www.uos.harvard.edu/ehs/ih/lp.shtml
- National Institute of Occupational Safety and Health (NIOSH) Guide to Chemical Safety
  http://www.cdc.gov/niosh/npg/npgsyn-a.html

5.1 Smoking and Eating
1. No eating or drinking is permitted in laboratories.
2. Food should not be stored in refrigerators or areas designated for storage of any chemical or biological specimen.
3. In accordance with the Smoking Policy in the McLean Hospital’s Human Resources Policy and Procedure Manual and Joint Commission on Accreditation of Healthcare Organizations standards, the use of smoking materials within hospital buildings and tunnels, and outside of building entrances is prohibited. Smoking outside on the Hospital grounds is permitted in designated areas. Smoking areas are located away from building entrances.
4. Department Heads of the Hospital must provide adequate space for eating outside of laboratory areas. Separate offices, lunchrooms and lounge areas are considered appropriate locations for consumption of food. Food should not be stored in laboratory refrigerators. Coffee, tea, and hot water for beverages should not be prepared in laboratory areas. Cups, dishes and food utensils should not be present or be cleaned in laboratories. Where lack of appropriate space proscribes coffee breaks or lunches in the vicinity of the laboratories and restricted areas, personnel should avail themselves of the central cafeteria facilities provided by the hospital.

5.2 Fire
1. NO SMOKING is permitted in any laboratory, hospital building, tunnel, or outside building entrances.
2. No individual should perform potentially hazardous operations while working alone, especially where there is a danger of fire or explosion. This is particularly important on evenings, weekends, or holidays.
3. Everyone must know the location and understand how to operate fire alarms, fire blankets, safety showers, and eye washes.

4. In case of fire, pull closest fire alarm and call x2222. Look for the x2222 emergency telephone number on telephones in all areas where you will be working. If it is not on the telephone, notify the Telecommunications Office (x2481).

5. Designate a group meeting spot in the event of a fire alarm (e.g. deMarneffe foyer)

5.3 Chemicals
Hazardous chemicals can cause harm when they enter the body in sufficient amounts via inhalation, ingestion, injection or skin absorption. Harmful effects can also occur by eye or skin contact alone. The nature of the hazardous chemical and the routes by which it enters or contacts the body determine the type of controls that are needed. The Occupational Safety and Health Administration (OSHA) and other organizations have set occupational exposure limits on airborne chemical exposure. Keeping exposures below these limits is generally believed to protect employees. Permissible Exposure Limits (PELs) set by OSHA can be found at [http://www.osha.gov/SLTC/pel/index.html](http://www.osha.gov/SLTC/pel/index.html). PELs can also be found in the NIOSH Pocket Guide to Chemical Hazards, which are distributed in each Chemical Spill kit. Threshold Limit Values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) are available on MSDSs. Regardless of the established exposure limit for a particular chemical, all laboratory workers should take steps to minimize chemical exposure via all routes of entry.

5.3.1 Chemical Storage and Handling
Many potential hazards are associated with the storage and handling of laboratory chemicals. Understanding the properties of the chemicals and planning procedures by which they may be handled safely may minimize these hazards. Simply storing chemicals alphabetically is not prudent. Flammable, corrosive, explosive, and peroxide forming agents require special precautions. Storing incompatible chemicals together may have disastrous results.

The following guidelines are prudent for all chemical storage and handling:

**Chemical handling:** Use bottle carriers to transport chemicals. Close caps securely. Pour all chemicals carefully. Add acid to water, not water to acid. No non-technical assistant or untrained person is to assist in any chemical procedures involving flammable materials, strong acids, or corrosive chemicals, nor is such non-technical assistant to be "cleaning up" except when technical assistants, graduate students or staff members are present.

**Chemical transporting:** Use the rubber buckets with handles when transporting one or two bottles by hand; make sure your lab has these buckets. Always use a cart that has side guard rails and appropriate secondary containment to transport larger amounts of chemicals. Do not transport glass bottles containing chemicals on ordinary laboratory carts - the cart can easily tip over or bottles can slide off the cart.

**Labels:** Be sure all labels are securely attached and legible. Keep chemicals in their original container if possible. Label all secondary containers to avoid unknown chemicals and/or inadvertent reaction. Date all chemicals that may become unstable over time or are peroxidizable. Chemical labels need to have the full chemical name visible, not an abbreviation (e.g. Ethanol not EtOH).
Shelves: Avoid storing hazardous liquid chemicals on hard-to-reach shelves. Labels on stored chemicals should be able to be read easily. Shelves should be made of a chemically resistant material.

Incompatible chemicals: Incompatible chemicals must not be stored together. For each chemical, the hazardous nature must be considered individually and in relation to other chemicals in the area. Refer to the chemical MSDSs, or see Appendix C for a guideline to proper chemical storage.

Excessive storage: Avoid stockpiling chemicals. Purchase only what is needed. Use older stock first. Discard chemicals, which are no longer needed or that have expired.

Dishwashing: "Dishwashers" are to wash only empty dishes. Partially filled vessels that are to be washed must be emptied and rinsed by the technical staff. Make sure anything you dispose of in the trash will not be dangerous to Building Service personnel. These precautions are essential to avoid consequences such as inadvertent contact with toxic substances, potentially hazardous chemical reactions, ignition of flammable solvents or inappropriate disposal of chemicals.

Hallway storage: Hallways should not be used as storage areas for chemicals.

Chemical Fume hoods: In general, fume hoods should not be used for storage of chemicals, unless they are part of the experiment being conducted in the fume hood at that time. The exception is storage in a fume hood, which is specifically designed for that storage, and where experimental procedures are not carried out.

5.3.2 Flammable Liquids

Contact the Hospital Safety Officer (Andy Heally; x2621; AHEALY5@PARTNERS.ORG) for storage facilities for infrequently used solvents. See "Guidelines for Handling and Storage of Flammable Liquids" for more details (Section 6.3 and Appendix D).

Glass containers: Whenever practical, glass containers should not be used for storing flammable liquids. If a glass container must be used, the maximum allowable container size is one gallon.

Metal (non-DOT) or plastic containers: No more than 5 gallons of flammable liquid should be stored in regular metal or plastic containers.

Safety cans: Safety cans are the preferred containers for storage outside a flammable liquid storage cabinet. Safety cans are available in several sizes. They have spring-loaded spout covers that can open to relieve internal pressure when subjected to fire, and will prevent leakage if tipped over. Flame arresters are present in the spout to prevent flame propagation into the can. The maximum size of the container should be 5 gallons.

Flammable liquid storage cabinets: Use of flammable liquid storage cabinets is the method of choice for storage of small quantities of flammable liquids. Flammable storage cabinets are made of double-walled steel, and are equipped with flame arresters. Some models have doors that close automatically and some have sprinkler systems. Some may also have the capability to exhaust fumes. The cabinet must bear a label assuring that it is approved by Factory Mutual or Underwriters Laboratories.

Refrigerators/freezers: Refrigerators and freezers used for storage of flammable materials must be rated for flammable storage.
Maximum quantities: In general, no more than 10 gallons of flammable liquids per 100 square feet of laboratory space should be stored outside a flammable liquid storage cabinet or safety can.

Handling: Transfer and storage of flammable materials should not be in an area where a spill of the liquid could block an exit from the room, hallway, or building in the event of a fire, and where there is a source of ignition.

Incompatibles: Store flammable liquids separate from oxidizers, compressed gases, highly toxic materials, corrosives, and water-reactive chemicals.

5.3.3 Oxidizing Agents

Storage: Oxidizers should be stored on fire-resistant shelving, in a well-ventilated area.

Incompatibles: Oxidizing agents can initiate combustion and therefore should not be stored in the same area with fuel, such as flammable, organic chemicals, dehydrating agents, or reducing agents.

5.3.4 Perchloric Acid

At ordinary temperatures at concentrations of 72% and weaker, perchloric acid reacts as a strong, non-oxidizing acid. But at concentrations above 72% or at elevated temperatures (usually above 160 degrees Celsius), it is an exceedingly strong and active oxidizer and dehydrating agent. Anhydrous perchloric acid is unstable at room temperature and will ultimately decompose spontaneously with violent explosion.

Handling: Perchloric acid should be handled in a fume hood designed for perchloric acid use (must have a wash down system to prevent accumulation of crystals on the ductwork and the ductwork must be specially coated).

Incompatibles: Perchloric acid must be stored away from oxidizers and organic materials, including wood, paper, and cloth.

5.3.5 Peroxidizable Materials

Ethers, liquid paraffins, and olefins form peroxides on exposure to air or light and may detonate with extreme violence on becoming concentrated (as by evaporation of the more volatile ether) or on being disturbed by shock, heat or friction. Since these chemicals are packaged in an air atmosphere, peroxides can form even if the containers have not been opened (e.g. isopropyl ether, diethyl ether, dioxane, tetrahydrofuran, glyme, and diglyme). Simple removal of a screw cap or glass stopper has been known to cause detonation with fatal results. The hazard becomes particularly acute when the ether is being distilled, with resultant concentration of peroxides in the distillation flask.

The peroxides may be present in unopened ethers as purchased and form in freshly distilled ethers within less than two weeks. Formation is accelerated by light and by exposure to air (as in partly empty containers). It is not retarded by refrigeration nor accelerated by heat.

Common laboratory solvents that readily form peroxides:

Ethers
Dioxane
Tetrahydrofuran
Diethyl Ether
Ethylene Glycol Dimethyl Ether
Diethylene Glycol Dimethyl Ether
Isopropyl Ether

**Compounds Known to Autooxidize to Form Peroxides**

These compounds can readily form peroxides when exposed to atmospheric oxygen and light:
- aldehydes.
- ethers, esp. cyclic ethers and those containing 1º and 2º alkyl groups.
- compounds containing benzylic hydrogens.
- compounds containing allylic hydrogens (C=C-CH), including most alkenes, vinyl, and vinylidene compounds.
- compounds containing a 3º C-H group (decalin and 2,5-dimethylhexane).

A representative list of common peroxidizable materials can be found in Appendix E.

**Storage time limit:** Opened containers should be used up or discarded within 6 months after they are first opened. Unopened containers should be stored no more than one year. Containers should be dated upon receipt and upon opening the bottle.

**Container inspection:** Containers should be inspected for peroxide formation before opening or moving the containers. If crystals are present around the lip of the container or the liquid appears cloudy, do not move or open it. Colorimetric tests are available to test for peroxide formation. Although some ethers contain a peroxide inhibitor, they should still be inspected before opening.

**Dating of containers:** To ensure storage time limits are not exceeded, containers of peroxidizable materials should be dated when received, when opened and when tested for peroxide formation.

Guidelines for precautionary steps, preventative measures, detection, and removal of peroxides are described in section 6.3.4.

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**5.3.6 Corrosive Materials**

Corrosive substances are some of the most hazardous substances commonly encountered in the laboratory. In general, corrosive substances cause destruction of living tissue very rapidly at the site of contact (skin, eyes, respiratory tract and gastrointestinal tract). For this reason, proper selection and use of personal protective equipment is critical, when working with corrosives. See Section 15.0 for more specific guidance regarding personal protective equipment.

**Containers:** Whenever practical, corrosive materials should be purchased and stored in break-proof or break-resistant containers.
Storage: Many acids and alkalis are corrosive to their containers and other materials in a storage area. In general, they should be stored in a cool, dry area, equipped with corrosion-resistant shelving and plumbing, preferably in a corrosives storage cabinet. Acids react with many metals to form hydrogen gas, and alkalis may form hydrogen gas when in contact with aluminum. Since hydrogen forms an explosive mixture with air, accumulation of hydrogen in storage areas must be prevented.

5.3.7 Toxic Materials

Toxic materials include carcinogens, reproductive toxins (teratogens, mutagens, etc.) and acutely hazardous materials. Toxic materials that are simultaneously hazardous because of another attribute (i.e. flammable, corrosive) should be evaluated to determine which is the most significant hazard and stored accordingly.

Access to these materials should be restricted to the people involved in the experiment and people who have been informed of the hazardous properties of the chemical. These chemicals should not be stored in a hallway, stairway, or any other emergency egress path regardless of whether they are contained in a storage can or cabinet.

If the toxicity of the chemical is the primary hazard, the chemical should be stored in one of the following ways:

- In a continuously operating chemical storage fume hood;
- In a volatile storage cabinet with restricted access, such as a locked cabinet;
- In a hermetically sealed container at a temperature low enough to significantly reduce its volatility (i.e. a deep freeze).

5.3.8 Compressed Gas

Compressed gas cylinders present an important hazard because they have the potential for both mechanical and chemical hazards. The danger of fire or explosion is acute with a high rate of diffusion. Additional hazards arise from the reactivity and toxicity of the gas. Asphyxiation can be caused by high concentrations of even "harmless" gases such as nitrogen. Finally, the large amount of potential energy resulting from the compression of the gas makes a compressed gas cylinder a potential rocket.

Identification: The contents of the cylinder should be clearly marked. Gas lines from the cylinder should be labeled as to the gas and the laboratory served. A tag should be attached to the cylinder to indicate whether the cylinder is full, in use, or empty.

Handling: During transport cylinders should be secured to appropriate handcarts. Highly toxic gases should not be moved through corridors in areas where occupants not knowledgeable in the hazards of the gases may be present. Cylinder valves should be opened slowly, using a hand wheel or wrench while standing away from the valve opening. Compressed Gas Association (CGA) approved valves, fittings and other connections of the proper configuration for the gas being used, should be employed at all times.

Storage: All cylinders, regardless of whether they are full or empty, must be firmly secured at all times, using a clamp and belt. They should be stored in a cool, dry, well-ventilated area free from sources of ignition. Chemical oxidizers should be stored at least 20 feet away from flammable gas cylinders. A cylinder cap or regulator valve should always be
Empty cylinders: Cylinder caps should always be secured and cylinders should be clearly marked “empty”. Empty cylinders should be kept secured as noted above.

5.4 Radioisotopes

1. The rules and regulations established by MGH for working with radioisotopes must be followed explicitly. (See Section 9 on Radiation Safety for details.)

2. You must take an orientation by the Department of Environmental Health and Safety at the West End House Basement at MGH (offered every week) before working in an area where radioisotopes are being used. For information, call 617-726-2425. If you have never worked with radioisotopes before, the MGH safety office will instruct you to take an additional 6 hour course in the proper handling of radioactivity. This course is given several times a year at various locations. This office will also issue film badges and rings if necessary. (Determination of required attendance for the 6 hour course will be made by the MGH Radiation Safety Committee)

5.5 Explosive Materials

1. Any area in which a potentially explosive material is being used must be clearly marked.

2. Cylinders of compressed gas must be secured at all times with straps and clamps to walls or fixed benches.

5.6 Animals

1. All personnel using animals must be familiar with the Public Health Service "Guide for the Care and Use of Laboratory Animals" NIH Publication No. 85-23) and with the OPRR publication "Public Health Service Policy on Humane Care and Use of Laboratory Animals".

2. All personnel receiving an injury while working with laboratory animals should immediately wash the affected area with a suitable disinfectant, (rinse frequently but do not scrub an open wound). Report to the Occupational Health Clinic as soon as possible and file an accident report.

3. If you are to work with animals, know the potential dangers. Each person should have had a tetanus or tetanus booster shot within the past ten years. Wear gloves when handling animals. If ever scratched or bitten by an animal, wash the wound and go immediately to the Occupational Health Clinic.

4. Special precautions must be taken with primates. Do not touch or handle any monkey unless specifically employed and trained for this purpose.
5. Unauthorized personnel must not enter animal rooms.

6. Regulations governing animal use, care and handling are under the jurisdiction of the IACUC, questions should be directed to Chair. Information can also be obtained through McLean Research Intranet and IACUC website within https://research.mclean.harvard.edu/index.php.

5.7 First Aid
1. Anyone injured in any way is to go or be taken immediately to the Occupational Health Clinic, Service Building Room 136, Telephone x2438.

5.8 Equipment
1. Do not attempt to operate any piece of equipment unless you are fully acquainted with its operations.
2. Any instrument that is supplied with an electrical plug designated to ground the instrument must be used with a properly designed outlet. A grounded instrument can prevent serious electrical injury.
3. All laboratory equipment must be inspected by the Plant & Operations Department for approval prior to use.

5.9 Biological Materials

See Partner’s Institutional Biosafety Committee (PIBC) website for guidelines and recommendations: http://resadmin.partners.org/RM_Home/Research_Support_Depts/Research_Oversight/PIBC/PartnersPIBC.aspx

6.0 POLICIES AND GUIDELINES FOR HANDLING HAZARDOUS MATERIALS

6.1 Security of Hazardous Chemicals and Equipment
Federal and state regulations require that substances such as ethyl alcohol, scheduled drugs, radioisotopes, and high hazard chemicals be stored and used under conditions of strict security. You can download a list of high hazard chemicals from the “Chemical Hygiene Plan – Hazardous Chemicals” pull down menu on the Safety section of the Research intranet: https://research.mclean.harvard.edu/safety/Hazchemicals.php. Their acquisition and use or disposal must also be adequately documented, often in accordance with prescribed procedures. More recently, the possession and use of other substances has come under increasing regulation because of the hazards associated with toxicity or abuse potential.

Regardless of the rules and regulations governing hazardous chemicals, every investigator and laboratory worker should consider it his/her moral responsibility to prevent potentially hazardous substance (including nearly all chemicals) from falling into the hands of untrained personnel, the incompetent, or the criminally inclined. Especially in
a psychiatric facility it should be apparent that access to such substances must be strictly controlled. Every laboratory
worker, and especially each supervisor and principal investigator, has an extremely important responsibility to maintain
control over the chemicals and equipment within his/her jurisdiction. If it is apparent that existing security measures
are inadequate to prevent injury or access and possible theft or misuse by unauthorized persons, the Lab Safety Officer
should be consulted. In some cases the solution may be as simple as providing a locked storage cabinet, or in other
circumstances the location might be considered for connection to the hospital's ADT security alarm system.

6.2 Safety Procedures for Particularly Hazardous Substances
Additional protection is required for work with high hazard substances such as carcinogens, reproductive toxins (mutagens and
teratogens), biotoxins and substances with a high degree of acute toxicity. Listings of these materials can be found at
https://research.mclean.harvard.edu/safety/Hazchemicals.php. When working with these particularly hazardous materials the
following general procedures must be followed:

1. Obtain approval from the principal investigator to use these particularly hazardous chemicals.
2. Consult with LSSC and Lab Safety Officer for help generating SOP for use of chemical.
3. Consult the MSDS for exposure and emergency information to generate SOP.
4. Submit SOP to LSSC and Lab Safety Officer for approval prior to initiating work with chemical.
5. Order the smallest quantity of the chemical necessary to perform the procedure or experiment.
6. Wear appropriate personal protective equipment, paying close attention to glove type.
7. Work only in a properly functioning, uncluttered chemical fume hood or biological safety cabinet. This area should
   be posted or labeled as a “Designated Area” for the use of particularly hazardous materials. Permit only authorized
   personnel to use any Designated Area.
8. Determine, in consultation with the principal investigator and the Lab Safety Officer whether fume hood exhaust
   air should be filtered prior to discharge.
9. Label ALL containers with the contents, date, manufacturer’s name and hazardous properties of the material(s) in
   the containers.
10. Transfer particularly hazardous chemicals in tightly closed containers placed within a durable outer container.
11. Limit traffic through the immediate area.
12. Decontaminate the work surface immediately after working with these materials. To facilitate decontamination,
    work surfaces may be covered with stainless steel or plastic trays, absorbent paper with moisture-proof lining or
    other impervious material, which may be cleaned or disposed of as hazardous waste or biological waste after
    completing the procedure.
13. Securely store these materials immediately after use.
14. Label all waste materials with the corresponding chemical classification (e.g. Toxic) or as biological waste.
15. Log the amount of chemical used and other information in a High Hazard Use Log (see below). This form can be downloaded from: https://research.mclean.harvard.edu/safety/safetyforms.php

Laboratories that use particularly hazardous chemicals should document specific standard operating procedures (SOPs) for these materials with the help of the Lab Safety Subcommittee and the Lab Safety Officer.

### USE LOG FOR HIGH HAZARD AGENTS: MCLEAN HOSPITAL

<table>
<thead>
<tr>
<th>NAME</th>
<th>DATE</th>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
<th>AMOUNT</th>
<th>REASON</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When experiment is complete or chemical has been used completely, sign the form and return to Lab Safety Officer (Elena Chaboff). Further purchase of this chemical is prohibited until the form has been completed, signed, and returned to Lab Safety Officer.

### 6.3 Guidelines for Handling and Storage of Flammable Liquids

#### 6.3.1 General Requirements

**Flammable Liquid Storage Room**

The storage room for flammable solvents is located in the basement of the Service Building, Area #47 next to the Pharmacy. Procedures relating to the use of the room are outlined below:

(a) The room will be kept locked at all times. Designated administrators in MRC, Oaks, and NIC will keep key cards. When access to the room is needed, researchers should sign out the key-card from the relevant administrator and return it ASAP. Because the room is wired to the ADT security system, ext. 2121 must be called before entering the area and also upon leaving.

(b) All excess flammable solvents must be stored in this room. Always use a sturdy cart with side rails and appropriate secondary containment when transporting solvents to and from storage room.

(c) Your attention is also called to the accompanying classification of solvents (Tables 1 and 2, pp 40,41). Allowable types and sizes of storage containers are specified depending on the amount of flammable liquid and the degree of flammability. Wherever possible, you are requested to order solvents in safe containers. This applies particularly to Class I-A and I-B liquids. Safe containers are so designated by manufacturers of chemicals to assure containment of a highly flammable liquid should the container
fail. In general, they may be plastic, plastic-coated glass, metal coated or metal cans. Certain companies offer such containers for a limited number of solvents. In addition, approved flammable liquid storage containers are available for purchase. These containers are designed to protect the flammable liquids inside from the effects of heat and flame for a period of time in the event that a fire occurs. Flammable liquid storage cabinets are also designed to provide protection of stored flammable liquids from heat and flame.

(d) Care should be taken in ordering supplies to insure that unnecessarily large quantities of solvents are not stored in this area.

**GENERAL HAZARDS**

Flammable liquids present a serious fire and explosion hazard because the vapors are easily ignited and burn with great rapidity. The degree of danger depends mainly on the size of the container, the flash point of the liquid and the possibility of a source of ignition.

These hazards can be minimized by following proper storage and handling methods.

(a) Supervisors and persons in charge of laboratories must issue instructions covering the handling and storage of flammable liquids in their areas in accordance with the guidelines below. They must assure themselves that all users are fully trained and observe these regulations.

(b) Hazardous areas must be properly identified and the proper notices must be posted to eliminate sources of ignition. (e.g. No Smoking or open flame).

(c) Adequate fire protection must be provided and persons trained in its use.

(d) Flammable liquids must be stored in approved refrigerators (i.e. explosion-proof).

**LABORATORY USE**

(a) The quantity of flammable liquids in laboratories must be kept at a minimum at all times and stored in approved containers as outlined in Table 1, pg 40. The quantity on hand should be limited to one week's needs.

(b) In special cases (where extraordinary chemical purity must be maintained), storage in glass or plastic containers is permissible in lots of one gallon or less.

(c) Large glass bottles of flammable liquids must be handled separately (or singly) in rubber buckets or trays large enough to hold the contents if breakage occurs.

(d) All flammable liquid containers must be clearly identified as to contents.

(e) All containers must be stored on low shelves and in closed cabinets (preferably ventilated) when not in immediate use. Do not store containers of flammable liquids on the floor.

(f) Wherever possible flammable liquid should be stored in an approved storage cabinet or in an approved storage room. Flammable liquids must be stored separately from acids and bases.

(g) Adequate ventilation must be provided for any area where flammable liquids are in use.
(h) Adequate eye and appropriate personal protective equipment must be worn whenever flammable liquids are handled or processed and where splashing or spraying may occur. Advice concerning appropriate equipment may be obtained from the Lab Safety Officer.

(i) Suitable safe disposal methods must be arranged (See Section 7.2).

**STORAGE AND DISPENSING AREAS**

**Grounding:**

(a) Static electricity is a serious concern and is caused by the motion of the flammable liquid through the containers and the air. Static sparks may have other causes, also. Because static charges can generate during transfer, storage and handling, metal flammable liquid dispensing and receiving containers must be grounded together before pouring.

(b) In addition, large containers such as drums must be connected to an adequate electrical ground when they are used as dispensing or receiving vessels.

(c) The only approved location for dispensing flammable liquids is Area #47, Service Building which is equipped with a copper grounding strip attached to the rear wall.

**Drums:**

(a) Dispensing must be done from only one drum at a time and all dispensing of one material must be completed before the dispensing of another material is begun.

(b) When pouring liquids into drums, recognized combination vent and fill units must be used.

For more information on handling and storage of flammable materials, see:

**Boston Fire Department information on hazardous materials**
(https://research.mclean.harvard.edu/safety/Hazchemicals.php)

- Hazardous Materials Storage Practice
- Flammable storage guidelines
- Compressed gas limits

**BUILDING FIRE SAFETY**

All laboratory doors which open onto a corridor must be either closed or held open with automatic closers which release upon activation of the fire alarm. Doors must not be propped open. If you are having difficulty with your doors contact Facilities.

The hallways must be free of all materials i.e., file cabinets, gas cylinders, trash barrels, carts, liquid nitrogen tanks, etc.

**6.3.2 HAZARD CLASSIFICATION / ALLOWABLE STORAGE QUANTITIES IN LABORATORIES**
Hazard Classification

The Belmont Fire Department has very strict requirements on the amount of flammable and combustible chemicals that can be stored in any lab. The following tables are meant to assist you in determining the maximum allowable quantities for your lab.

**FLAMMABLE LIQUID:** A liquid having a flash point below 100°F. There are three classifications of flammable liquids.

- **CLASS IA** flash point < 73°F, boiling point < 100°F
- **CLASS IB** flash point < 73°F, boiling point ≥ 100°F
- **CLASS IC** flash point > 73°F and < 100°F

**COMBUSTIBLE LIQUID:** A liquid having a flash point at or above 100°F. Two classifications of combustible liquids are:

- **CLASS II** flash point > 100°F and < 140°F
- **CLASS IIIA** flash point > 140°F and < 200°F

Allowable Storage Quantities in Laboratories

Maximum allowable container sizes for specific classes of flammable liquids are shown in Table 1. Maximum allowable quantities of flammable liquids which may be stored in laboratories are shown in Table 2. The flash points and boiling points for a number of Class IA and Class IB liquids are shown in Appendix D.

Table 1. Flammable Liquids - Maximum Allowable Size of Containers

<table>
<thead>
<tr>
<th>Container Type</th>
<th>Class I-A</th>
<th>Class I-B</th>
<th>Class I-C</th>
<th>Class II</th>
<th>Class III Combustible Liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flash Point &lt; 73°F</td>
<td>Boiling Point &lt; 100°F</td>
<td>Flash Point &lt; 73°F and Boiling Point &gt; 100°F</td>
<td>Flash Point &gt; 73°F and Boiling Point &gt; 100°F</td>
<td>Flash Point &gt; 100°F and &lt; 140°F</td>
</tr>
<tr>
<td>Glass</td>
<td>1 pint</td>
<td>1 quart</td>
<td>1 gallon</td>
<td>1 gallon</td>
<td>1 gallon</td>
</tr>
<tr>
<td>Approved high-density polyethylene or metal</td>
<td>1 gallon</td>
<td>5 gallon</td>
<td>5 gallon</td>
<td>5 gallon</td>
<td>5 gallon</td>
</tr>
</tbody>
</table>
| In approved storage areas only
| Safety Cans          | 2 gallon  | 5 gallon  | 5 gallon  | 5 gallon | 5 gallon                     |
| Metal drums ICC specifications (storage vaults) | 60 gallon | 60 gallon | 60 gallon | 60 gallon | 60 gallon |
only)

<table>
<thead>
<tr>
<th>Examples</th>
<th>Flammable Storage Cabinets</th>
<th>Total Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethyl ether, methyl alcohol oxide, isopentane</td>
<td>Class I</td>
<td>4</td>
</tr>
<tr>
<td>Benzol, mercaptan, gasoline, ethyl alcohol, acetone, xylene, toluene</td>
<td>Class I+II+IIIA</td>
<td>8</td>
</tr>
<tr>
<td>Ethyl acetate, turpentine, methyl alcohol (30% in water)</td>
<td>Class II+IIIA</td>
<td>8</td>
</tr>
<tr>
<td>Methl amyl, kerosene</td>
<td>Class I</td>
<td>16</td>
</tr>
<tr>
<td>Stoddard solvents, amyl alcohol, fuel oil</td>
<td>Class I+II+IIIA</td>
<td>32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Excluding liquids in</th>
<th>Total quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>flammable storage cabinets</td>
<td>allowed in lab</td>
</tr>
<tr>
<td>Class</td>
<td>Class</td>
</tr>
<tr>
<td>Class I</td>
<td>Class I</td>
</tr>
<tr>
<td>Class I+II+IIIA</td>
<td>Class I+II+IIIA</td>
</tr>
</tbody>
</table>

6.3.3 HAZARD IDENTIFICATION

NFPA 704M SYSTEM: A numerical system for the identification of the fire hazards of materials developed by the National Fire Protection Association. The numbers given in the three columns have been taken from NFPA publication. For full definitions of the various degrees of hazard (0 to 4 in each category) see NFPA No. 704M-1969. Abbreviated definitions are as follows:

**HEALTH**

4 can cause death or major injury despite medical treatment.
3 can cause serious injury despite medical treatment.
2 can cause injury, requires prompt treatment.
1 can cause irritation if not treated.
0 no hazard.

**FLAMMABILITY**
very flammable gases or very volatile flammable liquids. 

can be ignited at all normal temperatures. 

ignites if moderately heated. 

ignites after considerable preheating. 

will not burn.

**REACTIVITY**

4 readily detonates or explodes. 

3 can detonate or explode, but requires strong initiating force or heating under confinement. 

2 normally unstable, but will not detonate. 

1 normally stable. Unstable at high temp and pressure. Reacts with water. 

0 normally stable. Not reactive with water.

An example of the NFPA 704M diamond label is shown below. The flash point, boiling point, ignition temperature and hazard identification for a number of Class IA and Class IB liquids are presented in Table 5, pg 122.

6.3.4 ** Peroxide Formation in Ethers**

There are frequent reports of laboratory accidents attributable to peroxide formation in stored ethers. These accidents have resulted in many serious injuries and some deaths. Ethers in contact with atmospheric oxygen form unstable peroxides that may detonate with extreme violence on becoming concentrated (as by evaporation of the more volatile ether) or on being disturbed by shock, heat or friction.
**PRECAUTIONS**

To minimize the possibility of peroxide detonation, the following precautions should be observed when ethers are used:

a. Purchase ethers that contain a stabilizer or inhibitor (such as BHT) to retard the formation of peroxides.

b. If there is any doubt about the peroxide content of a bottle of ether and the cap is stuck, or if a viscous phase or crystals are visible in the bottom of a bottle of ether, the contents are extremely dangerous and must be disposed of with special precautions. *Call Security or the Lab Safety Officer for assistance. Do NOT attempt to remove it yourself.*

c. When receiving and/or opening a bottle or can of any ether, write the expiration date on the container.

d. Do not store opened containers of ether for more than six months. Even temporary storage should be in the dark under an atmosphere of nitrogen and, preferably, over water.

e. Be sure that you provide for the ultimate disposal of any container of any ether (including dioxane) which you receive. Do not leave it on the shelf to become hazardous in the months and years after you have left the laboratory.

**PREVENTIVE MEASURE**

(a) Isopropyl ether and anhydrous ether must be purchased in small quantities and in iron containers if possible. The containers must be dated when placed in the storeroom, and be shielded from light and heat.

(b) All ethers used in the laboratories must be kept in cans rather than in bottles.

(c) Isopropyl, iso-amyl and anhydrous ethers must not be kept over six months. Ethyl and other ethers must not be kept over one year or beyond the expiration date on the container.

**DETECTION OF PEROXIDES**

Peroxidizable solvents should always be suspected of containing peroxides. Accordingly, the practice of routinely testing for peroxides prior to distillation, or other such potentially hazardous procedure, should be adopted. A little practice with standard peroxide detection procedures enables a chemist to make a rough estimate of the quantity of peroxide. The presence and level of peroxides can be rapidly and conveniently semi-quantitatively determined using commercially available peroxide test strips (example: EM Quant Test Strips by EMD Chemical, 10011-1). Alternatively, some peroxide tests, which, from a safety viewpoint, are satisfactory for monitoring laboratory samples are the iodide test and the ferrous thiocyanate test.

**IODIDE TEST:**

This is a test based on the oxidation of iodide to iodine by the peroxide. Several procedures that have been employed are as follows:

**Method A:** Add 0.5-1.0 ml of the material to be tested to an equal volume of glacial acetic acid to which has been added about 0.1 g of sodium iodide or potassium iodide crystals. A yellow color indicates a low concentration. A blank determination should be made. Always prepare the iodide-acetic acid mixture at the
time the test is made, because air oxidation slowly turns the blank to a brown color.

Method B: The procedures recommended by the Manufacturing Chemists' Association calls for addition of 1 ml of a freshly prepared 10% aqueous solution of potassium iodide to the 10 ml of the organic liquid in a 25-ml glass-stoppered cylinder of colorless glass that is protected from strong light. A yellow color (brown at high peroxide content) indicates the presence of peroxide.

**FERROUS THIOCYANATE TEST:**

This very sensitive test is based on the reaction of peroxides with colorless ferrothiocyanate to form red ferrithiocyanate. In this test, a drop of the compound is mixed with a drop of sodium ferrothiocyanate reagent. The latter is prepared by dissolving nine grams of FeSO₄·7H₂O in 50 ml of 18 per cent hydrochloric acid. Granulated zinc (0.5-1.0g) is added, followed by 5 g of sodium thiocyanate. When the transient red color fades, 12 g of sodium thiocyanate is added, and the liquid is decanted from the unused zinc into a clean stoppered bottle.

**Note:** It should be remembered that these tests are valid only for relatively simple chemicals. Some organic compounds may also act as oxidizing agents and, therefore, appear to give positive tests for peroxides. When dealing with peroxidizable materials that may be insoluble in the test solution, it may be necessary to use a cosolvent, such as peroxide-free isopropanol, to facilitate the peroxide test.

**PEROXIDE REMOVAL TECHNIQUES**

There are several laboratory procedures for removing traces of peroxides from solvents that should only be performed by knowledgeable, experienced staff. Note: do NOT attempt to remove peroxides from solvents that may contain a dangerously high amount of peroxides, including: old or expired bottles, ether bottles that have crystals in the bottle or around the cap, or a viscous layer. Call the Lab Safety Officer to coordinate having them removed.

**6.3.5 EXPLOSIONS OF SOLVENTS STORED IN REFRIGERATORS**

A frequent cause of laboratory explosions is vaporization of solvents within refrigerators. Although "explosion proof" refrigerators and deep freezers are available, most laboratory units are of the ordinary household type: the switches for the refrigeration units, lights, etc. have not been externalized nor sealed against vapors. Consequently, if vapors from stored solvents reach an explosive concentration, they are easily ignited by the refrigerator itself.

Because of the high volatility of such solvents as ethyl ether at room temperature, it is a natural reaction to want to refrigerate them. However, if the container does not have a vapor-tight seal, build up of vapors during refrigeration can result in an explosion. Furthermore, if the container is of glass, there is always the possibility that it will be broken or cracked when another container is pushed against it in the typically crowded refrigerator.

Because of the above consideration the following rules should be followed:

(a) Never store an explosive solvent (such as ether, acetone, benzene or toluene) in a closed space (such as a refrigerator, deep freeze, or cold room) at a temperature above its flash point if there is any possibility of vapor escaping from the container. These types of solvents belong in a vented flammable
(b) If special cases require such storage, use an "explosion proof" storage space.

The feeling that evaporation of ether at refrigerator temperature will be negligible is mistaken: the flash point of diethyl ether is -45°C. This means that at -45°C or any higher temperature, vaporization is sufficient to generate an explosive concentration of vapor within the containing space. Other flash points: Acetone, -18°C; Benzene, -11°C; Toluene, 4°C.

6.4 Laboratory Chemical Inventory and Hazard Warning Signage

The Belmont Fire Department requires that we comply with the National Fire Prevention Association Standard 704 on hazard labeling of laboratory areas and laboratory inventory. A sample inventory form and directions on how to complete the inventory are included on the following pages. A detailed list of NFPA 704 chemical hazard ratings is included in Appendix B.

If you have any questions or would like additional information please contact the Lab Safety Officer.

6.4.1 Instructions for Filling out the Hazardous Material Inventory Form

1. Complete a separate inventory for each room (lab module, lab room, cold room, procedure room, equipment room, etc.) in which chemicals are used or stored. Where two or more investigators share a space you can either arrange to fill out one inventory or each investigator can fill out an inventory for the chemicals / gases they are storing in the area. Please note if you are submitting a partial inventory for an area.

If you are responsible for several lab benches in a given lab module you only need to complete one inventory for those benches. Please make sure to indicate which lab benches your inventory describes.
If you are storing chemicals that are not included on the inventory list (including compressed gases), please write the chemical and amount on the last page of the inventory form.

3. A Hazardous Material inventory template is available online: [https://research.mclean.harvard.edu/safety/safetyforms.php](https://research.mclean.harvard.edu/safety/safetyforms.php)

### 6.4.2 Signage Requirements

A slightly modified version of the NFPA 704 diamond shall be employed to warn occupants and Fire Department personnel of the presence and identification of hazardous materials.

1. Placement of Sign

   a. The sign is to be placed in a designated zone area. Establishing a zone area allows institutions to place the sign on the door or on the wall directly alongside of the door. It also allows for differing needs of various institutions. The width of the zone would be 18” on each side of the door knob, and its height would be limited to directly above the door knob.

   b. When placed on the wall, it must be located so that it is obvious that the sign refers to that door.

   Large laboratories, which have several entrance doors, require labeling on each entry door with the same sign. The labels on the doors shall be based on the volumes in the entire lab unit.

   c. In laboratories located in a building where it is not evident that a lab may be present (i.e., off secondary corridors rather than a main corridor), the sign shall be placed on the last fire-rated entry partition separating the hazardous area from the low-hazard area.
2. **Sign Size**

   No sign smaller than a 2 in. by 2 in. 704 diamond shall be used; letters must be 1/2 in. min.

3. **Keeping Signs Current**

   a. Every effort shall be made to keep the information on the 704 diamonds current.
   
   b. Dated backup inspections shall be made available to the Boston Fire Department inspector on demand.

4. **704 Sign Marking Determination**

   a. **Flammability**
      
      1. The greatest volume of one code determines the marking.

      Exception: If a more severe code has at least a volume of 3 gallons or greater, then that code is used instead of a lower code of greater volume.

      For example:

      | Flammability Code Rating | Total Volume of Chemicals with that rating |
      |--------------------------|-------------------------------------------|
      | 4                        | 3 gallons                                 |
      | 3                        | 10 gallons                                |
      | 2                        | none                                      |
      | 1                        | 2 gallons                                 |
      | 0                        | none                                      |

      The Flammability code for the room sign is 4.

   2. If lab total volume is less than one pint for all solvents, the rating of the lab for this area shall be zero.

   b. **Health Hazard**

      Use the most severe rating code regardless of volume.

   c. **Reactivity**

      Use the most severe rating code regardless of volume.

5. **Compressed Gases**

   a. The symbol to be used to indicate the presence of a gas is a "G".

   b. Minimum letter size is to be 1/4 in.

      white square = inert gas
blue square = poisonous gas or corrosive gas
red square = flammable gas
yellow square = oxidizing gas

6. Water Reactives

If present in the lab, require a BFD Lab Inspector to assess the volumes for the 704 diamond determination.

6.5 Chemical Safety

6.5.1 Toxic Vapor Hazards

Mercury Vapor

Mercury vapor is toxic. The volatility of mercury is such that at ordinary room temperature vaporization from an exposed mercury surface is sufficient to raise the vapor concentration in the air of a closed room to 20 times the recommended threshold level (if the air is not replaced by means of adequate ventilation). For this reason, open mercury surfaces should never be allowed in a laboratory.

Wherever mercury is handled, it is spilled. Its density is so high and its viscosity so low that it cannot be poured without splashing, although the droplets may be microscopic. The spilled mercury cannot be completely cleaned up; droplets will break to microscopic size; will adhere to any smooth surface, will form amalgams with metals, will get into inaccessible cracks in table tops or between floor tiles. Because the vapor pressure of mercury goes up sharply with temperature, spills near a radiator are especially hazardous. Accordingly, although any spilled mercury should be cleaned up as completely as possible, one must assume that some exposed mercury remains.

In view of the above, the following recommendations should be followed wherever mercury is used.

(a) Many instruments that historically contained mercury are available in mercury-free form with equivalent accuracy (e.g., thermometers, manometers, sphigmomanometers, etc). Use mercury-free instruments whenever possible to minimize potential exposure to mercury.

(b) If any mercury has ever been spilled or transferred in a particular room:

(1) The room should be well ventilated when anyone is working in it; the only way to prevent the buildup of toxic concentrations in the air is to keep the air moving.

(2) If the room has been kept with doors and windows closed for long periods of time, the room air should be exchanged before the room is used.

If the use of mercury cannot in any way be avoided in the laboratory:

(c) Any mercury reservoirs should be well stoppered or covered with oil or water - preferably both covered and stoppered.
(d) Spill pans should be kept beneath vessels or apparatus containing mercury, to permit recovery of the mercury in case of a spill or broken vessel.

(e) Approval from the LSSC must be obtained for procedures using mercury.

**SOLVENT VAPOR HAZARDS**

Several other common chemicals have surprisingly low toxic threshold levels. Some recommended threshold vapor concentrations in room air for eight-hour exposure:

- **Formaldehyde** 0.75 ppm by volume
- **Nitric acid (HNO₃)** 2 ppm by volume
- **Phenol** 5 ppm by volume
- **Acetic acid (HOAc)** 10 ppm by volume
- **Hydrochloric acid (HCl)** 10 ppm by volume
- **Carbon tetrachloride (CCl₄)** 10 ppm by volume (hepatotoxin; restricted chemical)
- **Methylene Chloride** 25 ppm by volume (proposed cancer hazard)
- **Benzene** 1 ppm by volume (carcinogen; restricted chemical)
- **Chloroform (CHCl₃)** 50 ppm by volume (hepatotoxin)
- **Toluene** 200 ppm by volume
- **Diethyl Ether** 400 ppm by volume
- **Acetone** 1000 ppm by volume

The toxic vapor concentrations of the first group of compounds are of a lower order of magnitude than those of the second group. However, volatility of each of the compounds listed is sufficient to generate toxic concentrations in room air if care is not exercised in restricting vaporization from spills, open containers, etc. For the flammable solvents listed, these toxic vapor concentrations are very much lower than the lower limits of the explosive concentrations in air. For example, the lower limit for an explosive concentration of benzene - the lowest of the solvents listed here is 1.3% or 13,000 ppm, whereas the toxic vapor concentration is only 1 ppm. Therefore, one should be alert to the toxic hazards of flammable solvents as well as the dangers of fire and explosion.

Exposure to high vapor concentrations of these compounds can result in rapid appearance of toxic symptoms. In general, solvents are central nervous system (CNS) depressants and exposure to elevated concentrations may produce effects similar to alcohol intoxication. Prolonged and repeated over-exposure may result in a range of chronic health effects, including effects on the CNS, kidneys, liver and blood forming tissues. For example: exposure to benzene vapor concentration of more than 3,000 ppm will produce acute poisoning within minutes. However, a more common danger is probably that of long term low level exposure.

**PREVENTIVE MEASURES**

1. Keep containers closed when not in use and avoid breathing any vapors.  
2. Immediately seek medical treatment for
afflicted personnel.  3). Use in fume hoods only.  4). Clean up spills immediately in accordance with procedures described in Section 3.3 or as instructed by your supervisor, and remove all unnecessary apparatus from the area to permit rapid and complete removal of spilled liquid.

6.5.2  PHENOL TOXICITY

GENERAL PRECAUTIONS

A commonly used chemical whose toxicity is often under-estimated is phenol. It is highly toxic whether ingested, inhaled, or absorbed through the skin. Even if only fairly small areas of the body, such as a hand or arm, are affected, serious and possibly fatal poisoning may result. Absorption of phenol through the intact skin is so rapid that even immediate emergency measures can be ineffective.

Like other chemicals, phenol can be used safely if the user knows the hazards and applies this knowledge intelligently:

(a) Do not store bottles of phenol solutions on a high shelf from which they may fall, break and splash bystanders.

(b) Use extra care in handling phenol solutions; wear safety goggles and protective clothing; operate in such a manner that if the container should break, no one will be splashed.

(c) Take all appropriate measures to control phenol vapor concentrations in room air; keep phenol containers covered; if chromatograms are developed with solutions containing phenol, they should be dried in an operating fume hood; recover and dispose of any spilled crystals of phenol. The vapor concentration should not be allowed to exceed 5 ppm.

It is well known that phenol and its solutions (carbolic acid), and likewise cresol, can cause poisoning of the whole organism, apart from local cauterization of the skin.

Note: The following statements are taken from the MCA Chemical Safety Data Sheet SD-4, Phenol 1964.

From 10.1.2. Acute Toxicity: "Collapse and death may occur in a few minutes after massive exposure despite prompt emergency care."

From 5.2.2.5: "Clothing made of neoprene or other impervious material may be worn to protect the body against phenol splashes."

6.5.3  PERCHLORIC ACID

REFERENCES


HAZARDS OF PERCHLORIC ACID

Perhaps the most disturbing features of accidents involving perchloric acid are:
(a) The severity of the accidents;
(b) That the persons involved are, in the majority of cases, experienced workers.

The basic cause of accidents involving perchloric acid is due to contact with organic material, strong reducing agents, or to the accidental formation of the anhydrous acid.

(a) Perchloric acid is a strong acid, and contact with the skin, eyes or respiratory tract will produce severe burns.
(b) Perchloric acid is a colorless, fuming, oily liquid. When cold its properties are those of a strong acid, but when hot, the concentrated acid acts as a strong oxidizing agent.
(c) Aqueous perchloric acid can cause violent explosions if misused, or when in concentrations greater than the normal commercial strength (72%).
(d) Anhydrous perchloric acid is unstable even at room temperatures and ultimately decomposes spontaneously with violent explosion. Contact with oxidizable material can cause immediate explosion.

The following are common causes of fires and explosions involving perchloric acid.

(a) The instability of aqueous perchloric acid under various conditions. (Note that anhydrous perchloric acid is often formed inadvertently, as when aqueous solution or vapors are allowed to dry on reagent bottles, table tops or fume hood walls and ducts.)
(b) The dehydration of aqueous perchloric acid by contact with dehydrating agents such as concentrated sulfuric acid, phosphorus pentoxide or acetic anhydride.
(c) The reaction of perchloric acid with other substances to form unstable materials. Combustible materials, such as sawdust, excelsior, wood, paper, burlap bags, cotton waste rags, grease, oil and most organic compounds, contaminated with perchloric acid solution are highly flammable and dangerous. Such material may explode on heating, in contact with flame, by impact or friction, or may ignite spontaneously.

When considering the hazards involved in the use of perchloric acid, it should be clearly recognized that many of the reported serious laboratory accidents involved only small quantities (gm of reactant).

**STORAGE AND HANDLING**

(a) Laboratory quantities should be limited to a 450 g (1-lb) reagent bottle per hood. It is good practice to keep the reagent bottle in a hood or in a ventilated storage cabinet on a deep glass tray with sufficient capacity to hold the entire contents in case of breakage. The tray and outside of the reagent bottle should be rinsed daily or after each use. To prevent breakage, the larger supply bottle should be carried inside a spun glass padded container with sufficient capacity to catch the entire contents. It is good practice to pour, over a sink, from the reagent bottle directly into a graduated flask and hence into the digestion or reaction flask. When a perchloric acid bottle stopper is replaced, the reagent bottle should be rinsed and returned to the glass tray. All glass apparatus used should be rinsed thoroughly.
(b) Every effort should be made to avoid spillage and breakage. Wooden floors and shelves, or other combustible material, may absorb the perchloric acid solution and later contact with heat, such as a steam radiator or a hot plate, may result in intense fire or explosion. Perchloric acid spillage should be washed up immediately, using large quantities of water with repeated mopping up, and final thorough rinsing of the mopping-up material used.

(c) Perchloric acid beyond immediate requirements should be stored in a detached isolated building, away from combustible materials, protected against temperature extremes.

(d) The acid should be examined periodically (e.g. once per month) and any acid that shows signs of contamination or discoloration should be disposed of at once by pouring into ten times its own volume of cold water in a porcelain or glass vessel.

THE USE OF MAGNESIUM PERCHLORATE AS A DRYING AGENT

Several cases are on record in which magnesium perchlorate (anhydrone) has exploded while being used as a desiccant. Explosions involving magnesium perchlorate may be caused by the formation of perchloric esters in the system. It should be noted that methyl and ethyl perchlorate are violently explosive compounds.

FUME OR VAPOR EXTRACTORS

Use of a simple apparatus using a water aspirator or pump for the drawing of the fumes from a reaction vessel is recommended. Contamination of the fume cupboard duct with a dust/perchloric acid layer is then avoided and the vapors are drawn into water and discharged safely into the drain. A very similar apparatus is marketed for carrying out Kjeldahl digestions.

SAFE WORKING CONDITIONS

When assessing the minimum requirements to ensure safe working conditions the following three questions are of importance.

(1) Is the work involving the use of perchloric acid likely to be a continuing rather than an occasional and infrequent commitment?

(2) Will the use of perchloric acid be accompanied by any form of heating? (Heat of reaction and frictional heat should not be overlooked in this context).

(3) Is it intended to use perchloric acid more concentrated than 72% azeotrope

Should the answer to all these questions be "no", then, in the absence of any other contradictions, relaxation of the normal standards may be considered. If however, a positive answer is received to any of these questions, the working conditions should conform to the recommended standards. Nevertheless, care should always be exercised when handling perchloric acid.

HOODS

(a) Work involving the use of perchloric acid should be carried out in a suitable hood or fume-cupboard reserved for the purpose.

(b) Materials of construction should be chemically inert and non-absorbent so that they can be thoroughly
washed with water.

(c) The exhaust system should discharge to a safe location, and be capable of being washed down with water when necessary.

(d) Glazing should be splinter-proof armored glass.

(e) The painting of fume-cupboards is not recommended.

(f) **Note particularly that none of the hoods presently certified for use at McLean Hospital are designed for perchloric acid use.** The investigator should make every attempt to substitute experimental protocols before initiating any work with perchloric acid. Such work should only be performed in approved enclosures and under stringently controlled conditions. Consultation with the Laboratory Safety Subcommittee is strongly recommended before initiating procedures that involve perchloric acid.

6.6 Guidelines for Use and Storage of Compressed Gas Cylinders

**USE**

- Cylinders of compressed gas must be securely supported by wall clamps, where clamps are bolted into the wall and a single clamp is used to strap in one gas tank.

- Transportation in or through all buildings must be by means of a cylinder truck (dolly) with the safety chain secured.

- Protective cylinder caps must not be removed until the cylinder is made secure. Protective caps must be replaced on cylinders before returning to storage area.

- It is recommended when working with compressed gas cylinders that you wear safety glasses, work near an area equipped with eye washes, safety showers, and fire extinguishers.

- Select the right regulator (regulators are marked when supplied by the manufacturer for a given gas). Use a close fitting wrench with which to attach the regulator. Be sure the threads of the regulator are the same as the cylinder outlet. Do not permit dirt or oil to enter any part of the regulator.

- Protect the identification label on the cylinders.

- Never completely empty a cylinder as "suck back" contamination might result in an explosive mixture. Cylinders should be considered "empty" and turned off when the pressure gauge reads slightly above zero.

- Empty cylinders should be so marked (the symbol M.T. is preferred).

**STORAGE**

- All non-flammable compressed gases (air, nitrogen, carbon dioxide, etc.) are to be stored in the room designated for oxygen storage, located next to the receiving area.
• In the absence of a satisfactory central storage area for flammable compressed gases (hydrogen, etc.), the amount of such gases on hand at any given time should be restricted to that being used at the time. Storage will consequently be at the site of use.

• It is strongly recommended that standing orders be set up by users of compressed gases so that orders can be filled on short notice by telephone. By this means the number of cylinders in storage can be greatly reduced, cutting demurrage costs and decreasing hazards.

• Used and full cylinders should not be stored in the same area, and if vendor (e.g. Airgas) cannot come to pick up empty cylinder in a timely fashion, it should be brought to the receiving area and chained in the designated outside location.

• Cylinders should never be stored where they will be exposed to excessive increases in temperature, physical damage, or tampering by unauthorized persons.

6.7 Use and Storage of Cryogenic Liquids

GENERAL PRECAUTIONS

Personnel should be thoroughly instructed and trained in the hazards and proper use of cryogenic liquids, e.g. liquid nitrogen. Instruction should include emergency procedures, operation of equipment, safety devices, knowledge of the properties of the materials used, and personal protective equipment required.

Equipment and systems should be kept scrupulously clean to avoid contaminating materials that may create a hazardous condition upon contact with the cryogenic fluids or gases used in the system. This is particularly important when working with liquid or gaseous oxygen.

Mixtures of gases or fluids should be strictly controlled to prevent the formation of flammable or explosive mixtures. Extreme care should be taken to avoid contamination of a fuel with an oxidant, or the contamination of an oxidant by a fuel (i.e., oil). This is the primary defense against fire or explosion. As further prevention, when flammable gases are being used, potential ignition sources must be carefully controlled.

Work areas or laboratories where cryogenics are used and stored should be suitably monitored to automatically warn personnel when a dangerous condition is developing. When practical, it would be advisable to provide for the cryogenic system or equipment to be shut down automatically as well as to sound a warning alarm.

When there is a possibility of personal contact with a cryogenic fluid, full face protection, an impervious apron or coat, cuffless trousers, and high-topped shoes should be worn. Watches, rings, bracelets, or other jewelry should not be permitted when personnel are working with cryogenic fluids. Basically, personnel should avoid wearing anything capable of trapping or holding a cryogenic fluid in close proximity to the flesh. Gloves may or may not be worn, but if they are necessary in order to handle containers or cold metal parts of the system, they should be impervious, and sufficiently large to be easily tossed off the hand in case of a spill. A more desirable arrangement would be hand protection of the potholder type.

While there are many hazards related to cryogenic systems and fluids, it is possible to provide safe working conditions
in connection with their use. The best protection available for safe operation of cryogenic systems is a thorough knowledge of the materials and equipment used by those responsible for the design and operation of the systems.

For further information, the article from which the above information was taken may be found in "Safety in the Chemical laboratory", edited by Norman V. Steere, page 79.

HAZARDS

There are four principal hazards inherent in the use of cryogenic liquids -- flammability, high pressure gas, materials and personnel exposure. At McLean Hospital, liquid nitrogen is the only material presently in use relevant to this section. Anyone considering the use of other cryogenic fluids must consult with the Laboratory Safety Subcommittee before initiating such work.

Flammability:

Flammability is much less of a hazard if gases such as hydrogen, methane and acetylene are not in use. Even gases normally thought to be nonflammable can, however, increase the hazard of fire. This potential is due to the capability of liquified inert gases such as liquid nitrogen or liquid helium to condense oxygen from the atmosphere under the right conditions, thus causing oxygen enrichment or entrapment in unsuspected areas. Oxygen is required for combustion, and higher oxygen concentrations feed fires and cause them to burn more intensely. The presence of oxygen will greatly enhance the flammability of ordinary combustibles and even cause some noncombustible materials like carbon steel to burn readily under certain circumstances. Extremely cold metal surfaces are also capable of condensing oxygen from the atmosphere.

High Pressure Gas:

High pressure gas hazards are always present when cryogenic fluids are used or stored at or near their boiling point, which is usually the case. Some gas is therefore always present in the container. The large expansion ratio from liquid to gas provides a source for the build-up of pressures due to the evaporation of the liquid. The rate of evaporation will vary, depending on the characteristics of the fluid, container design, insulating materials, and environmental conditions of the atmosphere. Container capacity must include an allowance for that portion which will be in the gaseous state. These same factors must also be considered in the design of transfer lines and piping systems.

Materials:

Materials to be used in cryogenic service must be carefully selected because of the drastic changes in the properties of materials when they are exposed to extremely low temperatures. Materials that are normally ductile at atmospheric temperatures may become extremely brittle when subjected to temperatures in the cryogenic range, while other materials may improve their properties of ductility. Some metals that are suitable for cryogenic use are stainless steel (300 series and other austenitic series), copper, brass, bronze, and aluminum. Nonmetal materials that perform satisfactorily in low temperature service are Dacron, Teflon, Kel-F, asbestos impregnated with Teflon, Mylar, and Nylon. Once the materials are selected, the method of joining them must receive careful consideration to insure that desired performance is preserved by using the proper soldering, brazing or welding techniques and materials. Finally, chemical reactivity between the fluid or gas and the storage containers and equipment must be studied. Wood or asphalt saturated with oxygen has been known to literally explode when subjected to mechanical shock. When properties of materials which are being considered for cryogenic uses are unknown, or not to be found in the known guides, experimental evaluation should be performed before the materials are used in the system.
Personnel Exposure:

Personnel hazards exist in several areas where cryogenic systems are in use. Exposure of personnel to the hazards of fire, high pressure gas and materials failures previously discussed must be avoided. Of prime concern is bodily contact with the extreme low temperatures involved. A very brief contact with fluids or materials at cryogenic temperatures is capable of causing burns similar to thermal burns from high temperature contacts. Prolonged contact with these temperatures will cause embrittlement of the exposed members because of the high water content of the human body. The eyes are especially vulnerable to this type of exposure.

While the gases likely to be used at the McLean Hospital are not toxic, they are capable of causing asphyxiation by displacing the air necessary for support of life.

Storage:

Storage of cryogenic fluids is usually in a well insulated container designated to minimize loss of liquid due to boil-off. The fluids may be stored in small laboratory containers; the most common container is a double-walled, evacuated container known as the Dewar flask. The container may be of glass or metal. This type of container is used for cryogenic fluids in the temperature range of liquid nitrogen or above. Generally, the lower portion will have a metal base which serves as a stand. Exposed glass portions of the container should be taped to minimize the flying glass hazard if the container should break or implode. Metal containers are generally used for large quantities of cryogenic fluids and usually have a capacity of 10 - 100 liters. These containers are also of doubled walled design. The inner container is usually spherical in shape because this has been found to be the most efficient in use. Both metal and glass Dewars should be kept covered with a loose-fitting cap to prevent air or moisture from entering the container, and to allow pressure to escape. Cryogenic fluids with boiling points below that of liquid nitrogen require specially constructed and insulated containers to prevent rapid loss of gas.

Transfer of liquids from the metal Dewar vessels should be accomplished with special transfer tubes or pumps designated for the particular application. Since the inner vessel is mainly supported by the neck, tilting to pour the liquid may damage the container, shortening its life or creating a hazard due to container failure at a later date.

Piping or transfer lines should be so constructed that it is not possible for fluids to become trapped between valves or closed sections of the line. Evaporation of the liquid in a section of line may result in pressure build-up and eventual explosion. If it is not possible to empty all lines, they must be equipped with safety relief valves and rupture discs.

6.8 Standard Operating Procedures (SOPs) for Select Hazardous Agents

Standard Operating Procedures (SOPs) are intended to address hazards that are specific to a department, laboratory, research group, procedure or hazardous substance. They are designed to contain specific safety procedures developed by laboratory personnel, with the assistance of McLean’s LSSC as needed. An SOP must be developed for any operation or hazardous material for which the general safety procedures contained in this Lab Safety Manual are inadequate to address hazards. These procedures must be written to clearly identify additional or special precautions, controls, personal protective equipment and emergency procedures that are required, as well as the nature of the hazards the procedure is intended to minimize. Each SOP must be reviewed by (at least) the Principal Investigator and the Lab Safety Officer. The PI is responsible for reviewing all SOPs on a regular basis and update them if necessary.
An SOP that addresses the requirements noted above must be documented and maintained in an accessible location in the laboratory. In addition, personnel authorized to perform operations for which an SOP has been established must be trained in the specific procedure.

An SOP template can be downloaded from: https://research.mclean.harvard.edu/safety/Hazchemicals.php. In addition, template SOPs for several commonly used hazardous chemicals are also provided to facilitate SOP development. Examples of SOPs for commonly used particularly hazardous substances from Harvard University are available at www.uos.harvard.edu/ehs/longwood.

The procedure for the preparation, approval, and use of an SOP at McLean is as follows:

1. Based on the MSDS, federal, state, or local regulations, or McLean policy, a chemical is determined to pose a sufficient hazard to warrant an SOP. This can be decided by the laboratory itself, or can be required by the LSSC or Research Administration.

2. The PI or a member of the laboratory prepares an SOP for the specific use of that chemical in the laboratory.

3. A list of staff who will be trained in the procedures outlined in the SOP and their qualifications is provided.

4. The PI of the lab reviews and signs the SOP.

5. The SOP is submitted to the Lab Safety Officer for review.

6. The Lab Safety Officer reviews the SOP, and if acceptable forwards it to the LSSC for final approval. If the Lab Safety Officer requests changes or additional information, the laboratory must provide that prior to acceptance.

7. Once approved, the laboratory should keep the SOP in a location close to where the procedure will be done.

8. A copy of the approved SOP is kept in the LSSC’s records.

A non-exhaustive list of agents that require SOPs at McLean can be found at:
https://research.mclean.harvard.edu/safety/Hazchemicals.php

Generic templates for each agent can be downloaded and completed with laboratory-specific information.

7.0 MCLEAN HOSPITAL HAZARDOUS WASTE DISPOSAL POLICY

The McLean Hospital community is conscious of the need to separate the various waste streams generated throughout our facility. The three types of hazardous wastes: medical/biological, chemical/hazardous and radioactive must be treated separately from the regular hospital trash. Treatment for each is identified as follows:
7.1 Medical/Biological Waste

Massachusetts law requires that special care be taken when discarding biological waste. It must be in 3 ml polyethylene “red bag” liners identified with an international biohazard symbol. Ultimately it will be disinfected and ground up so that it is no longer physically dangerous. Then it’s discarded in a landfill.

Biological waste (“red bag waste”) is collected in Red Bag Waste boxes, which are large cardboard containers provided by Building Services. A red biohazard bag goes in the box, and when the box is ¾ full it should be closed up and picked up by Building Services. Building Services loads it on an outside disposal contractor’s truck. Once processed, the boxes are decontaminated and returned to us for reuse.

Refer to the Waste Disposal Table (Table 3, pg 64) for guidance. Also refer to the Waste Streams Diagram on the McLean Safety website: ://research.mclean.harvard.edu/newsite/safety/Hazwaste.php

General Recommendations

- Decontaminating Liquids.
  - Add hospital approved chlorine bleach (e.g. A-1 Bleach; does not contain mercury) to a final 1/10 dilution for 20 minutes or,
  - Add a phenolic to a final dilution of 1/20 for 20 minutes.

- Decontaminating Surfaces
  - Wipe with a 1/10 dilution of chlorine bleach, or
  - Wipe with 70% ethanol, or
  - Wipe with a 1/20 dilution of a phenolic

Only OSHA approved sharps containers are to be used for the disposal of sharps, i.e.; hypodermic needles and syringes, Pasteur pipettes, broken medical glassware, scalpel blades, disposable razors and suture needles.

The management of medical waste is a jointly held responsibility of the Building and Laundry Service Department (UNICCO), Environmental Health and Safety, Infection Control and waste generators throughout the hospital community. The Storeroom stocks OSHA approved sharps containers, which are required for the disposal of sharps. The Building Service Department stocks and distributes the biohazard boxes and 3 ml liners.

**Sharps** When a Sharps container is ¾ full, the end user should secure the container and discard the bucket into a biohazard box with a 3 ml polyethylene liner.

**Liquid medical waste** must be decontaminated via chemical means (see above) or autoclaved prior to sink disposal.

**Solid medical waste** (non-sharp) must be appropriately discarded into the biohazard boxes with 3 ml polyethylene liners. Building Service should be contacted at x2656 for a pick up. After medical waste is picked up by the Building Service Department it is stored onsite until weekly removal.

**Animal carcasses** generated in the research laboratories are packaged in 3 ml red bags and brought down to Mailman
Research Center (MRC 017), and stored in a freezer, which is collected by the Building Service Department weekly.

Human tissue must be discarded in a double-layer 3 ml red biohazard bag and placed in a biohazard box SEPARATE from other non-human tissue biohazard waste. Contact UNICCO to coordinate pickup with a Partner’s Health Care-run service that picks up waste and brings to a special incinerator.

A daily pick-up schedule, Monday through Friday, is conducted hospital wide or upon request. Weekends and holidays are by request.

Management (Cradle to Grave Method) of the Medical Waste Tracking Form is the responsibility of the Building Service Department, ensuring that the destination facility returns the completed Medical Waste Tracking Form within 30 days of pick-up. If the time frame is exceeded, Building Services will contact the Safety Officer, who is responsible for notifying the Department of Public Health. Building Services will forward all Medical Waste Tracking Forms to Environmental Health and Safety upon completion.

7.2 Hazardous/Chemical Waste

The proper collection of Hazardous/Chemical waste in individual laboratories is the responsibility of the principal investigator. Proper disposal of Hazardous/Chemical Waste is managed by, and the responsibility of, the Hospital Safety Officer. Hazardous Waste disposal is continually monitored by the E.P.A., D.E.P., and the M.W.R.A. through various permits that the hospital is required to maintain. Therefore, every effort shall be made to collect all regulated substances to prevent releases to the environment. Hazardous/Chemical Waste labels (available in the Facilities Office) must have all contents and associated hazards recorded and label firmly affixed to waste container prior to collection.

If you generate hazardous waste, you are responsible for:

- Determining if it is hazardous and what the hazards are
- Collecting it properly as hazardous waste in a Satellite Accumulation Area (SAA)
- Removing full hazardous waste from your SAA to the Main Accumulation Area (MAA)

7.2.1 Determining if a Chemical Waste is Hazardous

McLean Hospital is required to comply with sink/drain discharge limitations and prohibitions established by the local wastewater treatment authority, the Massachusetts Water Resources Authority (MWRA). McLean is required to report all chemical discharge violations to the MWRA that can result in enforcement actions. MWRA enforcement actions are cumulative and can ultimately result in fines or penalties that can jeopardize McLean’s research and operational capabilities. In addition, repetitive discharge violations can ultimately lead to requirements for closer monitoring of routine laboratory operations.

Prohibited Discharge Substances

The following substances are prohibited (in any amount or concentration), by MWRA 360 CMR 10.00, from sink or drain disposal. Please be aware that the dilution of substances for wastewater disposal purposes is strictly prohibited.
• Hazardous Wastes (see Listed Hazardous Chemical Wastes):

Hazardous wastes are prohibited from sink/drain disposal. A substance is deemed a hazardous waste if it:

1. Is listed in the Department of Environmental Protection (DEP) hazardous waste lists (see Appendix F) or is a mixture and contains any amount of the listed substance

2. Exhibits any one of the four hazardous waste characteristics:

   1) ignitability = flashpoint less than 140 degrees F and less than 24% by volume alcohol;
   2) corrosivity = ph less than 2 or greater than 12.5 or both;
   3) reactivity = contains cyanides or sulfides or may emit toxic vapor when mixed with water;
   4) toxicity = contains concentrations of substances in amounts greater than those listed in the TCLP table when tested using the toxicity characteristic leaching procedure (TCLP) test. A person generating such a waste can apply their knowledge without having to test substance.

Ensure that you have made a proper determination before disposing of substance.

• Corrosive Solutions (pH at/or below 5.5 or at/above 12.0):

Lab buildings at McLean contain wastewater treatment systems for the neutralization of lab wastewater that may be mildly corrosive. Therefore, the discharge of weak corrosive solutions (5.5 < pH <12.0) to the laboratory sinks in small quantities (less than one liter per hour) is permissible. Corrosive solutions with pH ranges (2.0< pH<5.5) and (12.0<pH<12.5) must be neutralized before sink/drain disposal. Corrosive solutions with pH ranges (pH<2.0) and (pH>12.5) at the conclusion of the lab process must be managed as hazardous waste.

![Corrosive Substance Sink Disposal Guide](image)

- Flammable or Explosive Substances

Solutions that are flammable (flash point less than 140F) or explosive at the time of disposal - must not be disposed into a sink or drain. The sink or drain disposal of flammables/explosives (based on nature and quantity) can create an unsafe condition for lab and/or facilities maintenance personnel especially during periods of “low flow” conditions (e.g. after normal working hours). Examples of these substances include: acetone, gasoline, methyl ethyl ketone, ketones, aldehydes, peroxides, ethers, xylene, toluene, or alcohols.

• Mercury or mercury salts or dyes
• Hexachlorobutadiene
• Methylene Chloride
• Benzene
• Xylene
• Infectious/Biological Waste (see Biosafety page)
• Radioactive wastes in excess of established limits (see Radiation page)
• Polychlorinated Biphenyls (PCBs)
• Any noxious or malodorous liquid, gas or solid in amount to create a nuisance
  • Any solid or viscous substance in amount or size that may obstruct flow (e.g. sand, animal tissues, bones, plastics, rubber, glass, wood chips, wood shavings, etc.)
  • Any liquid or vapor with a temperature higher than 180°F.
• Any slug (e.g. excessive quantities of viscous material) or sludge
• Oils, Fats, grease at levels above 300 mg/l
• Petroleum Hydrocarbons at levels above 15 m

7.2.2 LIMITED DISCHARGE SUBSTANCES

• MWRA Regulated Substances List (see Appendix G, pg 159)

In addition to the prohibited substances above, the MWRA maintains a list of substances that can be discharged to the sewer system in extremely low concentrations. The MWRA list posts daily concentration thresholds of regulated substances in a building’s wastewater discharge to MWRA system. A building’s discharge would include the aggregate discharge of all laboratories and operations throughout a building.
Given the volume of chemical usage in our lab buildings and the extremely low thresholds, the substances on this list – or mixtures containing these substances - may NOT be disposed of by the sink. They must be collected as Hazardous Waste. You should note that the MWRA assesses various permit fees by monitoring and calculating the total quantity of these substances in McLean’s wastewater discharge. These permit fees can add up to thousands of dollars so minimizing or eliminating discharge of these substances will help to control these permit fees.

Please Note: RINSEATE – In most cases, the first rinse (w/water) from containers, beakers, etc. which previously contained any of the prohibited or limited substances mentioned above must not be disposed into a sink or drain however, subsequent rinses, in which very low concentrations of these materials exist, may be discharged to a sink or drain.

7.2.3 COLLECTION OF HAZARDOUS CHEMICAL WASTE IN SATELLITE ACCUMULATION AREA (SAA)
McLean Hospital is designated as a Small Quantity Generator of hazardous waste. Consequently, we must adhere to the following rules (from 310 CMR 30.351) concerning the collection and storage of hazardous chemical waste within the laboratory.

SAA Requirements:

1. Area must be under the control of the individual directly responsible for the process that generates the waste.

2. Satellite area must be at or near each specific point of generation where wastes initially accumulate.

3. The wastes must be generated as a result of a process occurring at the specific point of generation where the wastes are initially accumulated.

4. Only one container per waste stream may be in use at any one time.

5. Maximum capacity of containers is as follows: 55 gallons of hazardous waste and/or 1 quart of acutely hazardous waste.

6. When the container is filled or exceeds the storage limits, it shall be dated immediately and within 3 days moved to the main storage area (MAA) and be made compliant with all regulations pertaining to that area.

7. The surface underlying the containers shall be free of cracks, gaps, and sufficiently impervious to contain leaks.

8. Each container shall be marked with a Hazardous Waste label that contains the following information:
   - The words “Hazardous Waste”
   - The chemical names (e.g., acetone, toluene) and % of each hazardous chemical
   - The hazard associated with those chemicals (e.g., ignitable, toxic, dangerous when wet).

   (see Harvard’s waste labeling tool for assistance: http://www.uos.harvard.edu/ehs/environmental/hw_label_tool.shtml)

9. Containers must be in good condition. (Free of rust and/or structural damage).

10. Container must be compatible with waste inside.

11. Container must be closed during storage.

12. Containers must be kept in secondary containment large enough to catch the entire volume of the container.
13. Containers must be spaced so they can be inspected.

14. INSPECTION REQUIREMENTS –
   a) The satellite area must be inspected weekly.
   b) Logs of inspections are required.
   c) A generator shall, during the inspection, remedy all malfunctions, deteriorations, operator errors, and discharges that any inspection reveals.

15. Containers of incompatible waste must be separated by means of berm, wall, or other device.

7.2.4 TRANSPORT OF WASTE TO MAIN ACCUMULATION AREA (MAA)

Hazardous/Chemical waste is stored in the Main Accumulation Area (MAA) / Flammable Storage Room, which is area #47 in the Service Building. Access to the MAA is through key card, which can be signed out from a designated administrator in MRC, Oaks, or NIC. Before entering the MAA, the Security Department must be notified by calling ext. 2121.

Transport waste bottles in appropriate secondary containment to the MAA. Fill out a Chemical Waste Log Sheet (download from: https://research.mclean.harvard.edu/safety/safetyforms.php) for each waste bottle you are disposing of, and place that on the shelf directly across from the door. These log sheets comprise the Hospital’s chemical waste manifest.

Place your waste in the secondary containers provided in the MAA. Make sure you do not mix incompatible wastes (i.e. do NOT put an oxidizer in the same container as a flammable solvent).

The accumulation of chemical waste is regularly monitored by the Department of Environmental Health and Safety at least weekly and is removed quarterly by a licensed transporter to a designated Hazardous Waste Facility for treatment. (Classification: SQG, USEPA I.D. # MAD046514535)

All Hazardous Waste Manifests are managed by the Hospital Safety Officer who is responsible for signing and properly distributing all Hazardous Waste Manifests (Copy 6: Destination State, Copy 7: Generator State, Copy 8: Retain until copy 3 is received, EH&S file - 3 Years). *DEP to be notified if copy 3 is not received within 45 days.

7.3 Radioactive Waste

The Massachusetts General Hospital NRC Material License governs our use of Radioactive Material through the issuance of Permits, which are granted through the MGH Radiation Safety Committee. Permit operations which generate radioactive waste are closely monitored and utilize Harvard University's, MGH and the following guidelines: Radioactive waste must be properly packaged according to the MGH Radiation Safety Manual. Personnel from the MGH Radiation Safety Office conduct weekly laboratory inspections at which time waste is picked up transferred to the waste room. For special or non-routine pick-ups, M.G.H. Radiation Safety Office personnel should be contacted. All laboratories permitted to store and handle Radioactive Materials must be registered with the M.G.H. Radiation Safety Office.
7.3.1  Radioactive Waste Disposal Guidelines

1. Keep dry and liquid wastes separate
2. Do NOT put lead containers in with waste
3. Deface all radioactive labels
4. Do not mix isotopes (except $^{14}$C and $^{3}$H)
5. Do NOT put sharps into waste
6. Gallon jugs of liquid waste shall be double bagged in small bags
7. When waste is being put out for disposal, tape the top shut and attach a radioactive waste tag.
8. When disposing of barrels, shielding, lead, or any other material, remove all radiation labels.

7.3.2  Radioactive Waste Codes

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DL</td>
<td>Isotope with $T_{1/2} \leq 65$ days</td>
</tr>
<tr>
<td>DM</td>
<td>Isotope with $65 &lt; T_{1/2} \leq 120$ days</td>
</tr>
<tr>
<td>DI</td>
<td>$^{14}$C or $^{3}$H waste with low Specific Activity (no sharps, metal or glass in waste)</td>
</tr>
<tr>
<td>DC</td>
<td>Isotope with $T_{1/2} &gt; 120$ days</td>
</tr>
<tr>
<td>SX</td>
<td>Liquid scintillation vials containing only $^{14}$C or $^{3}$H w/concentrations &lt;0.05 µCi/ml</td>
</tr>
<tr>
<td>SR</td>
<td>Liquid scintillation vials containing $^{14}$C or $^{3}$H w/concentrations &gt;0.05 µCi/ml or any other isotope.</td>
</tr>
<tr>
<td>RDS</td>
<td>Animals containing isotopes with $T_{1/2} \leq 65$ days, may also contain $^{14}$C or $^{3}$H cdc &gt;0.05 µCi/g</td>
</tr>
<tr>
<td>RDL</td>
<td>Animals containing isotopes with $T_{1/2} &gt; 65$ but $\leq 120$ days, may also contain $^{14}$C or $^{3}$H &lt;0.05 µCi/g</td>
</tr>
<tr>
<td>RE</td>
<td>Animals containing $^{14}$C or $^{3}$H with concentration &lt;0.05 µCi/g</td>
</tr>
<tr>
<td>WL</td>
<td>Aqueous liquids</td>
</tr>
<tr>
<td>UA</td>
<td>Uranyl Acetate</td>
</tr>
<tr>
<td>UO</td>
<td>Other uranyl compounds</td>
</tr>
</tbody>
</table>
TO HAVE RADIOACTIVE WASTE PICKED UP, OR FOR OTHER QUESTIONS, CONTACT:

Lori Connors

MGH Radioactive Waste Supervisor

Tel. 617-724-4576

Fax. 617-726-5126

Email: lconnors1@partners.org

7.3.3 SINK DISPOSAL

Within each registered research laboratory, there are authorized sinks in which limited quantities of radioactive waste may be disposed of. These sinks must be labeled with a Sink Disposal Sticker ("Radioactive Material") obtained from MGH Radiation Safety. The Sink Disposal Record form must be utilized and posted next to the sink on which relevant data, such as type of nuclide, amount of radioactivity, date, etc. is recorded each time radioactivity is disposed of in the sink. Sink disposal logs will be maintained by each Permit holder and photocopy sent to the Safety Officer.

Radioactive animal carcasses are kept in the lab freezers of the individual Principal Investigators until they are "safe". They are then relocated to the basement freezer in Room 117 of Mailman Research Center for disposal. All carcasses and bedding must be collected and packaged in clear 6 ml plastic bags and identified with a Harvard radioactive waste tag firmly attached to the neck of the bag. Waste supplies may be obtained by contacting the Safety Officer at x2620.

7.4 Waste Disposal Guidelines

<table>
<thead>
<tr>
<th>HOUSEHOLD TYPE</th>
<th>EXAMPLES</th>
<th>DISPOSAL</th>
<th>INFORMATION &amp; SERVICE RESOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-hazardous, non-recyclable items; &quot;regular trash&quot;</td>
<td>Everyday, non-hazardous waste items such as non-recyclable paper, plastics, packaging materials, etc.</td>
<td>Regular waste bins</td>
<td>Building Services: x2656</td>
</tr>
<tr>
<td>Foodstuffs</td>
<td>Food, drink, gum, candy, wrappers, cups</td>
<td>Regular waste bins NOT IN LABORATORIES</td>
<td>Building Services: x2656</td>
</tr>
<tr>
<td>Paper (non-confidential)</td>
<td>Office printer paper, envelopes, etc.</td>
<td>BLUE recycle bins</td>
<td>Building Services: x2656</td>
</tr>
</tbody>
</table>

Work Order Request (insert link: http://hisapps2.mclean.harvard.edu/gpmworequest.aspx)
<table>
<thead>
<tr>
<th>Paper (confidential)</th>
<th>Documents that include patient information, McLean's proprietary information, and/or employee data</th>
<th>GRAY locked bin</th>
<th>Building Services: x2656</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-paper items</td>
<td>Bottles, cans, plastic, some styrofoam</td>
<td>BLUE recycle bins</td>
<td></td>
</tr>
<tr>
<td>Cardboard</td>
<td>Packaging materials</td>
<td>Break down and place by regular trash bin or outside doorway</td>
<td>Building Services: x2656</td>
</tr>
<tr>
<td>Batteries</td>
<td>Consumer type (AA, AAA, C, D...)</td>
<td>Regular waste containers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If damaged or leaking, follow CHEMICAL/TOXIC disposal instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All other batteries</td>
<td>Lead-acid, Ni-Cads, etc.</td>
<td>Follow Universal Waste procedures</td>
<td>Laboratory Safety Officer</td>
</tr>
<tr>
<td>Fluorescent Light</td>
<td>Overhead lighting fixtures, specialty lighting</td>
<td>Handled by Facilities/Maintenance</td>
<td>Facilities: 2621</td>
</tr>
<tr>
<td>Bulbs</td>
<td></td>
<td></td>
<td>Work Order Request</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><a href="http://hisapps2.mclean.harvard.edu/gpmworequest.aspx">http://hisapps2.mclean.harvard.edu/gpmworequest.aspx</a></td>
</tr>
<tr>
<td>Computers</td>
<td>Old/broken whole or parts</td>
<td>Remove or “sweep” hard drive and put computer in Blue recycling bins located in tunnel system at base of stairs leading to Pierce Hall</td>
<td>Research Information Systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><a href="http://hisapps2.mclean.harvard.edu/gpmworequest.aspx">http://hisapps2.mclean.harvard.edu/gpmworequest.aspx</a></td>
</tr>
<tr>
<td>Electronics</td>
<td>TV’s, monitors, etc.</td>
<td>Handled by Facilities/Maintenance</td>
<td>Work Order Request</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><a href="http://hisapps2.mclean.harvard.edu/gpmworequest.aspx">http://hisapps2.mclean.harvard.edu/gpmworequest.aspx</a></td>
</tr>
<tr>
<td>Printer and FAX</td>
<td>Spent or damaged ink office printer and fax machine cartridges</td>
<td>Recycle through vendor</td>
<td></td>
</tr>
<tr>
<td>machine cartridges</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| BIOHAZARDOUS/       | EXAMPLES                                                                                         | DISPOSAL                                                  | INFORMATION & SERVICE RESOURCE |
| MEDICAL             |                                                                                                 |                                                           |                           |
| Infectious Agents   | Cultures and stocks of infectious bacteria,                                                     | BL1 waste: Liquid: inactivate prior to drain               | MGH Biosafety Office:    |
viruses, fungi, or material contaminated with such agents
disposal. Solid: directly into lined, red bag biohazardous waste containers

617-724-4579
McLean Lab Safety Officer: x2022
McLean Biosafety Manual

BL2 waste: Liquid: inactivate with bleach or other means prior to drain disposal. Solid: inactivate (chemical or autoclave) prior to disposal into lined, red bag biohazardous waste containers

Building Services: x2656

Sharps
Needles, syringes, Pasteur pipettes, scalpel blades, razors, contaminated broken medical glassware
Labeled red plastic sharps containers.
When full, place small sharps containers into lined, red bag biohazardous waste containers.
For large sharps containers, schedule pickup with Building Services.

Human and animal blood and blood products
Containers of blood and body fluids; items contaminated with blood and body fluids
Place into lined, red bag biohazardous waste containers
MGH Biosafety Office: 617-724-4579
McLean Lab Safety Officer
McLean Biosafety Manual

Pathological waste from clinical and Human anatomical parts, organs, body fluids in
Place into doubly lined, red bag biohazardous waste

Building Services: x2656
Work Order Request:
### Research Activities
- **Containers**
  - Boxes kept separate from other waste. Contact UNICCO to schedule pickup.
  - [http://hisapps2.mclean.harvard.edu/gpmworequest.aspx](http://hisapps2.mclean.harvard.edu/gpmworequest.aspx)
  - Or call x2623
  - ACF Manager, Erin Blanchfield: x3249
  - IACUC policies: [https://research.mclean.harvard.edu/IACUC/policies.php](https://research.mclean.harvard.edu/IACUC/policies.php)

### Animals
- **Animal carcasses**
  - Place in red biohazard bag and label with Name, Date, # animals, IACUC protocol.
  - Place in animal carcass freezer in ACF
  - ACF Manager, Erin Blanchfield: x3249
  - IACUC policies: [https://research.mclean.harvard.edu/IACUC/policies.php](https://research.mclean.harvard.edu/IACUC/policies.php)

### Animal waste, contaminated
- **Bedding and excreta from animals treated with toxic agents, viruses**
  - Place in red biohazard bag and then into lined, red bag biohazardous waste containers.
  - ACF Manager, Erin Blanchfield: x3249
  - IACUC policies: [https://research.mclean.harvard.edu/IACUC/policies.php](https://research.mclean.harvard.edu/IACUC/policies.php)

### Special Biowaste from research; Biotechnological by-products and effluents
- **Wastes from genetically altered living organisms including their biochemical by-products.**
  - Chemically inactivated or autoclaved prior to disposal into lined, red bag biohazardous waste containers.
  - MGH Biosafety Office: 617-724-4579
  - McLean Lab Safety Officer
  - McLean Biosafety Manual
  - [https://research.mclean.harvard.edu/safety/docs/MGH_Biosafety_Manual.pdf](https://research.mclean.harvard.edu/safety/docs/MGH_Biosafety_Manual.pdf)

### Chemicals

<table>
<thead>
<tr>
<th>CHEMICALS</th>
<th>EXAMPLES</th>
<th>DISPOSAL</th>
<th>INFORMATION &amp; SERVICE RESOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SINK DISPOSAL OF HAZARDOUS CHEMICALS IS STRICTLY PROHIBITED.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Many materials like heavy metals (mercury, nickel, zinc, copper, lead, silver), formaldehyde and pesticides can interfere with municipal wastewater treatment processes, especially those that rely on secondary biological treatment, and must be kept out of sinks.

**THIS IS ESPECIALLY CRITICAL FOR ALL MERCURY-CONTAINING MATERIALS**

**USE MSDSs TO ASSIST IN IDENTIFYING AND CHARACTERIZING YOUR CHEMICAL WASTES**

**NOTE:** Do not use MSDSs to determine mercury content.

**CONTACT LAB SAFETY OFFICER FOR ASSISTANCE AND SPECIFIC DISPOSAL INSTRUCTIONS WHEN NECESSARY**

<p>| Ignitables | All flammable or combustible substances and mixtures with flash points less than 140°F | Place in Satellite Accumulation Area (SAA). | McLean Lab Safety Officer |</p>
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Storage Location</th>
<th>Responsible Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxidizers</td>
<td>Materials that readily yield oxygen to stimulate combustion such as chlorates, permanganates, peroxides, and nitrates</td>
<td>Place in Satellite Accumulation Area (SAA) When full, bring in secondary container to Main waste Accumulation Area (MAA) in basement of Service Bldg (across from SVC-03)</td>
<td>Hospital Safety Officer, Facilities Director (Andy Healy, x2621)</td>
</tr>
<tr>
<td>Corrosives</td>
<td>pH is ( \leq 2 ) or ( \geq 12.5 )</td>
<td>Place in Satellite Accumulation Area (SAA) When full, bring in secondary container to Main waste Accumulation Area (MAA) in basement of Service Bldg (across from SVC-03)</td>
<td>Hospital Safety Officer, Facilities Director (Andy Healy, x2621)</td>
</tr>
<tr>
<td>Toxics</td>
<td>Includes acetonitrile, anilines, amines, benzenes, cyanides, ethylene oxide, formalin, methyl methacrylate, mercury and</td>
<td>Place in Satellite Accumulation Area (SAA)</td>
<td>McLean Lab Safety Officer</td>
</tr>
</tbody>
</table>

How to label waste:

- [https://research.mclean.harvard.edu/safety/Hazwaste.php](https://research.mclean.harvard.edu/safety/Hazwaste.php)
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Disposal Instructions</th>
<th>Responsible Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acutely Hazardous Waste (P-List)</td>
<td>Chemicals the EPA has determined to be acutely, highly hazardous to humans and/or the environment. Includes acrolein, epinephrine, osmium tetroxide, sodium azide.</td>
<td>Place in Satellite Accumulation Area (SAA). **Empty container must also be labeled with hazardous waste label and brought to SAA.</td>
<td>McLean Lab Safety Officer</td>
</tr>
<tr>
<td></td>
<td>See List Appendix E</td>
<td></td>
<td>Hospital Safety Officer, Facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Director (Andy Healy, x2621)</td>
</tr>
<tr>
<td>Reactives</td>
<td>Potentially unstable materials; may react violently with water or generate toxic gases; cyanide and sulfide-bearing wastes that can emit toxic vapors at pHs between 2 and 12.5; materials that may be heat or shock sensitive; aged and peroxidized ethers.</td>
<td>Place in Satellite Accumulation Area (SAA)</td>
<td>McLean Lab Safety Officer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hospital Safety Officer, Facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Director (Andy Healy, x2621)</td>
</tr>
<tr>
<td>Ethidium Bromide</td>
<td>Gels at &lt;0.1%</td>
<td>Double bag and place in regular trash</td>
<td>McLean Lab Safety Officer</td>
</tr>
</tbody>
</table>

All its compounds, pesticides, phenols...

When full, bring in secondary container to Main waste Accumulation Area (MAA) in basement of Service Bldg (across from SVC-03)

Hospital Safety Officer, Facilities Director (Andy Healy, x2621)

How to label waste:

https://research.mclean.harvard.edu/safety/Hazwaste.php
- **Solutions**
  - Solution at <10mg/ml
    - Collect as hazardous waste, label appropriately and place in SAA for pickup
  - Solution at >10mg/ml
    - Collect in a plastic jar with lid, label as hazardous waste, and place in SAA for pickup
  - Solution at >0.1%
    - Discard in sink, only if buffer ingredients are not hazardous

**Buffers, stains and other common lab solutions**

- User must assure absence of mercury and other heavy metals at level of parts per billion prior to any sink disposal
- User must determine if solution is hazardous.
- If solutions are hazardous, place in SAA

**Mercury-containing devices**

- Sphygmomanometers (these devices are usually on wheels), blood pressure cuffs, thermometers
- Place item in secondary container and dispose of as Universal Waste in MAA. Requires a Universal Waste sticker

For more information, visit:

- [https://research.mclean.harvard.edu/safety/Hazwaste.php](https://research.mclean.harvard.edu/safety/Hazwaste.php)

For disposal and labeling, contact:

- McLean Lab Safety Officer
- Hospital Safety Officer, Facilities
- Director (Andy Healy, x2621)

How to label waste:
<table>
<thead>
<tr>
<th><strong>Pesticides</strong></th>
<th>Chlordane, endrin, lindane, methoxychlor, parathion, malathion, toxaphene, 2, 4-D…</th>
<th>Strictly prohibited from sink disposal, even at trace quantities</th>
<th>McLean Lab Safety Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Place in Satellite Accumulation Area</td>
<td>Hospital Safety Officer, Facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Director (Andy Healy, x2621)</td>
</tr>
<tr>
<td><strong>Oils and greases, mechanical systems</strong></td>
<td>Motor oils, lubricants; pneumatic fluids</td>
<td>Place in Satellite Accumulation Area, contact Facilities for pickup if large amounts</td>
<td>McLean Lab Safety Officer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hospital Safety Officer, Facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Director (Andy Healy, x2621)</td>
</tr>
<tr>
<td><strong>Gases</strong></td>
<td>Compressed gases and cryogenic materials</td>
<td>Call Facilities for assessment and management on a case by case basis; in most instances the cylinders will be returned to the vendor, even if partially full</td>
<td>Hospital Safety Officer, Facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Director (Andy Healy, x2621)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Work Order Request</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><a href="http://hisapps2.mclean.harvard.edu/gpmworequest.aspx">http://hisapps2.mclean.harvard.edu/gpmworequest.aspx</a></td>
</tr>
<tr>
<td><strong>Empty chemical containers</strong></td>
<td>All contents removed to the best extent possible via pouring, pumping, aspirating etc. and (in the case of large drums for example) no more than one inch remains on the bottom of the container or container liner; containers of acutely hazardous materials must also be</td>
<td>Regular trash</td>
<td>McLean Lab Safety Officer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hospital Safety Officer, Facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Director (Andy Healy, x2621)</td>
</tr>
</tbody>
</table>
triple rinsed and the rinsate must be collected for disposal as hazardous waste.

**PHARMACEUTICALS** | **EXAMPLES** | **DISPOSAL** | **INFORMATION & SERVICE RESOURCE**
--- | --- | --- | ---
• The *P* and *U* EPA lists designate as hazardous waste pure and commercial grade formulations of certain unused chemicals that are discarded or intended to be discarded.

• However the presence of a *P* or *U* listed chemical alone does not trigger the listing. The *P* and *U* lists have a narrow applicability to unused commercial chemical products and manufacturing chemical intermediates. Any chemical which has been used for its intended purpose, does not meet a *P* or *U* listing. Wastes containing *P*- or *U*-listed chemicals still need to be collected as Hazardous Waste, but they do not need to be designated *P*- or *U*-listed.

<table>
<thead>
<tr>
<th>Toxic Pharmaceutical Waste (EPA U-Listed)</th>
<th>Acetone (Ignitable)</th>
<th>Place in Satellite Accumulation Area (SAA)</th>
<th>McLean Lab Safety Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorambucil, Chloroform, Cyclophosphamides, Daunomicin, Dichlorodifluoromethane, Diethylstilbestrol, Formaldehyde, Hexachlorophene, Lindane Melphan, Mercury, Mitomicin C, Paraldehyde, Phenacetin, Phenol, Reserpine, Resorcinol, Saccharin, Selenium sulfide (Reactive) Streptozotocin, Trichloromonofluoromethane, Uracil mustard, Warfarin, &lt;.3%, (Coumadin)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Accutely hazardous Pharmaceutical Waste (EPA P-Listed) | Epinephrine (adrenaline), Nicotine and its salts, Nitroglycerine (Reactive) Physostigmine, physostigmine salicylate, Sodium azide, Strychnine and its salts, warfarin and |
| --- | --- | --- | --- |
| | Place in Satellite Accumulation Area (SAA) | McLean Lab Safety Officer | Hospital Safety Officer, Facilities Director (Andy Healy, x2621) |
| | | How to label waste: | [https://research.mclean.harvard.edu/safety/Hazwaste.php](https://research.mclean.harvard.edu/safety/Hazwaste.php) |
salts at >0.3%

**DEA Regulated materials in clinical and research areas**

| Radioactive clinical and research materials | Highly regulated and dictated by permit requirements; contact Radiation safety for all disposal questions and issues | Radiation Safety Office | Lori Connors  
MGH Radioactive Waste Supervisor  
Tel. 617-724-4576  
Fax. 617-726-5126  
Email: lconnors1@partners.org |
|---|---|---|---|
| Refurbidators, microwave ovens, incubators, etc. | First assure no radiation contamination if equipment/appliance used for such purposes; contact radiation safety for equipment survey and certification | Hospital Safety Officer, Facilities Director (Andy Healy, x2621)  
Work Order Request  
http://hisapps2.mclean.harvard.edu/gpmworequest.aspx | Remove all biological and chemical materials and dispose of properly  
If used to store potentially infectious materials, wash down interior with disinfectant; bleach will suffice  
Remove all hazard warning labels  
Contact Facilities for removal to regular trash |
8.0 BIOSAFETY GUIDELINES IN THE LABORATORY

PURPOSE:
The following is a summary of procedures, guidelines and resources available to the researcher to aid in minimizing biosafety hazards in the laboratory. A complete discussion of all aspects of laboratory biosafety is beyond the scope of this handbook. The researcher is rather encouraged to use this section as a guide to locating and obtaining the specific information needed.

For complete information, refer to the MGH Biosafety website:

http://intranet.massgeneral.org/ehs/ehs_programs_biosafety.htm

And download the MGH/McLean Biosafety Laboratory Manual:

https://research.mclean.harvard.edu/safety/biosafety.php

Also reference the PIBC website:


8.1 Departmental Responsibility

The Principal Investigator is primarily responsible for the preparation of general safety protocols for the research program under his/her direction. He/she should be fully informed as to the pathogenic potential of any agent before it is introduced into a research protocol. It is also the responsibility of the Principal Investigator to ensure that all personnel receive adequate training in the procedures and techniques involved with the handling of any potentially dangerous biological materials, and to properly maintain all records should audit of procedures be necessary. The records should specify the biologic agent, the experimental timeframe, and the listing of involved personnel.

8.2 Oversight Responsibility

Oversight of Biosafety at McLean Hospital and other Partner’s hospitals is transitioning from the Harvard Committee on Microbiological Safety (COMS) to the Partner’s Institutional Biosafety Committee (PIBC), directed by Ted Myatt. The transition is expected to be complete in September 2011. On a practical level, the MGH Biosafety Office oversees biosafety at McLean Hospital. This office provides training, disseminates information about regulations and hazards, and conducts annual inspections of our facilities. They work with McLean’s Institutional Biosafety Officer and PIs to ensure that Universal Precautions and/or the recommendations set forth in the NIH Guidelines to Recombinant DNA Research (http://oba.od.nih.gov/rdna/nih_guidelines_oba.html) are followed. Further information can be found at:

http://intranet.massgeneral.org/ehs/ehs_programs_biosafety.htm

The Laboratory Safety Subcommittee is a subcommittee of the McLean Research Committee, and is charged with
the oversight of all aspects chemical and biological safety procedures in the Hospital. In almost all cases, contacting a Laboratory Safety Subcommittee member (see Appendix G) with specific questions is the best course. If the answer is not immediately available, he/she will act as a resource in contacting the appropriate authority or directing your inquiry to the proper channels.

The Infection Control Committee and the Hospital's Infection Control Nurse are available to advise the Principal Investigator or the Departmental Biosafety Officer regarding specific problem areas. Assistance may also be obtained through resources available to McLean Hospital through the MGH and Harvard Medical School.

McLean Hospital has contracted with the Harvard University Biosafety Office Committee on Microbiological Safety (COMS) (http://www.hms.harvard.edu/orsp/coms/) for oversight responsibilities regarding recombinant DNA issues and infectious agents. Note that this will transition to PIBC in late 2011.

PIBC requires that all work with recombinant DNA and infectious agents must be registered, reviewed and approved by PIBC prior to initiating any work with this material. It is the responsibility of the Principal Investigator to complete the online registration form using eIBC for review and approval.

Examples of materials or procedures that require registration:

**Non-Clinical Recombinant DNA and Infectious Agent** registrations must be completed for all in vitro and in vivo work using recombinant DNA or an infectious agent.

**Clinical Human Gene Transfer** registrations must be completed for all studies in which recombinant DNA will be administered to human subjects.

**Clinical Human Xenotransplantation** registrations must be completed for all studies involving the transplant of animal organs, tissues or cells into human subjects.

**Select Agent** registrations must be completed prior to obtaining possession of, transferring or using an agent identified by the federal government as an agent with the potential to serve as a Biological weapon. For information on and a current list of select agents, see: [www.selectagents.gov](http://www.selectagents.gov/)

All investigators working with recombinant DNA should be familiar with the NIH Guidelines (see below). An explanation of the NIH guidelines regarding recombinant DNA issues is available for download (http://www.hms.harvard.edu/orsp/coms/Government/2002_NIH-Guidelines_Explained.pdf).

Perhaps the most important part of the "Guidelines" is this statement:

The safe conduct of experiments involving recombinant DNA depends on the individual conducting such activities. The NIH guidelines cannot anticipate every possible situation. Motivation and good judgement are the key essentials to protection of health and environment. The NIH Guidelines are intended to assist the institution, Institutional Biosafety Committee, Biological Safety Officer, and Principal Investigator in determining safeguards that should be implemented. The NIH guidelines will never be complete or final since all conceivable experiments involving recombinant DNA cannot be foreseen. Therefore, it is the responsibility of the institution and those associated with it to adhere to the intent of the NIH Guidelines as well as to their specifics. (Section IV-A).
8.3 Review Mechanisms

It is the responsibility of the Principal Investigator to ensure that all new research grant proposals be reviewed from the point of view of biosafety issues prior to submission to outside agencies. A specific entry on the cover sheet of all new grant applications should note whether the use of biologically active, infectious, or recombinant DNA material is anticipated. If such is the case, the applicant should state that he/she understands the hazards involved in such research.

8.4 Training

The safety of laboratory personnel engaged in biomedical research is dependent on their understanding of the properties of potentially infectious agents and their knowledge of contamination control. The Principal Investigator is responsible for providing a level of training appropriate and adequate for the procedures being performed. Laboratory personnel are strongly encouraged to familiarize themselves with the following publications.

- MGH/McLean Hospital biosafety training module and biosafety manual is available for download from the McLean Hospital Research Intranet site (https://research.mclean.harvard.edu/safety/biosafety.php).


- The U.S. Department of Health and Human Services publication "Biosafety in Microbiological and Biomedical Laboratories" (fifth edition, 2009, available through Research Administration or available for download at http://www.cdc.gov/biosafety/publications/bmbl5/).


8.5 Specific Examples of Hazardous Agents 1

1. Known pathogenic bacteria, viruses, and other infectious agents.

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1 - A specific listing and classification of all known biologic agents which might be used in the laboratory on the basis of hazard is beyond the scope of this and, indeed, might report be misleading to the uninformed investigator. The degree of hazard depends not only on the etiologic agent, but also upon the titer of the agent, the nature of the investigation, and the techniques employed, the setting in which the study is being performed, and the experience of the investigator. In the case of viruses potentially oncogenic for man, the problem of classification of hazard is further complicated by the absence of definitive proof that any viruses can cause human cancer and by the unknown long-term effects of accidental human inoculation with oncogenic animal viruses.
2. Oncogenic viruses.

3. Infected, or potentially infected, human and animal cells.

4. Strains of bacteria, viruses, etc. whose pathogenicity is uncertain and whose use in the laboratory is not well established.

5. Experiments involving high concentrations of infectious agents (as in the preparation and purification of large quantities of viruses for biochemical studies) may significantly increase the associated hazard.

6. Infectious Nucleic Acids: Since the normal host range of most viruses is determined by properties of their outer coat, infectious nucleic acids from viruses which are ordinarily not infectious for man might be hazardous.

7. Any molecules that are constructed outside living cells by joining natural or synthetic DNA segments to DNA molecules that can replicate in a living cell, or molecules that result from the replication of those molecules. Synthetic DNA segments which are likely to yield a potentially harmful polynucleotide or polypeptide (e.g., a toxin or pharmacologically active agent) are considered as equivalent to their natural DNA counterpart.

### 8.6 Experimental Animals

It should be recognized that experimental animals, even when not specifically inoculated with infectious agents, may be the source of serious human infections. Consequently, all aspects of the use and housing of experimental animals, and of the handling of tissues, should be referred to the McLean IACUC (see link within: [https://research.mclean.harvard.edu/index.php](https://research.mclean.harvard.edu/index.php)).

i. **General Recommendations**:

a. Newly arrived animals should be quarantined and screened for pathogens where indicated (e.g., tuberculosis and Herpes B virus in primates). Refer to IACUC protocols for specific times.

b. Periodic monitoring for the presence of specific pathogens should be performed where appropriate.

ii. **Specific Procedures**:

a. Rooms in which animals are housed are restricted to authorized personnel only.

b. Authorized personnel are those associated with the care of the animals or with the investigation and are instructed regarding the hazards and safety practices relative to the handling of the animals or any hazardous agent used in the experiment.

c. Animals used in microbiological experiments must be kept under conditions of isolation appropriate to the degree of hazard and the area appropriately labeled.

(i) Animals used in microbiological experiments will not be housed in a room with other animals, except under a specific circumstance, i.e., when the microbiologic agent is known not to be transmitted to the other animals present, or has low infectivity and can be contained by filter
top cages or isolettes within the room.

(ii) Persons working around infected animals will wear gloves and protective clothing and will not enter another animal room until they have changed - it is suggested that animal handlers, etc. schedule the cleaning, feeding, etc. of these rooms after all other rooms have been completed.

(iii) When agents known to be highly infectious to other animals, or potentially but not seriously infectious or contagious to man are used, (ringworm for example) the animals must be housed in a strictly isolated room under negative air pressure and in cages with filtered (or incinerated) exhaust.

(iv) When agents potentially hazardous to man are used the animals must be kept under conditions of strict isolation and "glove box" condition: i.e., (1) all exhaust air must be filtered or incinerated, (2) air and all materials must be strictly contained within the unit, (3) all animals, animal waste and bedding must be sanitized before removal from the cage or placed in a sealed tight container which can be sanitized before removal, (4) all cages and containers must be sanitized before removal from area (d.(ii) below).

d. Disposal of contaminated materials:

(i) Materials potentially hazardous to other animals will be placed in biohazard containers within the isolation area until removal.

(ii) Materials of potentially slight hazard to humans will be place in biohazard containers and sealed to be delivered directly for incineration by a responsible individual associated with the project.

(iii) Materials hazardous to humans will not be removed from the isolation area until they have been sanitized. If an outer container is sanitized, but the contents are not, it is the responsibility of the principal investigator to ascertain that all the material is incinerated or rendered non-infectious before it is released from his control. (Materials include animals and animal waste.)

e. Protection of animal handlers:

(i) A physical examination, including immunization update and TB screening, will be made by Occupational Health before assignment to duty and regularly thereafter.

(ii) Appropriate vaccinations (as dictated by the particular agents and animals in use) should be given sufficiently in advance of assignment to duty to be effective. Infection Control Nurse should be informed if staff are to be exposed to any new infectious agents.

(iii) Work clothes, including shoes or shoe covering, will be provided. These clothes should not be worn outside of the facility.

(iv) In addition to ordinary work clothes, special clothing should be provided under various degrees of hazard. For example: gloves, masks, gowns and boot covers should be worn when working with materials hazardous to man. These items must be removed inside the isolation area and placed in containers to be incinerated.
(v) The laboratory supervisor and/or principal investigator must provide a thorough indoctrination in disease control, which should include the nature of agents used and the theory of containment.

f. Monitoring is an essential aspect of biohazard control in animal facilities.

(I) Animals provide a unique monitoring system if all sick or dead animals are examined on a routine basis.

(ii) All animals should be periodically inspected by a D.V.M.

(iii) Serological monitoring (titer conversions for specific agents) should be practiced for both animals and personnel as an indication of microbiological containment. Any abnormal values should be reported to the Principal Investigator and the Infection Control Nurse.

(iv) Under certain conditions (absolute containment) physical monitoring procedures offer excellent indication of degree of safety.

9.0 RADIATION SAFETY

Refer to MGH Radiation Safety Manual.

See Section 7.3 for information on radioactive waste.

10.0 CHEMICAL STORAGE PRECAUTIONS

Many chemicals, because of their nature, require special storage conditions to prevent their deterioration. The following lists are given as an aid to proper storage.

10.1 Chemicals to Keep Cool, Dry, and Tightly Closed
The following chemicals should be protected because of low melting point, deliquescence, efflorescence, or their hygroscopic nature, and to prevent caking, mold growth, or chemical decomposition.

Acetaldehyde
Albumen Egg Scales
Aluminum Chloride
Ammonium Acetate
Ammonium Carbonate
Ammonium Nitrate
Ammonium Sulfite
Ammonium Thiocyanate
Amyl Nitrate
Antimony Trichloride
Bismuth Chloride
Cadmium Chloride
Cadmium Nitrate
Calcium Nitrate
Chloral Hydrate
Citric Acid
Cobalt Acetate
Cobalt Chloride
Cobalt Nitrate
Cobalt Sulfate
Cupferron
Cupric Nitrate
Ether
Ferric Ammonium Sulfate
Ferric Chloride
Ferric Nitrate
Ferric Oxalate
Ferrous Chloride
Ferrous Sulfate
Gold Chloride
Lanolin
Magnesium Chloride
Manganese Chloride
Menthol
Mercuric Nitrate
Mercurous Nitrate
Methyl Iodide
Monochloroacetic Acid
Nickel Chloride
Nickel Nitrate
Phenol
Phenyl Salicylate
Platinum Chloride
Potassium Fluoride
Potassium Nitrite
Potassium Thiocyanate
Sodium Perborate
Sodium Phosphate Dibasic Heptahydrate
Sodium Sulfate
Sodium Sulfide
Stannous Chloride
Thymol
Trichloroacetic Acid
Zinc Nitrate

10.2 Chemicals to Keep Above Freezing Temperature:
The following chemicals should be protected from freezing.

The freezing points are given:

F°

Acetic Acid 99.5% +60
Aniline +21
Benzene +41
Benzoyl Chloride +31
Benzyl Benzoate +50
** Cold might cause crystallization.

** 11.0 INCOMPATIBLE MATERIALS

Certain combinations of chemicals are remarkably explosive, poisonous or hazardous in some other way, and these are generally avoided as a matter of course. There are many others that are perhaps equally dangerous but do not come to mind as readily. The following list, although not complete, may serve as a memory-refresher. Stop and think for a moment before starting any work, especially if one hazardous chemical is involved.

In addition to the list below, some other resources are:

Forbidden mixtures list from MGH EH&S
http://intranet.massgeneral.org/ehs/ehs_programs_laboratorysafety.htm#23

Chemical Reactivity Worksheet (CRW) – a free program that lets you input chemicals to be mixed and tells you the potential hazards.
11.1 Incompatible Chemicals: Do Not Contact:

Alkali metals, such as calcium, potassium and sodium with water, carbon dioxide, carbon tetrachloride, and other chlorinated hydrocarbons.

Acetic Acid with chromic acid, nitric acid, hydroxyl-containing compounds, ethylene glycol, perchloric acid, peroxides and permanganates.

Acetone with concentrated sulphuric and nitric acid mixtures.

Acetylene with copper (tubing), fluorine, bromine, chlorine, iodine, silver, mercury or their compounds.

Ammonia Anhydrous with mercury, halogens, calcium hypochlorite or hydrogen fluoride.

Ammonium Nitrate with acids, metal powders, flammable fluids, chlorates, nitrates, sulphur and finely divided organics or other combustibles.

Aniline with nitric acid, hydrogen peroxide or other strong oxidizing agents.

Bromine with ammonia, acetylene, butadiene, butane hydrogen, sodium carbide, turpentine, or finely divided metals.

Chlorates with ammonium salts, acids, metal powders, sulphur, carbon, finely divided organics or other combustibles.

Chromic Acid with acetic acid, naphthalene, camphor, alcohol, glycerine, turpentine and other flammable liquids.

Chlorine with ammonia, acetylene, butadiene, benzene, and other petroleum fractions, hydrogen, sodium carbides, turpentine and finely divided powdered metals.

Cyanides with acids.

Hydrogen Peroxide with copper, chromium, iron, most metals or their respective salts, flammable fluids and other combustible materials, aniline and nitro-methane.

Hydrogen Sulfide with nitric acid, oxidizing gases.

Hydrocarbons, generally, with fluorine, chlorine, bromine, chromic acid or sodium peroxide.

Iodine with acetylene or ammonia.

Mercury with acetylene, fulminic acid.

Nitric Acid with acetic, chromic and hydrocyanic acids, aniline, carbon, hydrogen sulfide, flammable fluids or gases and substances which are readily nitrated.

Oxyns with oils, grease, hydrogen, flammable liquids, solids and gases
Oxalic Acid with silver or mercury.

Perchloric Acid with acetic anhydride, bismuth, an its alloys, alcohol, paper, wood, and other organic materials.

Phosphorous Pentoxide with water.

Potassium Permanganate with glycerine, ethylene glycol, benzaldehyde, sulfuric acid.

Sodium Peroxide with any oxidizable substances, for instance: methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerine, ethylene glycol, ethyl acetate, furfural, etc.

Sulfuric Acid with chlorates, perchlorates, permanganates, and water.

12.0 ULTRAVIOLET RADIATION PROTECTION

The use of ultraviolet lights in the Hospital serves an important function in the control of bacteria. They also present a hazard to the personnel working in the area where they are located if the proper safety precautions are not adhered to.

Specific Rules:

1. When ultraviolet lights are controlled by manual switches, the switch should be located outside the room, preferably by the door with an indicator light to show that the lights are on or off.

2. Doors to the area where ultraviolet lights are being used must have appropriate warning signs posted.

3. If a zone barrier type of ultraviolet light is in use the floor or walls should be marked showing the areas of high ultraviolet intensity.

12.1 Personal Protective Equipment (PPE)

Ultraviolet radiation in the 254nm range has little penetrating effect, ordinary glass completely absorbs the energy, as do most plastics, rubber and similar materials. The penetration of ultraviolet light through clothing will depend upon the closeness of the weave of the fabric. Practical experience has shown that the skin is usually adequately protected by ordinary cotton laboratory clothing.

Eye Protection:

It is recommended that safety glasses or goggles with solid side pieces be used. The side pieces prevent the entrance of the radiation when the source is to the left or right of the exposed individual; cases of eye conjunctivitis have been known to occur when the individual wore ordinary spectacles.

Skin Protection:
Any ultraviolet radiation installation requiring skin protection also requires eye protection. The main portion of the body, arms, and legs are protected by ordinary clothing. Rubber or cotton gloves can be used to protect the hands. A plastic personnel hood may be used to protect eyes, head, and neck. In some cases face shields adequately protect the face and eyes. If a face shield is used, it is recommended that some type of cap be worn to protect the area of the upper part of the head. Personnel working in areas where respirators are required can be provided with modified face shields.

Whenever plastic items, such as face shields, are used for ultraviolet radiation protection, tests should be made to assure that the formulation has zero transmission of 254nm. Lucite face shields, for example, have on occasion been found to transmit radiation at the 254nm wave length.

**Note:**

When ultraviolet lights are used for bacterial control the tubes should be cleaned at least monthly and the intensity checked by meter at least every 3 months. (Normal effective lamp life is about 6 month in continuous service.)

### 13.0 LABORATORY BUNSEN BURNERS

The use of gas burners (Bunsen burners) is widespread and presents problems for the research laboratory. When operating, they provide sufficient heat and open flame to trigger flash fires. If not carefully used and watched they can be the source of a fire because of old cracked tubing, inadvertent turning on of the gas supply, or a flame-out with no one in attendance.

**The Following Guidelines Should Be Followed:**

1. Bunsen burners shall be replaced with hot plates or approved electrical heat mantels if possible (eliminating the gas and flame problem).

2. When use of a Bunsen burner is necessary, the burner, connecting tubing and connections to the burner and the gas supply must be inspected to assure safe operation.

3. The connecting tubing (between the burner and the gas supply) should be of minimum practical length, not to exceed 6 feet and shall not extend from one room to another, or pass through any walls, partitions, ceilings or floors. Under no circumstances shall gas tubing be concealed from view or used in a concealed location. Only gas tubing listed in Section 54-43 of the National Fire Protection Association Codes shall be used, and in accordance with its listing [http://www.nfpa.org/aboutthecodes/list_of_codes_and_standards.asp](http://www.nfpa.org/aboutthecodes/list_of_codes_and_standards.asp)

4. Bunsen burners shall be turned off and left in a safe condition by the responsible person whenever the laboratory is unattended.

5. Location of burner - Bunsen burners in use shall be located so that open flame or heat from the burner is not in close proximity with combustible materials.
14.0 ELECTRICAL HAZARDS

14.1 Electrical Safety Procedures

There are many precautionary procedures for working around and on electrical equipment and the procedures vary with the kind of equipment and the extent of use. Some general guidelines are presented below.

(a) Equipment producing a "tingle" should be reported promptly for repair. "Shorts" become progressively worse and can become extremely hazardous, especially where contact may readily be made against metal framework of an exhaust hood or the damp floor and bench surfaces of a cold room. Do not rely on grounding to mask a defective circuit nor attempt to correct a fault by insertion of another fuse, particularly one of larger capacity.

(b) Only extension cords approved by McLean’s Electrical Shop shall be used. Keep the use of extension cords to a minimum and cords as short as possible. Be sure insulation and wire size of extension cords are adequate for the voltage and current to be carried and the environmental conditions in which the cord is to be used. (See article 400, National Electrical Code).

(c) All electrical work should be done by licensed electricians.

(d) Treat all electrical devices as if they are live.

(e) After servicing electrical equipment do not turn the power back on until you are sure all persons have moved to a safe location and are aware the switch is to be activated.

(f) Enclose all electrical contacts and conductors so that no one can accidentally come into contact with them.

(g) Mark all high voltage equipment with signs stating the approximate voltage with letters at least three inches high if possible

(h) Never handle electrical equipment when hands, feet, or body are wet or perspiring, or when standing on a wet floor.

(i) With high voltages regard all floors as conductive and grounded unless covered with well maintained and dry rubber matting of suitable type for electrical work.

(j) When it is necessary to touch electrical equipment (for example, when checking for overheated motors,) use the back of your hand. Thus, if accidental shock were to cause muscular contraction, you would not “freeze” to the conductor.

(k) Keep in mind that on some equipment the interlocks disconnect the high voltage source when a cabinet door is opened but power for control circuits remains on.

(l) Immediately repair/replace any frayed or damaged cords or insulation at
14.2 Electrical Appliances and Equipment

(a) All new electrical equipment must be inspected by the electrical shop prior to use to assure proper power connection and grounding.

(b) All electrical appliances and equipment should show listing and approval by Underwriters' Laboratories, Inc., or other nationally recognized testing laboratory unless the device is one for which test standards have not been established.

(c) All electrical appliances and equipment should be properly grounded in accordance with the National Electrical Code.

(d) Low voltage equipment (Below 100V). Line powered equipment should use an isolation transformer for voltage reduction if possible. Auto transformers, rheostats, transformers with grounded secondary windings, or resistance networks are prohibited unless permanently installed.

(e) In laboratories where procedures involve human subjects, provisions must be made for a low shock hazard power center, including an isolation transformer and an equalizing potential grounding bus for each subject location. Ground fault interrupters may replace isolation transformers in some cases.

(f) Hand-held portable apparatus and tools must be equipped with a "Dead Man" switch. Hand-held portable apparatus and tools should be "Double Insulated" whenever possible. If a grounding wire is relied upon for safety, be certain that the grounding circuit and the grounding blade are intact. Maximal safety can be achieved by using a ground fault interrupter as a power path.

(g) Renovation and new construction should include a ground fault interrupter on feeders to distribution panels supplying electrical power to laboratory outlets in "wet locations".

(h) All "home-made" electrical apparatus should be inspected and approved by the electrical shop before being placed in service.

(i) All electrical appliances, equipment, and wiring should be inspected for use at the maximum temperature it can reasonably be expected to be subjected to in use.

(j) All electrical problems should be brought to the immediate attention of the Electrical Shop, Plant and Operations, Ext. 2621.

15.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)
Personal protective equipment (PPE) such as gloves, lab coat, and safety glasses, is often needed to assure an employee is adequately protected from hazards associated with the work they are doing. There are detailed OSHA regulations re: PPE.

### 15.1 Gloves

General requirements of OSHA. “Employers shall select and require employees to use appropriate hand protection when employees' hands are exposed to hazards such as those from skin absorption of harmful substances; severe cuts or lacerations; severe abrasions; punctures; chemical burns; thermal burns; and harmful temperature extremes.” In addition, for some jobs, the hands could become contaminated with work materials such as radioisotopes, biological agents, or chemicals. Gloves are often used to prevent hand contamination and to raise awareness regarding the potential for contamination of other surfaces touched by those gloves.

#### Table 4 Selection of Hand Protection

Below is a table to be used for assessing hand hazards and the appropriate type of glove for those hazards. It should be understood that each glove has limitations, and a glove selected for protection against one type of hazard will not necessarily be effective against another type of hazard. If the work or task involves more than one type of hazard, this must be taken into consideration in selecting the best type of glove for the circumstances. Contact the Lab Safety Officer if you require assistance with glove selection.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Glove</th>
<th>Comments</th>
</tr>
</thead>
</table>
Hot surfaces, e.g. steam pipes, items from autoclaves, welding operations. | Heat resistant gloves. | Gloves can prevent burns.
---|---|---
Radioactive materials in the laboratory. | Disposable glove. | N-dex nitrile glove or latex* glove offers a good barrier for most lab research.

*Some employees may be allergic to latex containing materials. These employees should be offered other options for hand protection under these circumstances, eg. Nitrile or vinyl disposable gloves.

### 15.1.1 McLean Hospital Glove Policy

It is the policy of McLean Hospital that gloves may NOT be worn in any public areas such as hallways, breakrooms, bathrooms, etc. It is acceptable to wear one glove in order to carry something and leave the other hand free to open doors. If transporting something large or unwieldy, use a cart.

The reason for this policy stems from the problem of perceived medical/chemical hazards. Since it is not possible to tell whether someone’s gloves are new and clean or covered in hazardous material, we err on the side of caution and require that NO gloves should be touching surfaces in public areas.

### 15.2 Protective Clothing

Safety clothing and equipment should be available to all McLean personnel and its use is encouraged. If you have a need for this equipment and it is not in your area, consult your PI or Lab Safety Officer. Items readily available are laboratory coats, glasses, goggles, face shields, gloves, aprons, hats, safety shoes (where approved) and the items designed for specific operations.

### 15.3 Policy & Guidelines on Eye Protection

#### 15.3.1 Use of Eye Protection

The following practices should be observed in laboratories in which hot or caustic chemicals are used, where other eye hazards are present, or where other chemicals may come into contact with the eyes:

(a) Safety glasses, goggles and face shield should be readily available and all workers should know of their location. It is highly preferable for each laboratory worker to possess his own personal prescription or non-prescription safety glasses.

(b) Workers are required to wear eye protection in designated areas and/or designated hazardous operations. It is preferable that all laboratory areas be so designated by the responsible departmental administrators and that especially hazardous locations be indicated by warning signs. It is especially advised that at such sites of high hazard (i.e. grinding wheel operation, glass-blowing bench), goggles or face shields be prominently displayed.
(c) All workers and visitors should wear eye protection in the vicinity of any operation that could result in an unexpected breakage, splash, flying chip, intense light or other radiation which could result in eye injury.

(d) Personnel with only one eye should wear safety glasses at all times.

15.3.2 Contact Lenses
In the event of eye accident, the lapse of time before the contact lenses are removed increases the potential for serious injury. If a contact lens is allowed to remain on the cornea of an unconscious person for example, the cornea may become damaged because the tears beneath the lens stop and the epithelium becomes devitalized. Knowing how to remove an accident victim's contact lenses is a skill known by too few individuals. Generally speaking, wearing contact lenses should be avoided in hazardous areas.

15.3.3 Proper Care of Safety Glasses
(a) Keep glasses protected from dust and abrasion.

(b) Clean the lenses with cool water, mild soap, soft cloth or Kimwipe to dissolve any oils, greases, etc.

(c) When the frames show small visible cracks or the lenses become scratched, have the frame or lenses replaced.

(d) Replace frame or lenses when needed.

15.4 Safety Showers
Safety showers are installed in the laboratory or adjacent corridors, normally from the ceiling, and can be easily identified by the large metal ring attached to the shower by a short chain or rod. To operate, you stand under the shower and pull the ring.

At least one safety shower and eye wash fountain or hose will be installed in each laboratory or near the entrance to each laboratory where dangerous chemicals or liquids are used. There should be no more than a 50-foot travel distance to such devices from any point in the laboratory. Care should be taken to locate these devices and the actuating mechanisms where they will not be blocked.

16.0 Equipment Safety

16.1 Machine Guarding
A common example of hazardous laboratory equipment that is not usually provided or purchased with the minimum safeguard is the vacuum pump or compressor with an exposed belt, a device that can surprise by catching clothing or injure by cutting off fingers. Belt guards should be purchased even if they are provided as standard equipment. Other
types of equipment may require shielding if there is a hazard from exposed moving parts. Consult the Facilities Department for further information and sources of belt guards.

16.2 High Pressure and Vacuum Equipment Protection

Any laboratory equipment operating at very high or low pressures should be adequately guarded to protect personnel from the consequences of explosion or implosion.

(a) One of the most common hazards of this type is the unprotected glass vacuum desiccator. It is recommended that such desiccators be evacuated by water aspirator vacuum pumps where feasible to minimize extreme vacuum formation. A safer substitute for the glass desiccator is one made of high strength plastic. Some of the plastic desiccators are also highly resistant to most chemicals and solvents. The best safeguard against the hazard of implosion is to enclose all glass vacuum desiccators in metal desiccator guards. This is an absolute requirement for glass desiccators that are evacuated by mechanical vacuum pumps. Information on the vendors of acceptable desiccator guards can be obtained from your laboratory Safety Advisor.

(b) Lab personnel can minimize the risk of injury caused by implosion of glass desiccators by taping desiccators and glass Dewar flasks with filament-reinforced self-adhesive tape.

(c) Pressurized equipment should have pressure-limiting devices to prevent over-pressure in the system.

(d) Gas-tight fittings and hoses rated for the application should be used if permanent piping is not practicable.

(e) Suitable check valves should be employed to prevent gases or liquids from surging back into evacuated or lower-pressure lines or containers.

(f) High pressure types of autoclaves should have adequate explosion protection and controls of the remote type so that the operator can be behind a protective wall.

(g) Other precautions, as related to the handling and storage of compressed gasses and cryogenic fluids, are to be found in Section 6.6 and 6.7.

16.3 Refrigerators and Freezers

Under recent federal law, refrigerators are now classified as to their intended use. There are three categories: 1) The Domestic Type, which is the standard household refrigerator; 2) The Laboratory Safe Refrigerator, which is altered, putting the controls on the outside, but does not have explosion-proof fixtures or motor assembly; and 3) The Explosion Proof Refrigerator, which comes equipped with all explosion-proof fixtures and motor assembly.

The Laboratory Safety Subcommittee has recommended that Laboratory Safe refrigerators be purchased for the hospital, even if your immediate application does not require such a refrigerator. The added cost is usually small, but this practice will contribute to the formation of safer conditions of laboratory practice.

All refrigerators must be properly labeled as to their approved use. The label shown below is available from your Lab Safety Officer. It should be applied to all refrigerators and freezers which have not been approved for the storage of
flammable solvents.

All electrical equipment must first be inspected by Plant & Operations before being placed in service.

16.4 Policy and Guidelines for the Safe Use of Laboratory Fume Hoods

(a) Be sure that the exhaust ventilation hood is suitable for your particular operation or application. It is essential that the air flow passing through the hood be high enough to adequately remove all fumes, mists and vapors generated within the hood.

(b) The fume hood sash should have a label similar to the one affixed below. This label serves to identify the hood for maintenance by Plant and Operations, and most importantly, designates its intended use and performance characteristics. A mark on the fume hood frame indicates the highest sash opening that, when aligned with the arrow on the sticker, will provide an adequate face velocity of air removal for the use designated on the sticker. Under the conditions prevailing for all fume hoods at McLean Hospital, the face velocity should increase by lowering the sash and decrease as the sash is raised. This permits the use of many hoods for even highly toxic materials providing that the sash opening is small enough to guarantee sufficient air flow. Many hoods have been modified to achieve higher face velocity by blocking the upper by-pass. Users should check to assure themselves that the by-pass is indeed covered.
(c) Required Minimum Velocities for Different Operations:

Radioactive Materials: 125 Linear feet/min.

Highly Toxic Materials: 100 Linear feet/min.

Moderately Toxic Materials: 80 Linear feet/min.

(d) All materials should be stored on shelving in the laboratory. The interior of the hood should be clear of all obstructions or stored materials. Only the equipment and chemicals that are to be used in your operation should be in the hood.

(e) Storage of chemicals should be kept to an absolute minimum in fume hoods. If storage is required within a hood, the use of metal, stoneware, or nonreactive plastic receptacles large enough to contain the entire volume is mandatory.

(f) Tempered laminated safety glass in hood sashes is a MUST. Cracked or otherwise defective glass must be replaced. If operations are to be conducted which involve flammable or explosive mixtures, a portable safety shield or barrier between the operator and the experiment is recommended.

(g) Any laboratory hoods that are used with perchloric acid should be equipped with wash-down facilities to prevent the build up of perchlorates (See also Section 7.5.3).

(h) For additional information pertaining to fume hood use, consult your Safety Advisor.

17.0 FACTORS TO CONSIDER IN PLANNING AND BUDGETING FOR SAFETY

17.1 General

Organization:
The major effort should be toward a well defined departmental accident prevention organization and employee training and instruction program. While this requires effort and time, it should not require major financial expenditures.

Inspections:

A thorough inspection of machines, equipment and working areas in each department is required to determine the magnitude of the problem to provide the required safe working place for your employees. This must be followed up with scheduled inspections to maintain the work areas free of hazards.

17.2 Specific Development of a Basic Safety Organization and Training Program:

- Appoint Safety Coordinator for laboratory.

  Responsibilities include:

  - Liaison between PI and lab members and the LSSC
  - Manage SAA
  - Communicate safety requirements/needs to lab members
  - Prepare for and host safety inspections

- Extra cost for training aids (e.g. lab-specific training packet).
- Attendance at outside Safety training sessions.
- New employee indoctrination.
- Preparation and maintenance of SOPs for hazardous chemicals/procedures used in lab.
- Preventative maintenance programs to be developed in coordination with Plant & Operations.

Personal Protection Equipment:

Increased safety requirements and awareness of employee may result in larger costs of subsidization programs for safety shoes and safety glasses as well as requests for more or new protective equipment which is supplied by the department, i.e. gloves, hard hats, hearing protection, etc.

First Aid Equipment and Training:

- First Aid training schedule (regular and overtime).
- Possible need of special equipment, i.e. resuscitators, etc.

Existing Mechanical Equipment Repairs:

Most items should be covered under normal maintenance planning and budget. However, inspections may disclose more than can be handled in this manner. If so, priorities should be determined and a schedule developed in coordination with the department of Plant & Operations and Hospital Administration.
Mechanical Alterations:

Alteration of equipment to meet present or future regulations may be required, i.e. reduce sound levels, improve ventilation etc.

New Equipment or Machinery:

Review all layouts for new facilities for possible violations of new standards. Purchase orders for machinery or equipment should require suppliers to comply with federal standards. All electrical equipment should be approved by the Electrical Shop of Plant & Operations.

Fire Protection:

Present requirements or surveys may show need of additional fire protection or detection (especially extinguishers). Flammable liquid storage and handling problems should be taken into consideration.

18.0 LABORATORY SAFETY ROUNDS

18.1 Procedures for Safety Inspections, Follow-up & Documentation

The Safety Rounds team consists of the Chair and/or co-Chair of the Laboratory Safety Subcommittee, the Lab Safety Officer, at least one other member of the Laboratory Safety Subcommittee, and representatives from Facilities, Research Administration, and the laboratory that is being inspected. This team will conduct the safety rounds in each designated laboratory. In addition, the Principal Investigator/Program Director of the laboratories being viewed is also invited.

PROCEDURE:

The Lab Safety Officer will communicate the Committee’s intent to conduct safety rounds of a laboratory via a memorandum to the Principal Investigator/Program Director. A Safety Rounds team will convene at the specified location and begin the rounds by addressing all items identified in the Laboratory Safety Checklist. Minor areas that require attention (such as signage, telephone numbers, waste basket placement location and minor storage issues) will be pointed out and can be corrected during the safety rounds. Other issues that require a work order from Plant & Operations or additional input from the Principal Investigator/Program Director will be dealt with directly through a communication from the Lab Safety Officer to the representative from Plant & Operations and to the Principal Investigator.

The Lab Safety Officer will send a summary report of the checklist to the Principal Investigator/Program Director, the LSSC Chair, the Vice President of Research, the Facilities Department, and the Hospital Safety Officer. Those individuals will deal directly with areas that require their attention. The Chair of the Laboratory Safety Subcommittee will retain a copy for permanent records in the Laboratory Safety Subcommittee Minutes.

Safety Rounds are designed to assist the Principal Investigator/Department Head in maintaining laboratories in a safe working order as per the continually changing safety regulations. Since the Principal Investigator/Program Director may not be able to keep up with these changing regulations, the Safety Rounds serves a dual purpose for the Principal
**ADMINISTRATIVE ISSUES:**

If the Principal Investigator/Department Head disagrees with the written report, he/she may request a meeting with the Safety Rounds team to discuss the items in question. If a satisfactory solution cannot be reached, the issue will be brought to the attention of the Vice President for Research Administration.

### 18.2 McLean Hospital Laboratory Safety Checklist

The McLean Hospital Laboratory Safety Checklist used during Safety Rounds is presented on the following pages. In addition, it can be downloaded from:

https://research.mclean.harvard.edu/safety/safetyforms.php

Laboratory personnel should use the list to pinpoint hazardous situations and appropriate steps should be taken to correct them without waiting for periodic inspections.

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>NA</th>
<th>Y</th>
<th>N</th>
<th>RECOMMENDED CORRECTIVE ACTION IF N IS CHECKED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Chemical Hygiene Plan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Hazardous Chemical Inventory updated during last year</td>
<td></td>
<td></td>
<td></td>
<td>PLEASE HAVE INVENTORY AVAILABLE FOR EXAMINATION WHEN TEAM ARRIVES</td>
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<td></td>
<td></td>
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<td></td>
<td>Last Updated on:______________</td>
</tr>
<tr>
<td>1.2 MSDS Maintained &amp; Accessible</td>
<td></td>
<td></td>
<td></td>
<td>Maintain all appropriate MSDS and inform staff of their location.</td>
</tr>
<tr>
<td>1.3 SOPs filed and approved</td>
<td></td>
<td></td>
<td></td>
<td>Download SOP form from <a href="http://research.mclean.harvard.edu/forms/">http://research.mclean.harvard.edu/forms/</a>. Submit to Elena Chartoff</td>
</tr>
<tr>
<td>2 Satellite Accumulation Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Properly Set Up</td>
<td></td>
<td></td>
<td></td>
<td>Appropriate containers stored at or near the point of generation and in a secondary containment bin. Waste containers must be properly labeled with Hazardous Waste tag. SAA must NOT be under sinks. Incompatible wastes must be kept segregated, containers kept closed.</td>
</tr>
<tr>
<td>CONDITION</td>
<td>NA</td>
<td>Y</td>
<td>N</td>
<td>RECOMMENDED CORRECTIVE ACTION IF N IS CHECKED.</td>
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<td>-----------------------------------------------</td>
</tr>
<tr>
<td>2.2 Filled Containers Removed within 3 Days</td>
<td></td>
<td></td>
<td></td>
<td>Close containers, complete the labeling, and take to the Solvent Storage Room. (Service G-47). Secondary containment required.</td>
</tr>
<tr>
<td>2.3 SAAs inspected weekly with documentation</td>
<td></td>
<td></td>
<td></td>
<td>Download inspection sheets from <a href="https://research.mclean.harvard.edu/safety/safetyforms.php">https://research.mclean.harvard.edu/safety/safetyforms.php</a></td>
</tr>
</tbody>
</table>

### 3 Fire Safety

**3.1 Fire Extinguishers**

- Contact P & O at X2621 to install or remount fire extinguisher.
- **Checked Monthly**: Properly Mounted (> 6 inches above floor) Properly Labeled

**3.2 Aisles free and clear**

- 44 inch (1.1 meters) unimpeded width.

**3.3 18 inch (~50 cm) ceiling clearance**

- (This is to satisfy Belmont Fire Regulations) Remove materials currently being stored closer than 18” (vertical) to sprinkler heads.

**3.4 Fire Doors can close.**

- Make sure these are not blocked. They should close automatically when a fire alarm is pulled.

**3.5 Exits Clearly Marked**

- Signs should be visible. Illuminated signs should be lit.

### 4 Compressed Gas Cylinders

**Properly Secured**

- Securing devices on cylinders must be at least 2/3 of the way to the top of cylinder.
- Contact P&O (X2621) to have securing device installed or adjusted.

### 5 Housekeeping

**5.1 Room is Free of Clutter**

- Reduce unnecessary storage of equipment in laboratory.

**5.2 Benchtops are Free of Clutter**

- Reduce unnecessary storage of materials on benchtops.

**5.3 Limit Floor Storage**

- Use pallets to raise objects from the floor.

**5.4 No heavy containers on high shelves.**

- (This is to protect staff from falling objects)

### 6 Electrical

**6.1 Cords in Good Condition**

- Replace any frayed cords.

**6.2 Eliminate use of Extension Cords**

- Contact P & O at X2621 to install wall strips

### 7 Chemical Storage OK?

Refer to Section 7.0 (Policies and Guidelines for Hazardous Materials) in the McLean Lab Safety Manual.

**7.1 Acids and Bases Segregated**

- Store acids and bases separately.
<table>
<thead>
<tr>
<th>CONDITION</th>
<th>NA</th>
<th>Y</th>
<th>N</th>
<th>RECOMMENDED CORRECTIVE ACTION IF N IS CHECKED.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2 Organic and Inorganic Acids Segregated</td>
<td></td>
<td></td>
<td></td>
<td>Store organic and inorganic acids separately; secondary containment required.</td>
</tr>
<tr>
<td>7.3 Flammable Liquids Segregated from Oxidizing Agents</td>
<td></td>
<td></td>
<td></td>
<td>Store flammable liquids away from oxidizing agents.</td>
</tr>
<tr>
<td>7.4 Storage of Chemicals on or below eye-level height</td>
<td></td>
<td></td>
<td></td>
<td>Limit storage of concentrated corrosive or toxic, liquid chemicals to benchtops and lower shelves. Storage of solvents and chemicals on floors is prohibited.</td>
</tr>
<tr>
<td>7.5 Discard very old Chemicals</td>
<td></td>
<td></td>
<td></td>
<td>&quot;Old chemicals&quot; are unused, dusty and, generally more than 5 years old.</td>
</tr>
<tr>
<td>8 Flammable Storage</td>
<td></td>
<td></td>
<td></td>
<td>Refer to Section 7.3.2 (Allowable Storage Quantities in Labs) in the McLean Lab Safety Manual to determine maximum quantities allowed to be stored in the lab.</td>
</tr>
<tr>
<td>8.1 Within Storage Limit for Area</td>
<td></td>
<td></td>
<td></td>
<td>Containers greater than 4L must be approved; secondary containment required.</td>
</tr>
<tr>
<td>8.2 Stored in Safety Containers</td>
<td></td>
<td></td>
<td></td>
<td>Large quantities should be stored in containers rated for flammables. Doors should be self-closing (and kept closed).</td>
</tr>
<tr>
<td>8.4 Stored in Rated Refrigerator</td>
<td></td>
<td></td>
<td></td>
<td>Remove all flammables from regular refrigerators or freezers, move to flammables cabinet or lab safe refrigerator.</td>
</tr>
<tr>
<td>8.5 Not Stored in Cold Rooms or Walk-in Freezers</td>
<td></td>
<td></td>
<td></td>
<td>The air in these rooms is recirculated, thus storage of flammables is prohibited. Remove all flammables immediately.</td>
</tr>
<tr>
<td>9 Chemical Labeling</td>
<td></td>
<td></td>
<td></td>
<td>All chemical containers should be labeled with contents, and, for hazardous chemicals, their hazard and expiration date.</td>
</tr>
<tr>
<td>80 Chemical Spill Kit</td>
<td></td>
<td></td>
<td></td>
<td>Available ☐; Properly Stocked ☐. Check kits for contents annually. Refer to Section 4.3 (Chemical Spills) of the McLean Lab Safety Manual</td>
</tr>
<tr>
<td>11 NFPA 704 Diamond Posted and Up to Date</td>
<td></td>
<td></td>
<td></td>
<td>Contact P&amp;O at X2621 for the NFPA diamond posting kits for your area. Please refer to section 7.3.3 of the Laboratory Safety Manual</td>
</tr>
<tr>
<td>CONDITION</td>
<td>NA</td>
<td>Y</td>
<td>N</td>
<td>RECOMMENDED CORRECTIVE ACTION IF N IS CHECKED</td>
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<td>---------------------------------------------</td>
</tr>
<tr>
<td><strong>12 Training</strong></td>
<td></td>
<td></td>
<td></td>
<td>All lab members must attend one Safety Fair per year and have attendance documented. Safety Videos on a variety of topics are available on loan from Facilities: <strong>Fire Safety</strong> ☑️; <strong>Waste Disposal</strong> ☑️; <strong>Bloodborne Pathogens</strong> ☑️; <strong>Protective Equipment</strong> ☑️; <strong>Lab Safety</strong> ☑️; <strong>Emergency Response</strong> ☑️</td>
</tr>
<tr>
<td>12.1 Annual Training Requirements; Certification of training for all lab members is through Peoplesoft</td>
<td></td>
<td></td>
<td></td>
<td><strong>12.2 Documentation of lab-specific training.</strong> Demonstrate a written safety training program for safety issues specific to your lab. For example, where is the closest fire extinguisher, what are primary and secondary egress routes, where is designated meeting spot in case of evacuation, what are most hazardous chemicals used in lab and how do you use and dispose of them. Suggest making training packet with quiz as documentation to be given to all new hires and once a year to staff.</td>
</tr>
<tr>
<td><strong>13 Liquid Nitrogen</strong></td>
<td>Appropriate PPE Available</td>
<td>Make appropriate PPE (Personal Protective Equipment) (Cryo gloves, goggles and a faceshield) available.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>14 Centrifuges Interlocked</strong></td>
<td>Replace non-interlocking centrifuges or retrofit them. Until repaired or replaced, post a warning label on centrifuge alerting users not to open it until rotor has stopped.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>15 PPE/Protective Clothing Available?</strong></td>
<td>Refer to Section 16.0 (Protective Equipment) of the McLean Laboratory Safety Manual. <strong>Lab Coats</strong> ☑️; <strong>No Shorts</strong> ☑️; <strong>No Open Toed Shoes</strong> ☑️; <strong>Gloves</strong> ☑️; <strong>Goggles, Face Shields</strong> ☑️</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>16 Biological Safety</strong></td>
<td>Contact Research Administration (X2922) for info on how to get Biosafety Cabinet certified. Medical Waste containers (Red Bags and Biohazard Boxes) required. Call Building Services (UNICCO) at X2656 for additional containers. <strong>Accessible</strong> ☑️ <strong>Leak resistant</strong> ☑️ <strong>Properly Labeled</strong> ☑️ Post sign in lab describing Waste Streams (contact Elena Chartoff at x2022).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.1 Tissue Culture Hoods Certified</td>
<td>Refer to Section 9.7.4 (Biohazard Spills) in the McLean Lab Safety Manual. <strong>Available</strong> ☑️; <strong>Properly Stocked</strong> ☑️. Check kit for contents annually.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>16.2 Biohazardous Waste Containers</td>
<td>Call the MGH Biosafety Office (726-5680) for information on buying protective filters.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.3 Biological Spill Kit</td>
<td>Refer to Section 16.2 (Eye Protection) of the McLean Laboratory Safety Manual.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.4 Hydrophobic Filters on all Aspirators</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CONDITION</strong></td>
<td><strong>NA</strong></td>
<td><strong>Y</strong></td>
<td><strong>N</strong></td>
<td><strong>RECOMMENDED CORRECTIVE ACTION IF N IS CHECKED.</strong></td>
</tr>
<tr>
<td>---------------</td>
<td>--------</td>
<td>-------</td>
<td>-------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>18 If injured while working, does staff know what to do?</td>
<td></td>
<td></td>
<td></td>
<td>Refer to section 5.0 (First Aid Procedures), Section 4.2 (Medical Emergency), and Section 4.3 (Chemical Spills) of the McLean Laboratory Safety Manual for situation specific instructions. Also see section 21.0 (Safety Tips) and review these regularly.</td>
</tr>
<tr>
<td>19 MWRA Regulations</td>
<td></td>
<td></td>
<td></td>
<td>Sink disposal prohibitions must be posted at all sinks.</td>
</tr>
<tr>
<td>19.1 No heavy metals down the drain.</td>
<td></td>
<td></td>
<td></td>
<td>Refer to Guideline on Sink Disposal of Chemical Substances (contact Elena Chartoff, x2022).</td>
</tr>
<tr>
<td>19.2 No solvents down the drain.</td>
<td></td>
<td></td>
<td></td>
<td>Refer to Guideline on Sink Disposal of Chemical Substances (contact Elena Chartoff, x2022).</td>
</tr>
<tr>
<td>19.3 Mercury Thermometers</td>
<td></td>
<td></td>
<td></td>
<td>Replace Mercury thermometers with Alcohol thermometers, if this is not possible use coated Mercury thermometers.</td>
</tr>
<tr>
<td>20 Emergency Numbers Posted?</td>
<td></td>
<td></td>
<td></td>
<td>&quot;Emergency Dial 2222&quot; stickers should be attached to each telephone in your department. Call Telecom at X2484 for replacements.</td>
</tr>
<tr>
<td>21 Bunsen Burner Hoses OK?</td>
<td></td>
<td></td>
<td></td>
<td>Thick, butyl rubber hoses are acceptable. Thin rubber or Tygon tubing are unacceptable.</td>
</tr>
<tr>
<td>22 Sharps Containers</td>
<td></td>
<td></td>
<td></td>
<td>Accessible ☐; Not Over Filled ☐; Closeable Top ☐; Obtain Sharps containers in Storeroom.</td>
</tr>
<tr>
<td>23 Eye Wash</td>
<td></td>
<td></td>
<td></td>
<td>Accessible ☐; Inspected Regularly ☐; Adequate Water Flow ☐; Properly assigned ☐; Contact P&amp;O at X2621 to have eyewash installed, serviced and inspected.</td>
</tr>
<tr>
<td>24 Drench Shower</td>
<td></td>
<td></td>
<td></td>
<td>Accessible ☐; Inspected Regularly ☐; Properly assigned ☐; Contact P&amp;O at X2621 to have a drench shower inspected</td>
</tr>
<tr>
<td>25 Hand Washing Facility</td>
<td></td>
<td></td>
<td></td>
<td>Accessible ☐; Soap available ☐; Paper Towels available ☐</td>
</tr>
<tr>
<td>26 Lab Fume Hoods</td>
<td></td>
<td></td>
<td></td>
<td>26.1 Functional</td>
</tr>
<tr>
<td>26.2 Certified</td>
<td></td>
<td></td>
<td></td>
<td>Contact P&amp;O at X2621 to have hood certified if more than a year has passed since last certification..</td>
</tr>
<tr>
<td>26.3 Free of Excess Storage</td>
<td></td>
<td></td>
<td></td>
<td>Move excess materials/equipment from hoods, ensure that slots and front air foil are not blocked so that adequate air can flow through fume hoods.</td>
</tr>
<tr>
<td>27 General Lab Condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONDITION</td>
<td>NA</td>
<td>Y</td>
<td>N</td>
<td>RECOMMENDED CORRECTIVE ACTION IF N IS CHECKED</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>----</td>
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<td>---</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>27.1 Ceiling Tiles Intact</td>
<td></td>
<td></td>
<td></td>
<td>Contact P&amp;O at X2621 to evaluate cause of damage, replace broken and discolored tiles, and repair underlying cause.</td>
</tr>
<tr>
<td>27.2 Proper Heating and Cooling</td>
<td></td>
<td></td>
<td></td>
<td>Contact P&amp;O at X2621 to evaluate and correct problems.</td>
</tr>
<tr>
<td>27.3 Plumbing OK (particularly under sinks)</td>
<td></td>
<td></td>
<td></td>
<td>Contact P&amp;O at X2621 to evaluate and correct problems.</td>
</tr>
<tr>
<td>27.4 No Free Standing Cabinets</td>
<td></td>
<td></td>
<td></td>
<td>All cabinets must be attached to a wall. Contact P&amp;O at X2621 to evaluate and correct problems.</td>
</tr>
<tr>
<td>27.5 Floor Condition</td>
<td></td>
<td></td>
<td></td>
<td>Contact Building Services (UNICCO) at X2656 for stains, etc.; contact P&amp;O for floor damage at X2621</td>
</tr>
</tbody>
</table>

28 This box is for your comments, suggestions, recommendations and gripes ...

19.0 MCLEAN HOSPITAL SAFETY COMMITTEE POLICY STATEMENT ON WORKING ALONE WITH HAZARDOUS MATERIALS OR EQUIPMENT OR IN ISOLATED AREAS

Working alone with hazardous materials or equipment or in isolated areas is recognized as fundamentally unsafe. It is the responsibility of each director of a laboratory, head of a department or administrative unit of the Hospital to identify the hazardous or isolated areas under his or her jurisdiction where working alone is not allowed. Where hazards are identified, every effort must be made to minimize or eliminate them.

20.0 SAFETY TIPS FOR LABORATORY PERSONNEL

1. Always be sure that your hands are dry before handling bottles, test tubes or instruments.

2. Keep flammable or explosive liquids and chemicals a safe distance from Bunsen burners and other sources of
ignition.

3. There is no smoking in any building on the McLean Campus.

4. Bottles and other equipment should be kept away from edge of tables and shelves. If shelves and cabinets are crowded, ask the Maintenance Department to install "shelf guards."

5. Make sure gas cylinders are secured to the wall. Ask the Maintenance Department to install wall brackets and chains if necessary.

6. Examine test tubes and other glassware for cracks and defects before using them. Place defective glassware in a special container provided for that purpose.

7. Use a pan and brush—not your hands—to remove broken equipment or glass from the floor or table.

8. Dispose of all broken glassware, even if it is still usable; fire polish glass tubing and glass rods.

9. Keep test tubes and other containers away from your face when pouring liquids or conducting experiments. Pour below eye level and avoid splashing.

10. All bottles should be clearly and legibly marked, identifying their contents.

11. Always wear gloves when working with or handling animals.

12. Always practice good housekeeping.

13. Work with flammable or toxic materials should be conducted under exhaust hoods.

14. Keep only a small supply of reagents and flammable liquids in the lab at one time. Store excess amounts of flammable liquids in explosion-proof refrigerators or in the flammable storage room next to the Pharmacy.

15. Flammable liquids which require cooling are to be stored in explosion-proof refrigerators only.

16. Learn the fire regulations. Do you know the locations of extinguishers?

17. When inserting glass tubing into rubber tubing, always moisten or lubricate the glass ends first. Place a protective material (such as a gauze pad) over the glass tubing to protect your hands.

18. When removing glass tube from rubber tubing, use a twisting motion. If the glass tube breaks inside the rubber tubing, remove the broken glass with tweezers, not with your fingers.

19. When irritant chemicals are splashed into the eye, for example, caustics, individuals may experience a powerful reflex to close their eyes and may not be able to use an eyewash without assistance to a) locate the eyewash b) hold their eyelids open in order to wash the eye. Therefore, never use any strong irritant chemicals while working alone without using eye protection.
1910.1450(a)

Scope and application.

1910.1450(a)(1)

This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

1910.1450(a)(2)

Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

1910.1450(a)(2)(i)

For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

1910.1450(a)(2)(ii)

Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

1910.1450(a)(2)(iii)

Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.

1910.1450(a)(3)
This section shall not apply to:

1910.1450(a)(3)(i)

Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.

1910.1450(a)(3)(ii)

Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

1910.1450(a)(3)(ii)(A)

Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

1910.1450(a)(3)(ii)(B)

Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

1910.1450(b)

Definitions --

**Action level** means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

**Assistant Secretary** means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

**Carcinogen** (see select carcinogen).

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

**Chemical Hygiene Plan** means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

**Combustible liquid** means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

**Compressed gas** means:
(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

**Designated area** means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

**Emergency** means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

**Employee** means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

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

**Flammable** means a chemical that falls into one of the following categories:

(i) Aerosol, flammable means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) Gas, flammable means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) Liquid, flammable means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) Solid, flammable means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

**Flashpoint** means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:
(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous chemical means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

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

Laboratory scale means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii) Multiple chemical procedures or chemicals are used;
(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

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

Organic peroxide means an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer means a chemical other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Physical hazard means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water-reactive.

Protective laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive toxin means chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.
Unstable (reactive) means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

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

1910.1450(c)

Permissible exposure limits. For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

1910.1450(d)

Employee exposure determination --

1910.1450(d)(1)

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

1910.1450(d)(2)

Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

1910.1450(d)(3)

Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.

1910.1450(d)(4)

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

1910.1450(e)

Chemical hygiene plan -- General. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan).

1910.1450(e)(1)

Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

1910.1450(e)(1)(i)

Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and
Capable of keeping exposures below the limits specified in paragraph (c) of this section.

The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;

Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

Provisions for employee information and training as prescribed in paragraph (f) of this section;

The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer’s designee before implementation;

Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee; and
Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

1910.1450(e)(3)(viii)(A)

Establishment of a designated area;

1910.1450(e)(3)(viii)(B)

Use of containment devices such as fume hoods or glove boxes;

1910.1450(e)(3)(viii)(C)

Procedures for safe removal of contaminated waste; and

1910.1450(e)(3)(viii)(D)

Decontamination procedures.

1910.1450(e)(4)

The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

1910.1450(f)

Employee information and training.

1910.1450(f)(1)

The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

1910.1450(f)(2)

Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

1910.1450(f)(3)

Information. Employees shall be informed of:

1910.1450(f)(3)(i)

The contents of this standard and its appendices which shall be made available to employees;

1910.1450(f)(3)(ii)

the location and availability of the employer's Chemical Hygiene Plan;
The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

\textbf{1910.1450(f)(3)(iv)}

Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

\textbf{1910.1450(f)(3)(v)}

The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.

\textbf{1910.1450(f)(4)}

Training.

\textbf{1910.1450(f)(4)(i)}

Employee training shall include:

\textbf{1910.1450(f)(4)(i)(A)}

Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

\textbf{1910.1450(f)(4)(i)(B)}

The physical and health hazards of chemicals in the work area; and

\textbf{1910.1450(f)(4)(i)(C)}

The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

\textbf{1910.1450(f)(4)(ii)}

The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

\textbf{1910.1450(g)}

Medical consultation and medical examinations.

\textbf{1910.1450(g)(1)}

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

\textbf{1910.1450(g)(1)(i)}}
Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

1910.1450(g)(1)(ii)

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

1910.1450(g)(1)(iii)

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

1910.1450(g)(2)

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

1910.1450(g)(3)

Information provided to the physician. The employer shall provide the following information to the physician:

1910.1450(g)(3)(i)

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

1910.1450(g)(3)(ii)

A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

1910.1450(g)(3)(iii)

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

1910.1450(g)(4)

Physician's written opinion.

1910.1450(g)(4)(i)

For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

1910.1450(g)(4)(i)(A)

Any recommendation for further medical follow-up;
1910.1450(g)(4)(i)(B)

The results of the medical examination and any associated tests;

1910.1450(g)(4)(i)(C)

Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and

1910.1450(g)(4)(i)(D)

A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

1910.1450(g)(4)(ii)

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

1910.1450(h)

Hazard identification.

1910.1450(h)(1)

With respect to labels and material safety data sheets:

1910.1450(h)(1)(i)

Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

1910.1450(h)(1)(ii)

Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

1910.1450(h)(2)

The following provisions shall apply to chemical substances developed in the laboratory:

1910.1450(h)(2)(i)

If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

1910.1450(h)(2)(ii)

If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.
If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labeling.

1910.1450(i)

Use of respirators. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

1910.1450(j)

Recordkeeping.

1910.1450(j)(1)

The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.

1910.1450(j)(2)

The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.

1910.1450(k)

[Reserved]

1910.1450(l)

Appendices. The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.


Next Standard (1910.1450 App A) Next Standard (1910.1450 App A)
APPENDIX B   NFPA 704 HAZARD DIAMOND SYSTEM

The above is an example of the 704 diamond system. The number in the designated square indicates the degree of hazard. This is the standard NFPA 704 diamond system. The hazard within the area could be a poisonous, flammable or reactive gas or liquid.

In the slightly modified version the letter "G" is added to the bottom of the appropriate square which indicates the presence of a compressed gas. (The example indicates the presence of a flammable and inert gas).
<table>
<thead>
<tr>
<th>Flammable Toxic Reactive Corrosive Group</th>
<th>Properties</th>
<th>Important Notes</th>
<th>Storage</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong> Flammables and Combustibles (Includes organic acids) AKA: organics, solvents</td>
<td>Flammable liquids have a flashpoint (FP) below 100°F (38°C). Combustible liquids have a flashpoint above 100°F and below 140°F Flashpoint is the lowest temperature at which a liquid gives off enough vapor to ignite.</td>
<td>The MSDS provides the flashpoint for flammable and combustible liquids. Ignition sources include spark from electrical outlet, vacuum pumps, and static electricity.</td>
<td>FP $&lt;$ 140°F (60°C) store in a metal flammable cabinet that is completely enclosed. If vented, the vent must have a flash arrestor. NO cardboard shipping boxes in the cabinet. Never store in cold rooms or refrigerators (unless the refrigerator is explosion-proof). Do not store with oxidizers or inorganic acids.</td>
<td>All alcohols: butanol, ethanol, methanol, isopropanol, etc. Acetone, acetaldehyde, acetonitrile, amyl acetate, benzene, cyclohexane, dimethyldichlorosilane, dioxane, ether, ethyl acetate, hexane, hydrazine, methyl butane, picolene, pyridine, all silanes, tetrahydrofuran, toluene, triethylamine, xylene, etc. Combustibles: dimethylformamide, formaldehyde</td>
</tr>
<tr>
<td>Peroxide-formers Generally, Group I</td>
<td>Highly flammable. May form low-power explosives that are very sensitive to shock, sparks, light, strong oxidizing and reducing agents, friction, and high temperatures.</td>
<td>Read Peroxide-Forming Chemicals SOP Distillation, evaporation, or other concentration can present a high risk of explosion. Test for peroxide formation monthly.</td>
<td>Store with flammables. Date when received and when opened. Dispose of as hazardous waste after 12 months.</td>
<td>Ether (diethyl and isopropyl), tetrahydrofuran, acetaldehyde, etc.</td>
</tr>
<tr>
<td><strong>Group II (volatile) and VII (non-volatile)</strong></td>
<td>Chronic exposure is a health hazard. Avoid inhalation, skin</td>
<td>Commonly mistaken for a flammable liquid. OK to store with flammables in flammable cabinet.</td>
<td>Volatile toxics: carbon tetrachloride, chloroform,</td>
<td></td>
</tr>
</tbody>
</table>
### Toxics
AKA: poisons, organics, halogenated solvents, carcinogens, mutagens, reproductive toxins

**contact.**
Many toxic solvents are highly volatile.
Non-flammable (some are combustible).

**Alternative:** Any enclosed cabinet or shelf to protect from accidental breakage.
Store containers larger than 1 liter below bench level.
Do not store with bases.

Non-volatile toxics:
dimethyl sulfate, halothane, mercaptoethanol, methylene chloride (dichlormethane), phenol

Non-flammable toxic acids:
dimethyl sulfate, halothane, mercaptoethanol, methylene chloride (dichlormethane), phenol

### Flammable Toxic Reactive Corrosive Group

<table>
<thead>
<tr>
<th>Properties</th>
<th>Important Notes</th>
<th>Storage</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxidizing acids are highly reactive, and may react with each other. Corrosive, burns skin and eyes.</td>
<td>Concentrated (&gt; 70%) perchloric acid reacts with wood and paper and may ignite. Never store concentrated perchloric acid directly on wood shelves without a plastic tub. Also, see Group IV.</td>
<td>Oxidizing acids should be separated from each other by use of a plastic tub. Oxidizing acids can be stored with mineral acids but not organic acids.</td>
<td>Oxidizing inorganic acids: nitric, sulfuric, perchloric, chromic</td>
</tr>
<tr>
<td>Corrosive, burns skin and eyes.</td>
<td>Acid mist escapes from closed bottles and builds up inside un-vented cabinets causing corrosion of labels, metal cabinets, etc.</td>
<td>Store in the vented cabinet under fume hood or in a vented stand alone cabinet. Do not store with bases. Store below eye level. It is a good idea to keep hydrofluoric acid in a separate tub or tray to avoid contamination of surfaces.</td>
<td>Mineral acids: hydrochloric, phosphoric, hydrofluoric Organic acids: acetic, acrylic, acetic anhydride, butyric, formic, glacial acetic, isobutyric, mercaptotropionic, trifluoroacetic, etc.</td>
</tr>
<tr>
<td>Corrosive burns skin and eyes.</td>
<td>Avoid contact with acids and volatile toxics.</td>
<td>Store in a separate cabinet. Alternative: store with other chemicals and keep in a separate tub</td>
<td>Sodium hydroxide, ammonium hydroxide, calcium hydroxide, potassium hydroxide, aqueous</td>
</tr>
<tr>
<td>AKA: alkaline</td>
<td>or tray. Can be stored with flammables if no volatile toxic (halogenated organics) are present. Store below eye level.</td>
<td>ammonia</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Flammable Toxic Reactive Corrosive Group</strong></th>
<th><strong>Properties</strong></th>
<th><strong>Important Notes</strong></th>
<th><strong>Storage</strong></th>
<th><strong>Examples</strong></th>
</tr>
</thead>
</table>
| **Group VI**
Oxidizing Liquids
(Excluding Oxidizing acids)
AKA: reactives | Provides oxygen that feeds fires and makes fires very difficult to extinguish. Oxidizing liquids react with many things potentially causing explosions or corrosion of surfaces. | The oxidizer symbol (a burning O) may be mistaken for a flammable symbol (a flame). Oxidizers are considered ignitable for hazardous waste management purposes. | Store on a separate shelf. Do not store directly on wood shelf or paper. If stored near other chemicals, including other oxidizers keep in a separate tub or tray. Do not store with flammables. | Ammonium persulfate, hydrogen peroxide >30% |
| **Group VIII**
Pyrophorics and Water Reactives | ignite spontaneously in air. Water reactives can react with moisture in the air to produce a flammable gas. Metal hydrides react violently with water, some ignite spontaneously in air. | Read Pyrophoric and Water Reactives SOP | Waterproof double containment (the shipping container may be an appropriate second container). Isolate from other chemicals. OK to store with dry chemicals. Do not store with liquid chemicals (oxidizers, flammables, acids, bases, toxics etc.) | Metal hydrides: sodium borohydride, calcium hydride, lithium aluminum hydride, etc. Pyrophorics: borane, diborane, dichloroborane, lithium, phosphorous, 2-furaldehyde, diethyl aluminum chloride, trimethyl aluminum, etc. Water Reactives: aluminum chloride |
### Flammable Toxic Reactive Corrosive Group Properties Important Notes Storage Examples

<table>
<thead>
<tr>
<th>Group IX Dry Solids</th>
<th>Properties</th>
<th>Important Notes</th>
<th>Storage</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies. They are dry, but when wet, may have different properties, depending on the material.</td>
<td>Keep Dry. Indicate where the more toxic materials are located. (See SOP)</td>
<td>Cabinets are suggested, but shelves are O.K. Store above liquids and separate from liquids.</td>
<td>Benidine, cyanogens, bromide, oxalic acid, potassium hydroxide.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemicals with no great storage options, e.g. anhydrides</th>
<th>Properties</th>
<th>Important Notes</th>
<th>Storage</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>These materials react with many things.</td>
<td>Keep isolated in some way by using secondary containment. Minimize quantities on hand.</td>
<td>Will depend on specific chemical. Call EHS for guidance.</td>
<td>Acetic anhydride, trichloro acetic anhydride</td>
<td></td>
</tr>
</tbody>
</table>

For more information see the Chemical Storage SOP and App A – Storage Scheme One of the SOP. Go to: [http://web.mit.edu/environment/ehs/chemical_storage.html](http://web.mit.edu/environment/ehs/chemical_storage.html) Basic Rules

**Common Problems**

- Oxidizing acids stored with organic acids, e.g. nitric acid and acetic acid.
- Oxidizers stored with flammables.
- Acids stored with bases.
- Flammables stored in non-flammable refrigerator.
- Large quantities offlammables stored outside.
<table>
<thead>
<tr>
<th>stored.</th>
<th>flammable cabinets.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Store hazardous liquids below eye level.</td>
<td>Corrosives (acids and bases) or other liquids stored above eye level.</td>
</tr>
<tr>
<td>Make sure chemical containers are in good condition and are compatible with contents.</td>
<td></td>
</tr>
<tr>
<td>Lids should be tightly closed.</td>
<td>Stock chemicals stored in fume hood.</td>
</tr>
<tr>
<td>Secondary containment for floor storage.</td>
<td>Reactives stored with incompatible chemicals.</td>
</tr>
<tr>
<td>Do not store solids with liquids</td>
<td>Liquids stored with solids that are incompatible with liquids, e.g. cyanides.</td>
</tr>
<tr>
<td>Do not store items in working space of fume hoods.</td>
<td>Anhydrides not stored with secondary containment.</td>
</tr>
<tr>
<td>Do not store hazardous chemicals in cold rooms</td>
<td></td>
</tr>
<tr>
<td>Annually discard unused, unwanted, and expired chemical</td>
<td></td>
</tr>
</tbody>
</table>
## Table 5. Flammability / Hazard Identification for Selected Class IA and Class IB Liquids

### CLASS I

**CLASS IA Flash Point <73°F with Boiling Point Below 100°F**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Flash Point</th>
<th>Ignition Temp</th>
<th>Boiling Point, °F</th>
<th>Health</th>
<th>Flammability</th>
<th>Reactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaldehyde</td>
<td>-36</td>
<td>365</td>
<td>70</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>1-Chloropropylene</td>
<td>21</td>
<td>95-97</td>
<td>62</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Ethyl Amine</td>
<td>0</td>
<td>723</td>
<td>62</td>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Ethyl Chloride</td>
<td>-58</td>
<td>966</td>
<td>54</td>
<td>2</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Ethylene Oxide</td>
<td>0</td>
<td>804</td>
<td>51</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Ethyl Ether</td>
<td>-49</td>
<td>356</td>
<td>95</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Ethyl Nitrite</td>
<td>-31</td>
<td>194</td>
<td>63</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Furan</td>
<td>32</td>
<td>88</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hydrocyanic Acid 96%</td>
<td>0</td>
<td>1000</td>
<td>79</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Isoprene</td>
<td>-65</td>
<td>428</td>
<td>93</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Isopropenyl Acetylene</td>
<td>19</td>
<td>92</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl Bromide</td>
<td>999</td>
<td>40</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2-Methyl Butene-1</td>
<td>20</td>
<td>88</td>
<td>4</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3-Methyl Butene-1</td>
<td>20</td>
<td>68</td>
<td>4</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Methyl Ethyl Ether</td>
<td>-35</td>
<td>374</td>
<td>51</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Methyl Formate</td>
<td>-2</td>
<td>853</td>
<td>90</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Pentane</td>
<td>-40</td>
<td>588</td>
<td>97</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Pentane-iso</td>
<td>-60</td>
<td>788</td>
<td>82</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Pentene-l</td>
<td>0</td>
<td>523</td>
<td>86</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Petroleum Ether</td>
<td>0</td>
<td>550</td>
<td>95-140</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Propylamine-iso</td>
<td>-35</td>
<td>756</td>
<td>89</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Chemical</td>
<td>Flash Point</td>
<td>Ignition Temp</td>
<td>Boiling Point, °F</td>
<td>Flammability</td>
<td>Reactivity</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-------------</td>
<td>---------------</td>
<td>-------------------</td>
<td>--------------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>Propyl Chloride-iso</td>
<td>-26</td>
<td>1100</td>
<td>95</td>
<td>2</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Propylene Oxide</td>
<td>-35</td>
<td></td>
<td>95</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Trichlorosilane</td>
<td>20</td>
<td>89</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Vinyl Ethyl Ether</td>
<td>-50</td>
<td>395</td>
<td>96</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Vinylidene Chloride Monomer</td>
<td>5</td>
<td>856</td>
<td>99</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Flammability / Hazard Identification for Selected Class IA and Class IB Liquids (cont'd.)

**FLAMMABLE LIQUID**

**CLASS I**

**CLASS IB FLASH POINT >73°, <100° F AND BOILING POINT ABOVE 100° F**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Flash Point</th>
<th>Ignition Temp</th>
<th>Boiling Point, °F</th>
<th>Flammability</th>
<th>Reactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetal</td>
<td>-5</td>
<td>446</td>
<td>215</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Acetone</td>
<td>0</td>
<td>1000</td>
<td>134</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Acetonitrile</td>
<td>42</td>
<td></td>
<td>179</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Acetyl Chloride</td>
<td>40</td>
<td>734</td>
<td>124</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Acetylene Dichloride</td>
<td>39</td>
<td></td>
<td>140</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Acetylene Dichloride trans</td>
<td>46</td>
<td></td>
<td>119</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Acrolein</td>
<td>0</td>
<td>532</td>
<td>125</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Acrylonitrile</td>
<td>32</td>
<td>898</td>
<td>171</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Allyl Alcohol</td>
<td>70</td>
<td>713</td>
<td>206</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Allylamine</td>
<td>-20</td>
<td>705</td>
<td>128</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Allyl Bromide</td>
<td>30</td>
<td>563</td>
<td>160</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Allyl Chloride</td>
<td>-25</td>
<td>737</td>
<td>113</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Allyl Ether</td>
<td>-20</td>
<td></td>
<td>203</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyl Alcohol-Ter iso</td>
<td>67</td>
<td>819</td>
<td>215</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Amylamine</td>
<td>45</td>
<td>210</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Amylamine-Sec</td>
<td>20</td>
<td>198</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Amyl Chloride</td>
<td>55</td>
<td>650</td>
<td>223</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Chemical</td>
<td>Flash Point</td>
<td>Ignition Temp</td>
<td>Boiling Temp, ° F</td>
<td>Flamma-Health</td>
<td>Bility</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------</td>
<td>---------------</td>
<td>------------------</td>
<td>--------------</td>
<td>--------</td>
</tr>
<tr>
<td>Butyl Peroxide</td>
<td>64</td>
<td></td>
<td>176</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Butyraldehyde</td>
<td>20</td>
<td>446</td>
<td>169</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Butyraldehyde-iso</td>
<td>-40</td>
<td>490</td>
<td>142</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Carbon Disulfide</td>
<td>-22</td>
<td>212</td>
<td>115</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Cellulos Nitrate</td>
<td>55</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Chlorobutadiene</td>
<td>-4</td>
<td></td>
<td>138</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorobutene</td>
<td>-3</td>
<td>143-159</td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Crotonaldehyde</td>
<td>55</td>
<td>450</td>
<td>216</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

FLAMMABILITY / HAZARD IDENTIFICATION FOR SELECTED CLASS IA AND CLASS IB LIQUIDS (CONT'D.)
<table>
<thead>
<tr>
<th>Compound</th>
<th>Temp</th>
<th>Vap</th>
<th>Mel</th>
<th>Cond</th>
<th>Boil</th>
<th>Came</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclohexane</td>
<td>-4</td>
<td>500</td>
<td>179</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Cyclohexene</td>
<td>20</td>
<td>181</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Cyclopentane</td>
<td>20</td>
<td>121</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Denatured Alcohol</td>
<td>60</td>
<td>750</td>
<td>175</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Di-Ter-Butyl Peroxide</td>
<td>65</td>
<td>231</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Dichloroethylene-1,2</td>
<td>43</td>
<td>141</td>
<td>2</td>
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**FLAMMABILITY / HAZARD IDENTIFICATION FOR SELECTED CLASS IA AND CLASS IB LIQUIDS (CONT'D.)**
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**FLAMMABILITY / HAZARD IDENTIFICATION FOR SELECTED CLASS IA AND CLASS IB LIQUIDS (CONT'D.)**

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<td>2</td>
<td>3</td>
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<tr>
<td>2,2,4-Trimethylpentane</td>
<td>10</td>
<td>211</td>
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</tr>
<tr>
<td>2,4,4-Trimethylpentene-1</td>
<td>20</td>
<td>214</td>
<td>3</td>
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<tr>
<td>2,2,4-Trimethylpentene-2</td>
<td>35</td>
<td>221</td>
<td>3</td>
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</tr>
<tr>
<td>Valeraldehyde</td>
<td>54</td>
<td>217</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vinyl Acetate</td>
<td>18</td>
<td>161</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Vinyl Allyl Ether</td>
<td>68</td>
<td>153</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Vinyl Butyl Ether</td>
<td>15</td>
<td>202</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Vinyl Butyl Ether-iso</td>
<td>20</td>
<td>181</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Vinyl Butyrate</td>
<td>68</td>
<td>242</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4 Vinyl Cyclohexene</td>
<td>61</td>
<td>266</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Vinyl Isobutyl Ether</td>
<td>15</td>
<td>182</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Vinyl Propionate</td>
<td>34</td>
<td>203</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
### APPENDIX E  POTENTIALLY UNSTABLE COMPOUNDS

Adapted from Harvard University EH&S Chemical Hygiene Plan:  
[www.uos.harvard.edu/ehs/ih/PotentiallyUnstableCompounds.pdf](http://www.uos.harvard.edu/ehs/ih/PotentiallyUnstableCompounds.pdf)

*Note: this is not an exhaustive list*

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1-Dichloroethylene (vinylidene chloride)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>2-Butenal (crotonaldehyde)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>2-Furaldehyde</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>2-propenal (acrylaldehyde)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>9,10-Dihydroanthracene</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Acetal (acetaldehyde diethyl acetal)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Acetaldehyde diethyl acetal (acetal)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Acetyl chloride</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Acetylenic compounds [especially polyacetylenes, haloacetylenes, and heavy metal salts of acetylenes (copper, silver, and mercury salts are particularly sensitive)]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Acrylaldehyde (2-propenal)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Acrylic acid</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Acrylonitrile</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Acyl nitrates</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Alkali metal amides</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Alkali metal hydrides</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Alkali metals</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Alkali metals [such as Na, K]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Alkyl aluminum [R-Al]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Alkyl and acyl nitrates</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Alkyl arsenic [R-As]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Alkyl boron [R-B]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Alkyl lithium [RLi]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Alkyl nitrates [particularly polyol nitrates such as nitrocellulose and nitroglycerine]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Alkyl perchlorates</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Chemical Compound</td>
<td>Reactivity</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Alkyl phosphorus $[\text{R}_3\text{P}]$</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Alkyl sodium $[\text{RNa}]$</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Alkyl zinc $[\text{R}_2\text{Zn}]$</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Aluminum alkyls</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Aluminum chloride $[\text{AlCl}_3]$</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Aluminum powder</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Amminemetal oxosalts [metal compounds with coordinated ammonia, hydrazine, or similar nitrogenous donors and ionic perchlorate, nitrate, permanganate, or other oxidizing group]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Anhydrous metal halides [such as $\text{AlCl}_3$, $\text{TiCl}_4$, $\text{ZrCl}_4$, $\text{SnCl}_4$]</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Arsine $[\text{AsH}_3]$</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Azides [including metal, nonmetal, and organic azides]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Boron</td>
<td>Pyrophoric $^1$</td>
</tr>
<tr>
<td>Boron trichloride $[\text{BCl}_3]$</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Boron trifluoride $[\text{BF}_3]$</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Butadiene</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Butadiene (diacetylene)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Cadmium (finely-divided)</td>
<td>Pyrophoric $^1$</td>
</tr>
<tr>
<td>Calcium (finely-divided)</td>
<td>Pyrophoric $^1$</td>
</tr>
<tr>
<td>Calcium carbide</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Calcium oxide</td>
<td>Water-reactive $^2$</td>
</tr>
<tr>
<td>Cellosolves (ethylene glycol monoethers)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Chlorite salts of metals [such as $\text{AgClO}_2$ and $\text{Hg(ClO}_2)_2$]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Chlorobutadiene (chloroprene)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Chloroprene (chlorobutadiene)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Chlorosulfonic Acid</td>
<td>Water-reactive $^3$</td>
</tr>
<tr>
<td>Chlorotrifluoroethylene</td>
<td>Peroxide-forming $^2$</td>
</tr>
<tr>
<td>Chromium (finely-divided)</td>
<td>Pyrophoric $^1$</td>
</tr>
<tr>
<td>Cobalt powder</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Crotonaldehyde (2-butenal)</td>
<td>Peroxide-forming $^2$</td>
</tr>
<tr>
<td>Cumene (isopropylbenzene)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Cyanamide $[\text{CH}_2\text{N}_2]$</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Cyclohexene</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Substance</td>
<td>Property</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Cyclooctene</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Cyclopentene</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Decahydronaphthalene (decalin)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Decalin (decahydronaphthalene)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Diacetylene (butadiene)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Diazo compounds [such as CH\textsubscript{2}N\textsubscript{2}]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Diazonium salts, when dry</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Dibenzocyclopentadiene</td>
<td>Peroxide-forming\textsuperscript{2}</td>
</tr>
<tr>
<td>Diborane [BH\textsubscript{6}]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Dichloroborane</td>
<td>Pyrophoric\textsuperscript{1}</td>
</tr>
<tr>
<td>Dicobalt octacarbonyl [Co\textsubscript{2}(CO)\textsubscript{8}]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Dicyclopentadiene</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Diethyl ether (ether)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Diethylene glycol dimethyl ether (diglyme)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Diglyme (diethylene glycol dimethyl ether)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Diisopropyl ether (isopropyl ether)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Dinitroacetonitrile</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Dioxane (p-dioxane)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Disulfur dichloride [S\textsubscript{2}Cl\textsubscript{2}]</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Divinyl acetylene (DVA)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Divinyl ether</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Ether (diethyl ether)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Ethylene glycol dimethyl ether (glyme)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Ethylene glycol ether acetates</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Ethylene glycol monoethers (cellosolves)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Ferrous sulfide</td>
<td>Water-reactive\textsuperscript{1}</td>
</tr>
<tr>
<td>Fulminates [silver fulminate, AgCNO, can form in the reaction mixture from the Tollens' test for aldehydes if it is allowed to stand for some time; this can be prevented by adding dilute nitric acid to the test mixture as soon as the test has been completed]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Furan</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Glyme (ethylene glycol dimethyl ether)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Grignard reagents [RMgX]</td>
<td>Pyrophoric/Water-reactive</td>
</tr>
<tr>
<td>Halides of nonmetals [such as BCl\textsubscript{3}, BF\textsubscript{3}, PCI\textsubscript{3}, PCI\textsubscript{5}, SiCl\textsubscript{4}, S\textsubscript{2}Cl\textsubscript{2}]</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Hydrogen peroxide at concentrations above 30% [when it becomes increasingly treacherous as the concentration rises,]</td>
<td>Shock-sensitive</td>
</tr>
</tbody>
</table>
forming explosive mixtures with organic materials and decomposing violently in the presence of traces of transition metals

<table>
<thead>
<tr>
<th>Substance</th>
<th>Property</th>
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<tbody>
<tr>
<td>Indene</td>
<td>Peroxide-forming²</td>
</tr>
<tr>
<td>Inorganic acid halides [such as POCI₃, SOCl₂, SO₂Cl₂]</td>
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</tr>
<tr>
<td>Iron pentacarbonyl [Fe(CO)₅]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Iron powder</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Isopropyl ether (diisopropyl ether)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Isopropylbenzene (cumene)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Lead (finely-divided)</td>
<td>Pyrophoric ¹</td>
</tr>
<tr>
<td>Lithium</td>
<td>Water-reactive²</td>
</tr>
<tr>
<td>Lithium alkyls</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Lithium aluminum hydride [LiAlH₄]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Water-reactive¹</td>
</tr>
<tr>
<td>Magnesium powder</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Maleic anhydride</td>
<td>Water-reactive³</td>
</tr>
<tr>
<td>Manganese powder</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Mercury chloride [Hg(ClO₂)₂]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Metal alkyls [such as lithium alkyls and aluminum alkyls]</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Metal alkyls and aryls [such as RLi, RNa, R₃Al, R₂Zn]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Metal carbonyls [such as Ni(CO)₄, Fe(CO)₅, Co₂(CO)₈]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Metal hydrides [such as NaH, LiAlH₄]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Metal powders [such as Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Methyl acetylene</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Methyl cyclopentane</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Methyl isobutyl ketone</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Methyl methacrylate</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>N-Halogen compounds [such as difluoroamino compounds and halogen azides]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Nickel (finely-divided)</td>
<td>Pyrophoric ¹</td>
</tr>
<tr>
<td>Nickel tetracarbonyl [Ni(CO)₄]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Nitric amide</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Nitrocellulose</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Material</td>
<td>Property</td>
</tr>
<tr>
<td>--------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Nitroglycerine</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Nitroguanidine</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Nitrourea</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>N-Nitro compounds [such as N-nitromethylamine, nitrourea,</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>nitroguanidine, and nitric amide]</td>
<td></td>
</tr>
<tr>
<td>N-nitromethylamine</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Nonmetal alkyls [such as R(\text{B}), R(\text{P}), R(\text{As})]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Nonmetal hydrides [such as diborane, B(_2)H(_6), and</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>other boranes, (\text{PH}_3), (\text{AsH}_3)]</td>
<td></td>
</tr>
<tr>
<td>Organic acid halides and anhydrides of low molecular weight</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Oxo salts of nitrogenous bases [perchlorates, dichromates,</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>nitrates, iodates, chlorites, chlorates, and permanganates</td>
<td></td>
</tr>
<tr>
<td>of ammonia, amines, hydroxylamine, guanidine, etc.]</td>
<td></td>
</tr>
<tr>
<td>Palladium powder</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>(\text{p-Dioxane (dioxane)})</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Perchlorate salts [most metal, nonmetal, and amine perchlorates</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>can be detonated and may undergo violent reaction in contact</td>
<td></td>
</tr>
<tr>
<td>with combustible materials]</td>
<td></td>
</tr>
<tr>
<td>Peroxides (solid) [that crystallize from or are left from</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>evaporation of peroxidizable solvents]</td>
<td></td>
</tr>
<tr>
<td>Peroxides and hydroperoxides, organic</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Peroxides, transition-metal salts</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Phosphine (\text{[PH}_3\text{]})</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Phosphoric trichloride (\text{POCl}_3)</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Phosphorus (white)</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Phosphorus (yellow)</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Phosphorus pentachloride (\text{PCl}_5)</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Phosphorus Pentasulfide</td>
<td>Water-reactive(^1)</td>
</tr>
<tr>
<td>Phosphorus pentoxide</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Phosphorus trichloride (\text{PCI}_3)</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Picrates [especially salts of transition and heavy metals,</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>such as Ni, Pb, Hg, Cu, and Zn; picric acid is explosive but</td>
<td></td>
</tr>
<tr>
<td>is less sensitive to shock or friction than its metal salts</td>
<td></td>
</tr>
<tr>
<td>and is relatively safe as a water-wet paste]</td>
<td></td>
</tr>
<tr>
<td>Platinum powder</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Polynitroalkyl compounds [such as tetranitromethane and</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>(\text{PCl}_5\text{]})]</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Indicates peroxide-forming properties due to exposure to air.
<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>dinitroacetonitrile</td>
<td></td>
</tr>
<tr>
<td>Polynitroaromatic compounds [especially polynitro hydrocarbons, phenols, and amines]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Potassium amide</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Potassium metal</td>
<td>Peroxide-forming / Pyrophoric / Water-reactive</td>
</tr>
<tr>
<td>Silicon tetrachloride [SiCl₄]</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Silver chlorite [AgClO₂]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Silver fulminate [AgCNO]</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Sodaamide (sodium amide)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Sodium amide (sodamide)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Sodium hydride [NaH]</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Sodium metal</td>
<td>Water-reactive / Pyrophoric</td>
</tr>
<tr>
<td>Stannic chloride [SnCl₄]</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Styrene</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Sulfuryl chloride [SO₂Cl₂]</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>t-Butyl alcohol</td>
<td>Peroxide-forming²</td>
</tr>
<tr>
<td>Tetrafluoroethylene (TFE)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Tetrahydrofuran (THF)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Tetrahydronaphthalene (tetralin)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Tetralin (tetrahydronaphthalene)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Tetranitromethane</td>
<td>Shock-sensitive</td>
</tr>
<tr>
<td>Thionyl chloride [SOCl₂]</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Tin powder</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Titanium powder</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Titanium tetrachloride [TiCl₄]</td>
<td>Water-reactive</td>
</tr>
<tr>
<td>Vinyl acetate</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Vinyl acetylene (MVA)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Vinyl ethers</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Vinyl pyridine</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Vinylvliden chloride (1,1-dichloroethylene)</td>
<td>Peroxide-forming</td>
</tr>
<tr>
<td>Zinc powder</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Zirconium powder</td>
<td>Pyrophoric</td>
</tr>
<tr>
<td>Zirconium tetrachloride [ZrCl₄]</td>
<td>Water-reactive</td>
</tr>
</tbody>
</table>
Sources


Additional: 1 Boston Fire Department, Fire Prevention Division, *Storage Practice for Hazardous Materials*, Issued by Fire Captain Thomas C. Scavitto, Special Hazards Officer, Boston, MA

2 National Safety Council, *Recognition and Handling of Peroxidizable Compounds*, Data Sheet I-655 Rev. 87, Chicago, IL
APPENDIX F  LISTED HAZARDOUS CHEMICAL WASTES

- Many substances have multiple names and organic nomenclature can be confusing. CAS numbers are included to help in finding individual items on the list.

- If questions remain after a thorough search of this list, contact the Lab Safety Officer for assistance.

- The letters following some of the entries stand for:
  
  I: ignitable
  
  C: corrosive
  
  R: reactive
  
  T: toxic

- All entries that are not followed by one of these letters are listed because of their toxicity.

- Materials considered to be acutely toxic (EPA P-Listed Wastes) are bolded and underlined. Acutely toxic wastes must only be collected in containers one quart in size or less.

A

- 75-07-0  Acetaldehyde (I)
- 107-20-0 Acetaldehyde, chloro-
- 75-87-6  Acetaldehyde, trichloro-
- 591-08-2 Acetamide, N- (aminothioxomethyl)-
- 62-44-2  Acetamide, N- (4-ethoxyphenyl)-
- 53-96-3  Acetamide, N-9H-fluoren-2-yl-
- 640-19-7 Acetamide, 2-fluoro-
- 94-75-7  Acetic acid, (2,4-dichlorophenoxy)-, salts & esters
- 141-78-6 Acetic acid ethyl ester (I)
- 62-74-8  Acetic acid, fluoro-, sodium salt
- 301-04-2 Acetic acid, lead (2+) salt
- 563-68-8 Acetic acid, thallium (1+) salt
- 93-76-5  Acetic acid, (2,4,5-trichlorophenoxy)-
- 67-64-1  Acetone (I)
- 75-05-8  Acetonitrile (I, T)
- 98-86-2  Acetophenone
- 53-96-3  2-Acetylaminofluorene
- 75-36-5  Acetyl chloride (C, R, T)
• 591-08-2  1-Acetyl-2-thiourea  
• 107-02-8  Acrolein  
• 79-06-1  Acrylamide  
• 79-10-7  Acrylic acid (I)  
• 107-13-1  Acrylonitrile  
• 116-06-3  Aldicarb  
• 309-00-2  Aldrin  
• 107-18-6  Allyl alcohol  
• 20859-73-8  Aluminum phosphide (R, T)  
• 763-96-4  5-(Aminomethyl)-3-isoxazolol  
• 504-24-5  4-Aminopyridine  
• 61-82-5  Amitrole  
• 131-74-8  Ammonium picrate (R)  
• 7803-55-6  Ammonium vanadate  
• 62-53-3  Aniline (I, T)  
• 506-61-6  Argentate (1-), bis (cyano-C)-, potassium  
• 7778-39-4  Arsenic acid, H₃AsO₄  
• 1327-53-3  Arsenic oxide, As₂O₃  
• 1303-28-2  Arsenic oxide, As₂O₅  
• 1303-28-2  Arsenic pentoxide  
• 1327-53-3  Arsenic trioxide  
• 692-42-2  Arsine, diethyl-  
• 75-60-5  Arsinic acid, dimethyl-  
• 696-28-6  Arsonous dichloride, phenyl-  
• 492-80-8  Auramine  
• 115-02-6  Azaserine  
• 151-56-4  Aziridine  
• 75-55-8  Aziridine, 2-methyl-  
• 50-07-7  Azirino [2', 3': 3,4] pyrrolo [1,2-a] indole-4, 7-dione, 6-amino-8-[[aminocarbonyl oxy] methyl]-1,1a, 2,8,8a, 8b-hexahydro-8a-methoxy-5-methyl-,[1aS-(1a alpha, 8 beta, 8a alpha, 8b alpha)]-  

B  
• 542-62-1  Barium cyanide  
• 56-49-5  Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-
- 225-51-4 Benz[c]acridine
- 98-87-3 Benzal chloride
- 23950-58-5 Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-
- 56-55-3 Benz[a]anthracene
- 57-97-6 Benz[a]anthracene, 7,12-dimethyl-
- 62-53-3 Benzenamine(I,T)
- 492-80-8 Benzenamine, 4,4'-carbonimidoylbis[N,N-dimethyl-
- 106-47-8 Benzenamine, 4-chloro-
- 3165-93-3 Benzenamine, 4-chloro-2-methyl-, hydrochloride
- 60-11-7 Benzenamine, N,N-dimethyl-4-(phenylazo)-
- 95-53-4 Benzenamine, 2-methyl-
- 106-49-0 Benzenamine, 4-methyl-
- 101-14-4 Benzenamine, 4,4'-methylenebis[2-chloro-
- 636-21-5 Benzenamine, 2-methyl-, hydrochloride
- 99-55-8 Benzenamine, 2-methyl-5-nitro-
- 100-01-6 Benzenamine, 4-nitro-
- 71-43-2 Benzene (I, T)
- 100-44-7 Benzene, (chloromethyl)-
- 510-15-6 Benzenacetic acid, 4-chloro-alpha- (4-chloro-phenyl)-alpha-
- hydroxy-, ethyl ester
- 101-55-3 Benzene, 1-bromo-4-phenoxy-
- 305-03-3 Benzenecarboxylic acid, 4-[bis (2-chloroethyl)amino]-
- 108-90-7 Benzene, chloro-
- 25376-45-8 Benzenediamine, ar-methyl-
- 17-81-7 1,2-Benzenedicarboxylic acid, bis (2-ethylhexyl) ester
- 84-74-2 1,2-Benzenedicarboxylic acid, dibutyl ester
- 84-66-2 1,2-Benzenedicarboxylic acid, diethyl ester
- 131-11-3 1,2-Benzenedicarboxylic acid, dimethyl ester
- 117-84-0 1,2-Benzenedicarboxylic acid, dioctyl ester
- 95-50-1 Benzene, 1,2-dichloro-
- 541-73-1 Benzene, 1,3-dichloro-
- 106-46-7 Benzene, 1,4-dichloro-
- 72-54-8 Benzene, 1,1'-(2,2-dichloroethylidene) bis [4-chloro-
- 98-87-3 Benzene, (dichloromethyl)-
- 26471-62-5 Benzene, 1,3-diisocyanatomethyl- (R, T)
- 51-43-4 1,2-Benzenediol, 4-[1-hydroxy-2- (methylamino)-ethyl]-, (R)
• 1330-20-7  Benzene, dimethyl- (l,T)
• 108-46-3  1,3-Benzenediol
• **122-09-8**  **Benzene ethanamine, alpha,alpha-dimethyl-**
• 118-74-1  Benzene, hexachloro-
• 110-82-7  Benzene, hexahydro- (l)
• 108-88-3  Benzene, methyl-
• 121-14-2  Benzene, 1-methyl-2, 4-dinitro-
• 606-20-2  Benzene, 2-methyl-1, 3-dinitro-
• 98-82-8  Benzene, (1-methylethyl)- (l)
• 98-95-3  Benzene, nitro-
• 608-93-5  Benzene, pentachloro-
• 82-68-8  Benzene, pentachloronitro-
• 98-09-9  Benzenesulfonic acid chloride (C, R)
• 98-09-9  Benzenesulfonyl chloride (C, R)
• 95-94-3  Benzene, 1,2,4,5-tetrachloro-
• **108-98-5**  **Benzenethiol**
• 50-29-3  Benzene, 1,1'-(2,2,2-trichloroethylidene) bis [4-chloro-
• 72-43-5  Benzene, 1,1'-(2,2,2-trichloroethylidene) bis [4-methoxy-
• 98-07-7  Benzene, (trichloromethyl)-
• 99-35-4  Benzene, 1,3,5-trinitro-
• 92-87-5  Benzidine
• 81-07-2  1,2-Benzisothiazol-3(2H)-one, 1,1-dioxide, & salts
• 94-59-7  1,3-Benzodioxole, 5-(2-propenyl)-
• 120-58-1  1,3-Benzodioxole, 5-(1-propenyl)-
• 94-58-6  1,3-Benzodioxole, 5-propyl-
• 189-55-9  Benzo[rst]pentaphene
• **81-81-2**  **2H-1-Benzopyran-2-one, 4-hydroxy-3- (3-oxo-1- phenylbutyl)-, & salts, hazardous at all concentrations; acutely toxic if >0.3%**
• 50-32-8  Benzo [a] pyrene
• 106-51-4  p-Benzquinone
• 98-07-7  Benzotrichloride (C, R, T)
• **100-44-7**  **Benzyl chloride**
• **7440-41-7**  **Beryllium**
• 1464-53-5  2,2'-Bioxirane
• 92-87-5  [1,1'-Biphenyl]-4,4'-diamine
• 91-94-1 [1,1'-Biphenyl]-4,4'-diamine, 3,3'-dichloro-
• 119-90-4 [1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethoxy-
• 119-93-7 [1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethyl-
• **598-31-2** *Bromoacetone*
• 75-25-2 Bromoform
• 101-55-3 4-Bromophenyl-phenyl ether
• **357-57-3** *Brucine*
• 87-68-3 1,3-Butadiene, 1,1,2,3,4,4-hexachloro-
• 924-16-3 1-Butanamine, N-butyl-N-nitroso-
• 71-36-3 1-Butanol (I); or n-Butyl alcohol (I)
• 78-93-3 2-Butanone (I, T)
• **39196-18-4** Butanone, 3,3-dimethyl-1- (methylthio)-, O-[(methylamino)carbonyl] oxime
• 1338-23-4 2-Butanone, peroxide (R, T)
• 4170-30-3 2-Butenal
• 764-41-0 2-Butene, 1,4-dichloro- (I, T)
• 303-34-4 2-Butenoic acid, 2-methyl-, 7-[[2,3-dihydroxy- 2-(1-methoxyethyl)-3-methyl-1-oxobutoxy)methyl]-2,3,5,7a-tetrahydro-1H-pyrrolizin-1-yl ester, [1S-[1alpha(Z), 7 (2S*, 3R*), 7alpha]]-

**C**

• 75-60-5 Cacodylic acid
• 13765-19-0 Calcium chromate
• **592-01-8** *Calcium cyanide, Ca (CN)2*
• 51-79-6 Carbamic acid, ethyl ester
• 615-53-2 Carbamic acid, methyl nitroso-, ethyl ester
• 79-44-7 Carbamic chloride, dimethyl-
• 111-54-6 Carbamodithioic acid, 1,2-ethanediylbis-, salts & esters
• 2303-16-4 Carbamothioic acid, bis(1-methylethyl)-, S-(2,3-dichloro-2-propenyl) ester
• **75-15-0** *Carbon disulfide*
• 6533-73-9 Carbonic acid, dithallium (1+) salt
• **75-44-5** *Carbonic dichloride*
• 353-50-4 Carbonic difluoride
• 79-22-1 Carbonochloridic acid, methyl ester (I,T)
- 353-50-4 Carbon oxyfluoride (R,T)
- 56-23-5 Carbon tetrachloride
- 75-87-6 Chloral
- 305-03-3 Chlorambucil
- 57-74-9 Chlordane, alpha & gamma isomers
- -------- Chlorinated fluorocarbons, not otherwise specified
- 494-03-1 Chlornaphazin
- **107-20-0** Chloroacetaldehyde
- **106-47-8** p-Chloroaniline
- 108-90-7 Chlorobenzene
- 510-15-6 Chlorobenzilate
- 59-50-7 p-Chloro-m-cresol
- 110-75-8 2-Chloroethyl-vinyl ether
- 67-66-3 Chloroform
- 107-30-2 Chloromethyl methyl ether
- 91-58-7 beta-Chloronaphthalene
- 95-57-8 o-Chlorophenol
- **5344-82-1** 1-(o-Chlorophenyl) thiourea
- **542-76-7** 3-Chloropropionitrile
- 3165-93-3 4-Chloro-o-toluidine, hydrochloride
- 13765-19-0 Chromic acid H2CrO4, calcium salt
- 218-01-9 Chrysene
- **544-92-3** Copper cyanide, CuCN
- -------- Creosote
- 1319-77-3 Cresol (Cresylic acid)
- 4170-30-3 Crotonaldehyde
- 98-82-8 Cumene (I)
- -------- Cyanides (soluble cyanide salts), not otherwise specified
- **460-19-5** Cyanogen
- 506-68-3 Cyanogen bromide CNBr
- **506-77-4** Cyanogen chloride CNCl
- 106-51-4 2,5-Cyclohexadiene-1, 4-dione
- 110-82-7 Cyclohexane (I)
- 58-89-9 Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1alpha, 2alpha, 3beta, 4alpha, 5alpha, 6beta)-
- 108-94-1 Cyclohexanone (I)
- **131-89-5** 2-Cyclohexyl-4, 6-dinitrophenol
- **77-47-4** 1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-
- **50-18-0** Cyclophosphamide

D

- **94-75-7** 2,4-D, salts & esters
- **20830-81-3** Daunomycin
- **72-54-8** DDD
- **50-29-3** DDT
- **2303-16-4** Diallate
- **53-70-3** Dibenz [a,h] anthracene
- **189-55-9** Dibeno [a,i] pyrene
- **96-12-8** 1,2-Dibromo-3-chloropropane
- **84-74-2** Dibutyl phthalate
- **95-50-1** o-Dichlorobenzene
- **541-73-1** m-Dichlorobenzene
- **106-46-7** p-Dichlorobenzene
- **91-94-1** 3,3'-Dichlorobenzidine
- **764-41-0** 1,4-Dichloro-2-butene (l, T)
- **75-71-8** Dichlorodifluoromethane
- **75-35-4** 1,1-Dichloroethylene
- **156-60-5** 1,2-Dichloroethylene
- **111-44-4** Dichloroethyl ether
- **108-60-1** Dichloroisopropyl ether
- **111-91-1** Dichloromethoxy ethane
- **542-88-1** Dichloromethyl ether
- **120-83-2** 2,4-Dichlorophenol
- **87-65-0** 2,6-Dichlorophenol
- **696-28-6** Dichlorophenylarsine
- **542-75-6** 1,3-Dichloropropene
- **60-57-1** Dieldrin
- **1464-53-5** 1,2:3,4-Diepoxybutane (l, T)
- **692-42-2** Diethylarsine
- **123-91-1** 1,4-Diethyleneoxide
- **117-81-7** Diethylhexyl phthalate
• 1615-80-1  N, N'-Diethylhydrazine
• 3288-58-2  O, O-Diethyl S-methyl dithiophosphate
• 311-45-5  Diethyl-p-nitrophenyl phosphate
• 84-66-2  Diethyl phthalate
• 297-97-2  O, O-Diethyl O-pyrazinyl phosphorothioate
• 56-53-1  Diethylstilbesterol
• 94-58-6  Dihydrosafrole
• 55-91-4  Diisopropylfluorophosphate (DFP)
• 309-00-2  1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1 alpha, 4 alpha, 4a beta, 5 alpha, 8 alpha)
• 465-73-6  1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4abeta,5beta,8beta,8abeta)
• 60-51-5  2,7:3,6-Dimethanonaphth [2,3-b] oxirene, 3,4,5,6,9,9-hexachloro-1a,2a,3,6,6a,7,7a-octahydro-, (1alpha,2beta,2aalpha,3beta,6beta,6alpha,7beta,7alpha)
• 60-57-1  2,7:3,6-Dimethanonaphth [2,3-b] oxirene, 3,4,5,6,9,9-hexachloro-1a,2a,3,6,6a,7,7a-octahydro-, (1alpha,2beta,2aalpha,3beta,6beta,6alpha,7beta,7alpha)
• 72-20-8  2,7:3,6-Dimethanonaphth [2,3-b] oxirene, 3,4,5,6,9,9-hexachloro-1a,2a,3,6,6a,7,7a-octahydro-, (1alpha,2beta,2aalpha,3alpha,6alpha,6abeta,7beta,7aalpha), & metabolites
• 60-51-5  Dimethoate
• 119-90-4  3,3'-Dimethoxybenzidine
• 124-40-3  Dimethylamine (I)
• 60-11-7  p-Dimethylaminoazobenzene
• 57-97-6  7,12-Dimethylbenz [a]anthracene
• 119-93-7  3,3'-Dimethylbenzidine
• 80-15-9  alpha, alpha-Dimethylbenzylhydroperoxide (R)
• 79-44-7  Dimethylcarbamoyl chloride
• 57-14-7  1,1-Dimethylhydrazine
• 540-73-8  1,2-Dimethylhydrazine
• 122-09-8  alpha, alpha-Dimethylphenethylamine
• 105-67-9  2,4-Dimethylphenol
• 131-11-3  Dimethyl phthalate
• 77-78-1  Dimethyl sulfate
• 534-52-1  4,6-Dinitro-o-cresol, & salts
• 51-28-5  2,4-Dinitrophenol
• 121-14-2  2,4-Dinitrotoluene
• 606-20-2  2,6-Dinitrotoluene
• **88-85-7**  **Dinoseb**
• 117-84-0  Di-n-octyl phthalate
• 123-91-1  1,4-Dioxane
• 122-66-7  1,2-Diphenylhydrazine
• **152-16-9**  **Diphosphoramid, octamethyl**-
• **107-49-3**  **Diphosphoric acid, tetraethyl ester**
• 142-84-7  Dipropylamine (I)
• 621-64-7  Di-n-propylnitrosamine
• **298-04-4**  **Disulfoton**
• **541-53-7**  **Dithiobiuret**

E

• **115-29-7**  **Endosulfan**
• **145-73-3**  **Endothall**
• **72-20-8**  **Endrin, & metabolites**
• 106-89-8  Epichlorohydrin
• **51-43-4**  **Epinephrine**
• 75-07-0  Ethanal (I)
• 55-18-5  Ethanamine, N-ethyl-N-nitroso-
• 91-80-5  1,2-Ethanediamine, N, N-dimethyl-N'-1-pyridinyl-N'-(2-thienylmethyl)-
• 106-93-4  Ethane, 1,2-dibromo-
• 75-34-3  Ethane, 1,1-dichloro-
• 107-06-2  Ethane, 1,2-dichloro-
• **460-19-5**  **Ethanedinitrile**
• 67-72-1  Ethane, hexachloro-
• 111-91-1  Ethane, 1,1-[methylenebis (oxy)] bis [2-chloro-
• 60-29-7  Ethane, 1,1'-oxybis- (I)
• 111-44-4  Ethane, 1,1'-oxybis [2-chloro-
• 76-01-7  Ethane, pentachloro-
• 630-20-6  Ethane, 1,1,1,2-tetrachloro-
• 79-34-5  Ethane, 1,1,2,2-tetrachloro-
• 62-55-5  Ethanethioamide
• 71-55-6  Ethane, 1,1,1-trichloro-
• 79-00-5  Ethane, 1,1,2-trichloro-
• **16752-77-5** Ethanimidothioic acid, N-\[((methylamino)-carbonyloxy)\]-methyl ester
• 110-80-5  Ethanol, 2-ethoxy-
• 1116-54-7  Ethanol, 2,2'-(nitrosoimino) bis-
• 98-86-2  Ethanone, 1-phenyl-
• 75-01-4  Ethene, chloro-
• 110-75-8  Ethene, (2-chloroethoxy)-
• 75-35-4  Ethene, 1,1-dichloro-
• 156-60-5  Ethene, 1,2-dichloro-, (E)-
• 127-18-4  Ethene, tetrachloro-
• 79-01-6  Ethene, trichloro-
• 110-80-5  2-ethoxyethanol
• 141-78-6  Ethyl acetate (I)
• 140-88-5  Ethyl acrylate (I)
• 100-41-4  Ethyl benzene
• 51-79-6  Ethyl carbamate (urethane)
• **107-12-0** Ethyl cyanide
• 60-29-7  Ethyl ether (I)
• 111-54-6  Ethylenebisdithiocarbamic acid, salts & esters
• 106-93-4  Ethylene dibromide
• 107-06-2  Ethylene dichloride
• 110-80-5  Ethylene glycol monoethyl ether
• **151-56-4** Ethyleneimine
• 75-21-8  Ethylene oxide (I,T)
• 96-45-7  Ethylenetriourea
• 75-34-3  Ethyldene dichloride
• 97-63-2  Ethyl methacrylate
• 62-50-0  Ethyl methanesulfonate

F

• **52-85-7** Famphur
• 206-44-0  Fluoranthene
• **7782-41-4** Fluorine
• **640-19-7**  Fluoroacetamide
• **62-74-8**  Fluoroacetic acid, sodium salt
• 50-00-0  Formaldehyde
• 64-18-6  Formic acid (C, T)
• **628-86-4**  Fulminic acid, mercury (2+) salt (R, T)
• 110-00-9  Furan (I)
• 98-01-1  2-Furancarboxaldehyde (I)
• 108-31-6  2,5-Furandione
• 109-99-9  Furan, tetrahydro- (I)
• 98-01-1  Furfural (I)
• 110-00-9  Furfuran (I)

G

• 18883-66-4  Glucopyranose, 2-deoxy-2- (3-methyl-3-nitroso- ureido)- D-
• 18883-66-4  D-Glucose, 2-deoxy-2- [((methylnitrosoamino)- carbonyl] amino]-
• 765-34-4  Glycidylaldehyde
• 70-25-7  Guanidine, N-methyl-N'-nitro-N-nitroso-

H

• **76-44-8**  Heptachlor
• 118-74-1  Hexachlorobenzene
• 87-68-3  Hexachlorobutadiene
• 77-47-4  Hexachlorocyclopentadiene
• 67-72-1  Hexachloroethane
• 70-30-4  Hexachlorophene
• 1888-71-7  Hexachloropropene
• **757-58-4**  Hexaethyl tetraphosphate
• 302-01-2  Hydrazine (R, T)
• **79-19-6**  Hydrazinecarbothioamide
• 1615-80-1  Hydrazine, 1,2-diethyl-
• 57-14-7  Hydrazine, 1,1-dimethyl-
• 540-73-8  Hydrazine, 1,2-dimethyl-
• 122-66-7  Hydrazine, 1,2-diphenyl-
• **60-34-4**  Hydrazine, methyl-
<table>
<thead>
<tr>
<th>CAS Number</th>
<th>Chemical Name</th>
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<tbody>
<tr>
<td>74-90-8</td>
<td><strong>Hydrocyanic acid</strong></td>
</tr>
<tr>
<td>7664-39-3</td>
<td>Hydrofluoric acid (Hydrogen fluoride) (C, T)</td>
</tr>
<tr>
<td>74-90-8</td>
<td><strong>Hydrogen cyanide</strong></td>
</tr>
<tr>
<td>7803-51-2</td>
<td><strong>Hydrogen phosphide</strong></td>
</tr>
<tr>
<td>7783-06-4</td>
<td>Hydrogen sulfide H₂S</td>
</tr>
<tr>
<td>80-15-9</td>
<td>Hydroperoxide, 1-methyl-1-phenylethyl- (R)</td>
</tr>
<tr>
<td>96-45-7</td>
<td>2-Imidazolidinethione</td>
</tr>
<tr>
<td>193-39-5</td>
<td>Indeno [1,2,3-cd] pyrene</td>
</tr>
<tr>
<td>85-44-9</td>
<td>1,3-Isobenzofurandione</td>
</tr>
<tr>
<td>78-83-1</td>
<td>Isobutyl alcohol (I, T)</td>
</tr>
<tr>
<td>465-73-6</td>
<td><strong>Isodrin</strong></td>
</tr>
<tr>
<td>120-58-1</td>
<td>Isosafrole</td>
</tr>
<tr>
<td>2763-96-4</td>
<td>3(2H)-Isoxazolone, 5-(aminomethyl)-</td>
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</tbody>
</table>

No entries

<table>
<thead>
<tr>
<th>CAS Number</th>
<th>Chemical Name</th>
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<tr>
<td>143-50-0</td>
<td><strong>Kepone</strong></td>
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<tr>
<td>303-34-4</td>
<td>Lasiocarpine</td>
</tr>
<tr>
<td>301-04-2</td>
<td>Lead acetate</td>
</tr>
<tr>
<td>1335-32-6</td>
<td>Lead, bis (acetato-O) tetrahydroxytri-</td>
</tr>
<tr>
<td>7446-27-7</td>
<td>Lead phosphate</td>
</tr>
<tr>
<td>1335-32-6</td>
<td>Lead subacetate</td>
</tr>
<tr>
<td>58-89-9</td>
<td>Lindane</td>
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</table>

M
• 70-25-7  MNNG
• 108-31-6  Maleic anhydride
• 123-33-1  Maleic hydrazide
• 109-77-3  Malononitrile
• 148-82-3  Melphalan
• 7439-97-6  Mercury
• 62-38-4  Mercury, (acetato-O) phenyl-
• 628-86-4  Mercury fulminate (R, T)
• 126-98-7  Methacrylonitrile (I, T)
• 124-40-3  Methanamine, N-methyl-(I)
• 62-75-9  Methanamine, N-methyl-N-nitroso-
• 74-83-9  Methane, bromo-
• 74-87-3  Methane, chloro-(I,T)
• 107-30-2  Methane, chloromethoxy-
• 74-95-3  Methane, dibromo-
• 75-09-2  Methane, dichloro-
• 75-71-8  Methane, dichlorodifluoro-
• 74-88-4  Methane, iodo-
• 624-83-9  Methane, isocyanato-
• 542-88-1  Methane, oxybis[chloro-
• 62-50-0  Methanesulfonic acid, ethyl ester
• 56-23-5  Methane, tetrachloro-
• 509-14-8  Methane, tetranitro-(R)
• 74-93-1  Methanethiol (I, T)
• 75-70-7  Methanethiol, trichloro-
• 75-25-2  Methane, tribromo-
• 67-66-3  Methane, trichloro-
• 75-69-4  Methane, trichlorofluoro-
• 115-29-7  6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8, 9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide
• 76-44-8  4,7-Methano-1H-indene,1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
• 57-74-9  4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octa-chloro-2,3,3a,4,7,7a-hexahydro-
• 67-56-1  Methanol (I)
• 91-80-5  Methapyrilene
1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a, 4,5,5, 
5a,5b,6-decachloro-octahydro-

16752-77-5 Methomyl

72-43-5 Methoxychlor
67-56-1 Methyl alcohol (I)
74-83-9 Methyl bromide
504-60-9 1-Methylbutadiene (I)
74-87-3 Methyl chloride (I,T)
79-22-1 Methyl chlorocarbonate (I,T)
71-55-6 Methyl chloroform
56-49-5 3-Methylcholanthrene
101-14-4 4,4'-Methylenebis(2-chloroaniline)
74-95-3 Methylene bromide
75-09-2 Methylene chloride
78-93-3 Methyl ethyl ketone (MEK) (I,T)
1338-23-4 Methyl ethyl ketone peroxide (R,T)
60-34-4 Methyl hydrazine
74-88-4 Methyl iodide
108-10-1 Methyl isobutyl ketone (I)
624-83-9 Methyl isocyanate
75-86-5 2-Methylactonitrile
80-62-6 Methyl methacrylate (I,T)
298-00-0 Methyl parathion
108-10-1 4-Methyl-2-pentanone (I)
56-04-2 Methylthiouracil
50-07-7 Mitomycin C

N

20830-81-3 5,12-Naphthacenedione, 8-acetyl-10- [(3-amino-2,3,6-trideoxy)- 
alpha-L-lyxo-hexo-pyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11- 
trihydroxy-1-methoxy-. (8S-cis)-
134-32-7 1-Naphthalenamine
91-59-8 2-Naphthalenamine
494-03-1 Naphthalenamine, N,N'-bis (2-chloroethyl)-
91-20-3 Naphthalene
• 91-58-7  Naphthalene, 2-chloro-
• 130-15-4  1,4-Naphthalenedione
• 72-57-1  2,7-Naphthalenedisulfonic acid, 3,3'-(3.3'-dimethyl [1,1'-biphenyl]-4,4'-diyl) bis (azo)bis[5-amino-4-hydroxy]-, tetraysodium salt
• 130-15-4  1,4-Naphthoquinone
• 134-32-7  alpha-Naphthalene
• 91-59-8  beta-Naphthalene
• **86-88-4**  alpha-Naphthylthiourea
• **13463-39-3**  Nickel carbonyl, Ni (CO) 4,
• **557-19-7**  Nickel cyanide Ni (CN) 2
• **54-11-5**  Nicotine, & salts
• 10102-45-1  Nitric acid, thallium (1+) salt
• **10102-43-9**  Nitric oxide
• **100-01-6**  p-Nitroaniline
• 98-95-3  Nitrobenzene (I,T)
• **10102-44-0**  Nitrogen dioxide
• **10102-43-9**  Nitrogen oxide NO
• **55-63-0**  Nitroglycerine (R)
• 100-02-7  p-Nitrophenol
• 79-46-9  2-Nitropropane (I,T)
• 924-16-3  N-Nitrosodi-n-butylamine
• 1116-54-7  N-Nitrosodiethanolamine
• 55-18-5  N-Nitrosodiethylamine
• **62-75-9**  N-Nitrosodimethylamine
• 759-73-9  N-Nitroso-N-ethylurea
• 684-93-5  N-Nitroso-N-methylurea
• 615-53-2  N-Nitroso-N-methylurethane
• **4549-40-0**  N-Nitrosomethylvinylamine
• 100-75-4  N-Nitrosopiperidine
• 930-55-2  N-Nitrosopyrrolidine
• 99-55-8  5-Nitro-o-toluidine

O

• **152-16-9**  Octamethylpyrophosphoramide
• **20816-12-0**  Osmium tetroxide, OsO4
• **145-73-3** 7-Oxabicyclo [2,2,1] heptane-2,3-dicarboxylic acid

• **1120-71-4** 1,2-Oxathiolane, 2,2-dioxide

• **50-18-0** 2H-1,3,2-Oxazaphosphor in-2-amine, N,N-bis (2-chloroethyl) tetrahydro-, 2-oxide

• **75-21-8** Oxirane (I,T)

• **765-34-4** Oxiranecarboxyaldehyde

• **106-89-8** Oxirane, (chloromethyl)-

• **P**

• **123-63-7** Paraldehyde

• **56-38-2** Parathion

• **62-44-2** Phenacetin

• **108-95-2** Phenol

• **108-95-2** Phenol, 2-chloro-

• **59-50-7** Phenol, 2,4-dinitro-

• **131-89-5** Phenol, 2-cyclohexyl-4, 6-dinitro-

• **131-89-5** Phenol, 2-(1-methylpropyl)-4, 6-dinitro-

• **105-67-9** Phenol, 2,4-dimethyl-

• **51-28-5** Phenol, 2,4-dinitro-

• **1319-77-3** Phenol, methyl-

• **534-52-1** Phenol, 2-methyl-4, 6-dinitro-, & salts

• **70-30-4** Phenol, 2,2'-methylenebis[3,4,6-trichloro-

• **88-86-7** Phenol, 2-(1-methylpropyl)-4, 6-dinitro-

• **100-02-7** Phenol, 4-nitro-

• **87-86-5** Phenol, pentachloro-

• **58-90-2** Phenol, 2,3,4,6-tetrachloro-
- 88-06-2 Phenol, 2,4,6-trichloro-
- 131-74-8 Phenol, 2,4,6-trinitro-, ammonium salt (R)
- 148-82-3 L-Phenylalanine, 4-[bis (2-chloroethyl) amino]-
- 62-38-4 Phenylmercury acetate
- 103-85-5 Phenylthiourea
- 298-02-2 Phorate
- 75-44-5 Phosgene
- 7803-51-2 Phosphine
- 311-45-5 Phosphoric acid, diethyl 4-nitrophenyl ester
- 7446-27-7 Phosphoric acid, lead (2+) salt (2:3)
- 3288-58-2 Phosphorodithioic acid, O,O-diethyl S-methyl ester
- 298-04-4 Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester
- 298-02-2 Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester
- 60-51-5 Phosphorodithioic acid, O,O-dimethyl S- [2- (methylamino)-2-oxoethyl] ester
- 55-91-4 Phosphorofluoridic acid, bis (1-methylethyl) ester
- 56-38-2 Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester
- 297-97-2 Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
- 298-00-0 Phosphorothioic acid, O,O-dimethyl O-(4-nitro-phenyl) ester
- 1314-80-3 Phosphorus sulfide (R)
- 85-44-9 Phthalic anhydride
- 109-06-8 2-Picoline
- 100-75-4 Piperidine, 1-nitroso-
- 78-00-2 Plumbane, tetraethyl-
- 151-50-8 Potassium cyanide, K (CN)
- 506-61-6 Potassium silver cyanide
- 23950-58-5 Pronamide
- 116-06-3 Propanal, 2-methyl-2- (methylthio)-, O- [(methyl- amino) carbonyl]oxime
- 107-10-8 1-Propanamine (l, T)
- 621-64-7 1-Propanamine, N-nitroso-N-propyl-
- 142-84-7 1-Propanamine, N-propyl- (l)
- 96-12-8 Propane, 1,2-dibromo-3-chloro-
- 78-87-5 Propane, 1,2-dichloro-
- 109-77-3 Propanedinitrile
- 107-12-0 Propanenitrile
- 542-76-7 Propanenitrile, 3-chloro-
- 75-86-5 Propanenitrile, 2-hydroxy-2-methyl-
- 79-46-9 Propane, 2-nitro- (I, T)
- 108-60-1 Propane, 2,2'-oxybis[2-chloro-
- 1120-71-4 1,3-Propane sultone
- 55-63-0 1,2,3-Propanetriol, trinitrate (R)
- 93-72-1 Propanoic acid, 2-(2,4,5-trichlorophenoxy)-
- 126-72-7 1-Propanol, 2,3-dibromo-, phosphate (3:1)
- 78-83-1 1-Propanol, 2-methyl- (I,T)
- 67-64-1 2-Propanone (I)
- 598-31-2 2-Propanone, 1-bromo-
- 107-19-7 Propargyl alcohol
- 107-02-8 2-Propenal
- 79-06-1 2-Propenamide
- 542-75-6 1-Propene, 1,3-dichloro-
- 1888-71-7 1-Propene, 1,1,2,3,3,3-hexachloro-
- 107-13-1 2-Propenenitrile
- 126-98-7 2-Propenenitrile, 2-methyl- (I,T)
- 79-10-7 2-Propenoic acid (I)
- 140-88-5 2-Propenoic acid, ethyl ester (I)
- 97-63-2 2-Propenoic acid, 2-methyl-, ethyl ester
- 80-62-6 2-Propenoic acid, 2-methyl-, methyl ester (I,T)
- 107-18-6 2-Propen-1-ol
- 107-10-8 n-Propylamine (I,T)
- 78-87-5 Propylene dichloride
- 75-55-8 3,2-Propylenimine
- 107-19-7 2-Propyn-1-ol
- 123-33-1 3,6-Pyridazinedione, 1,2-dihydro-
- 504-24-5 4-Pyridinamine
- 110-86-1 Pyridine
- 109-06-8 Pyridine, 2-methyl-
- 54-11-5 Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, & salts
- 66-75-1 2,4-(1H,3H)-Pyrimidinedione, 5-[bis (2-chloro- ethyl)amino]-
- 56-04-2 4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2- thioxo-
• 930-55-2 Pyrrolidine, 1-nitroso-

R

• 50-55-5 Reserpine
• 108-46-3 Resorcinol

S

• 81-07-2 Saccharin, & salts
• 94-59-7 Safrole
• 7783-0-8 Selenious acid
• 12039-52-0 Selenious acid, dithallium(1+) salt
• 7783-00-8 Selenium dioxide
• 7488-56-4 Selenium sulfide
• 7488-56-4 Selenium sulfide SeS2 (R,T)
• 630-10-4 Selenourea
• 115-02-6 L-Serine, diazoacetate (ester)
• 506-64-9 Silver cyanide, Ag(CN)
• 93-72-1 Silvex (2,4,5-TP)
• 26628-22-8 Sodium azide
• 143-33-9 Sodium cyanide, Na(CN)
• 18883-66-4 Streptozotocin
• 57-24-9 Strychnidin-10-one, & salts
• 357-57-3 Strychnidin-10-one, 2,3-dimethoxy-
• 57-24-9 Strychnine, & salts
• 77-78-1 Sulfuric acid, dimethyl ester
• 7446-18-6 Sulfuric acid, dithallium(1+) salt
• 1314-80-3 Sulfur phosphide (R)

T

• 93-76-5 2,4,5-T
• 95-94-3 1,2,4,5-Tetrachlorobenzene
• 630-20-6 1,1,1,2-Tetrachloroethane
• 79-34-5 1,1,2,2-Tetrachloroethane
• 127-18-4  Tetrachloroethylene
• 58-90-2  2,3,4,6-Tetrachlorophenol
• 3689-24-5  Tetraethylthiopyrophosphate
• 78-00-2  Tetraethyl lead
• 107-49-3  Tetraethyl pyrophosphate
• 109-99-9  Tetrahydrofuran (I)
• 509-14-8  Tetranitromethane (R)
• 757-58-4  Tetraphosphoric acid, hexaethyl ester
• 1314-32-5  Thalic oxide
• 563-68-8  Thallium (I) acetate
• 6533-73-9  Thallium (I) carbonate
• 7791-12-0  Thallium (I) chloride
• 7791-12-0  Thallium chloride TlCl
• 10102-45-1  Thallium (I) nitrate
• 1314-32-5  Thallium oxide Tl2O3
• 12039-52-0  Thallium (I) selenite
• 7446-18-6  Thallium (I) sulfate
• 62-55-5  Thioacetamide
• 3689-24-5  Thiodiphosphoric acid, tetraethyl ester
• 39396-18-4  Thiofanox
• 544-53-7  Thioimidodicarbonic diamide [(H2N)C(S)₂NH]
• 74-93-1  Thiomethanol (I, T)
• 137-26-8  Thioperxydicarbonic diamide [(H₂N)C(S)₂S₂, tetramethyl-
• 108-98-5  Thiophenol
• 79-19-6  Thiosemicarbazide
• 62-56-6  Thiourea
• 5344-82-1  Thiourea, (2-chlorophenyl)-
• 86-88-4  Thiourea, 1-naphthalenyl-
• 103-85-5  Thiourea, phenyl-
• 137-26-8  Thiram
• 108-88-3  Toluene
• 25376-45-8  Toluenediamine
• 26471-62-5  Toluene disocyanate (R,T)
• 95-53-4  o-Toluidine
• 106-49-0  p-Toluidine
• 636-21-5  o-Toluidine hydrochloride
• 8001-35-2  **Toxaphene**
  • 61-82-5  1H-1,2,4-Triazol-3-amine
  • 71-55-6  1,1,1-trichloroethane
  • 79-00-5  1,1,2-Trichloroethane
  • 79-01-6  Trichloroethylene
  • 75-70-7  **Trichloromethanethiol**
  • 75-69-4  Trichloromonomofluoromethane
  • 95-95-4  2,4,5-Trichlorophenol
  • 88-06-2  2,4,6-Trichlorophenol
  • 76-13-1  1,1,2-trichloro-1,2,2-trifluoroethane
  • 99-35-4  1,3,5-Trinitrobenzene (R,T)
  • 123-63-7  1,3,5-Trioxane, 2,4,6-trimethyl-
  • 126-72-7  Tris (2,3-dibromopropyl) phosphate
  • 72-57-1  Trypan blue

**U**

• 66-75-1  Uracil mustard
• 759-73-9  Urea, N-ethyl-N-nitroso-
• 684-93-5  Urea, N-methyl-N-nitroso-

**V**

• 7803-55-6  **Vanadic acid, ammonium salt**
• 1314-62-1  **Vanadium pentoxide, V2O5**
• 4549-40-0  **Vinylamine, N-methyl-N-nitroso**-
• 75-01-4  Vinyl chloride

**W**

• 81-81-2  **Warfarin, & salts, hazardous at all concentrations; acutely toxic if >0.3%**

**X**

• 1330-20-7  Xylene (l)
Y

- 50-55-5  Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-methyl ester, (3beta,16beta,17alpha,18beta,20alpha)-

Z

- 557-21-1  Zinc cyanide, Zn(CN)₂
- 1314-84-7  Zinc phosphide, Zn₃P₂, hazardous at all concentrations; acutely toxic if >0.3%
### APPENDIX G  MWRA REGULATED SUBSTANCES LIST

Disposal down the sink is prohibited

#### Attachment 1
**MWRA Regulated Substances List**

<table>
<thead>
<tr>
<th>CAS #</th>
<th>NAME</th>
<th>MWRA DAILY Threshold (mg/L) by Building Discharge Pipe(s)</th>
</tr>
</thead>
<tbody>
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<td>107-02-8</td>
<td>Acrolein</td>
<td>0.15</td>
</tr>
<tr>
<td>107-31-9</td>
<td>Acenaphthene</td>
<td>*1.0</td>
</tr>
<tr>
<td>208-96-8</td>
<td>Acenaphthylene</td>
<td>*1.0</td>
</tr>
<tr>
<td>75-07-0</td>
<td>Acetaldehyde</td>
<td>*1.0</td>
</tr>
<tr>
<td>107-13-1</td>
<td>Acrylonitrile</td>
<td>*1.0</td>
</tr>
<tr>
<td>107-18-6</td>
<td>Allyl alcohol</td>
<td>*1.0</td>
</tr>
<tr>
<td>107-69-1</td>
<td>Allyl chloride</td>
<td>*1.0</td>
</tr>
<tr>
<td>628-63-7</td>
<td>Amyl acetate</td>
<td>*1.0</td>
</tr>
<tr>
<td>53-53-3</td>
<td>Aniline</td>
<td>*1.0</td>
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<tr>
<td>130-12-7</td>
<td>Anthracene</td>
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<td>7440-36-0</td>
<td>Antimony (total)</td>
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</tr>
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<td>7440-38-2</td>
<td>Arsenic (total)</td>
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<tr>
<td>71-43-2</td>
<td>Benzene</td>
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</tr>
<tr>
<td>92-87-5</td>
<td>Benzidine</td>
<td>*1.0</td>
</tr>
<tr>
<td>56-55-3</td>
<td>Benzo(A) Anthracene</td>
<td>*1.0</td>
</tr>
<tr>
<td>50-32-8</td>
<td>Benzo(A) Prrene</td>
<td>*1.0</td>
</tr>
<tr>
<td>205-99-2</td>
<td>Benzo(B) Fluoranthene</td>
<td>*1.0</td>
</tr>
<tr>
<td>191-24-2</td>
<td>Benzo(GH) Perylene</td>
<td>*1.0</td>
</tr>
<tr>
<td>207-08-9</td>
<td>Benzo(K) Fluoranthene</td>
<td>*1.0</td>
</tr>
<tr>
<td>100-87-0</td>
<td>Benzotruxthiur</td>
<td>*1.0</td>
</tr>
<tr>
<td>85-68-7</td>
<td>Benzyl Butyl Phthalate</td>
<td>*1.0</td>
</tr>
<tr>
<td>100-44-7</td>
<td>Benzyl chloride</td>
<td>*1.0</td>
</tr>
<tr>
<td>111-91-1</td>
<td>Bis (2-Chloroethyl) Methane</td>
<td>*1.0</td>
</tr>
<tr>
<td>111-44-4</td>
<td>Bis (2-Chloroethyl) Ether</td>
<td>*1.0</td>
</tr>
<tr>
<td>108-60-1</td>
<td>Bis (2-Chloroisopropyl) Ether</td>
<td>*1.0</td>
</tr>
<tr>
<td>117-81-7</td>
<td>Bis (2-Ethylhexyl) Phthalate</td>
<td>*1.0</td>
</tr>
<tr>
<td></td>
<td>Boron</td>
<td>30</td>
</tr>
<tr>
<td>75-27-4</td>
<td>Bromodichloromethane</td>
<td>*1.0</td>
</tr>
<tr>
<td>15-25-2</td>
<td>Bromoform</td>
<td>*1.0</td>
</tr>
<tr>
<td>74-83-9</td>
<td>Bromomethane</td>
<td>*1.0</td>
</tr>
<tr>
<td>101-55-3</td>
<td>Bromophenyl Phenyl Ether (4-)</td>
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<tr>
<td>123-86-4</td>
<td>Butyl acetate</td>
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<td>1395-284-8</td>
<td>Butylamine</td>
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<td>7440-43-9</td>
<td>Cadmium (total)</td>
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<tr>
<td>75-15-0</td>
<td>Carbon Disulfide</td>
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<tr>
<td>56-23-5</td>
<td>Carbon Tetrachloride</td>
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<td>67-66-3</td>
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<tr>
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<td>Anita Bechtholt, Ph.D.</td>
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