Université d'Ottawa | University of Ottawa

Laboratory Safety Manual

For Wet Laboratories

Office of Risk Management

uOttawa.ca

uOttawa

Contents

KEY CONTACTS

EMERGENCY – 613-562-5411

Additional telephone numbers (uOttawa extension)

Protection Services (General Inquiries) 5499
- Fire Prevention Coordinator 6091

Health and Wellness Office (Human Resources) 1473
Facilities (Maintenance) 2222
Office of Risk Management (ORM) 5892
- Risk Management Specialist; Occupational Health and Safety 2486
- Risk Management Specialist; Environment and Hazardous Waste 3055
- Risk Management Specialist; Radiation 3057
- Risk Management Specialist; Biosafety 3153

Health, Safety and Risk Manager (Science) 6425
Health, Safety and Risk Manager (Medicine) 3210
Health, Safety and Risk Manager (Engineering) 6829
Health, Safety and Risk Manager (All Other Faculties, Housing Services) 2627
Health, Safety and Risk Manager (Facilities) 6992

EMERGENCY PROCEDURES

Immediately report all emergencies to Protection Services at ext. 5411 or 613-562-5411.

Campus landlines are preferred because they allow Protection Services to identify a caller's location.

Immediately notify Protection Services (ext. 5411) if a critical injury or fatality occurs.

If first aid treatment is required, report to the first aid station nearest you, or call Protection Services at ext. 5411.

Public authorities (i.e. 911) may also be contacted for assistance; however, the 911 dispatcher may not be familiar with uOttawa property, building addresses, or campus vernacular (such as building names), which could cost precious time in an emergency. Protection Services has thorough knowledge of the University's layout and is equipped to provide first aid, including oxygen therapy and automated external defibrillation (AED). Protection Services will also escort public authorities to the scene while providing assistance at the scene.

Be prepared: learn how to quickly evacuate your lab! Check the emergency procedures for specific events.

Accident / Incident Reporting Procedure

You must report all accidents/incidents to your supervisor and to the University by filling out a uOttawa Accident, Incident or Occupational Illness Report form. You must report:

- All accidents, incidents or suspected occupational diseases that require medical attention and/or cause a loss of work days due to a work-related hazard; and,
- Other incidents, including those involving only minor injuries, "close calls" or "near misses" without injury, direct exposure to chemicals, damage to equipment, chemical odours or spills, or leaks of hazardous materials.

The Accident, Incident or Occupational Illness Report form is available online. You must submit this report to the Health and Wellness Office within 24 hours of the accident/incident. The Health and Wellness Office is located at Tabaret Hall, Room 017. You can send this report by INTRA mail, fax it to 613-562-5206, or sent it by email to hrhealth@uottawa.ca.

There is no penalty or retribution for submitting a report.

First Aid and Medical Emergencies

In the event of any medical emergency, contact Protection Services at ext. 5411.

A basic knowledge of first aid is essential for anyone working where there is a significant risk of accidents, such as in laboratories and workshops. Standard First Aid workshops are offered (at a cost) by the Office of Risk Management.

Designated individuals in your work area are qualified in first aid, CPR and AED training. Refer to the uOttawa Designated First Aider program, look for the green first aid signage throughout the building, or contact the Office of Risk Management for information.

Faculties, departments and researchers can purchase supplemental first aid kits. You will find the recommended supplies listed in Appendix 2 of the Designated First Aider guidelines, or you can contact the Office of Risk Management for a copy of the list.

Initial First Aid Assessment

- Assess the safety of the scene for yourself and the casualty. If required, remove danger or remove the casualty from danger (if possible and safe to do so).
- Assess the cause of the accident. Quickly determine how the situation may have occurred, if possible. If you suspect a neck or spinal injury, do not move the casualty if the area is secure.
- Identify yourself and offer to provide assistance.
- Instruct the casualty to lie still (if conscious); offer reassurance and support.
- Assess the casualty.
    - Check the level of consciousness.
    - Is the airway open? Is the casualty breathing?
    - Does the casualty have a pulse? Is there severe bleeding?
- Send for help. Designate someone to go for help and have them return to the scene and report to you. Provide the following information to the designated person:
    - Who you are
    - Description of the suspected circumstances
    - Exact location of emergency
    - Number of casualties
        - Type(s) of injuries
        - Condition of casualty
    - Direct phone number where you can be reached, if applicable.

Critical Injuries or Fatality

- Immediately contact Protection Services at ext. 5411. Indicate that there has been a critical injury or fatality.
- Describe the emergency and the location. Provide any necessary first aid within your capabilities. Do not move the injured person unless they are in immediate danger.
- Remain with the injured person until help arrives.
- Do not further alter the scene except to:
    - Save life, relieve human suffering, maintain essential public utility or transportation services, prevent unnecessary damage, or comply with instructions from an authority having jurisdiction (i.e., Ministry of Labour Inspector).
- Await arrival of Protection Services; remain available in a safe location in case further information is required.

Chemical contact or burns to the skin

- Remove contaminated clothing. If the contaminant is in a powdered form, brush it off clothes and skin while limiting contact with uncontaminated surfaces as much as possible.
- Rinse the affected area thoroughly with copious amounts of cool, running water. Use an emergency shower if necessary. Rinse the area with running water for at least 15 minutes.

- Do not apply ointment unless specifically designed for the substance(s) involved.
- **Do not apply water to burns from any metals** (such as sodium, potassium, magnesium, and aluminium, etc.).
- Seek medical attention and bring the safety data sheet.

Chemical contact with eyes

- Immediately proceed to the emergency eye/face wash station and activate.
- Hold lids apart and flush the eye(s) with copious amounts of running water for at least 15 minutes. If using a tap or hose, direct the water flow on the bridge of the nose so that water runs into the eyes.
- Seek medical attention and bring the safety data sheet.

Asphyxiation

- If safe to do so, remove the casualty from the area.
- Loosen tight-fitting clothing.
- A person trained in CPR should monitor the victim's airway and vital signs.
- Seek medical attention.

Cuts and animal bites

- Allow the wound to bleed uninhibited for a few seconds to purge the wound.
- Apply pressure to the wound with a sterile pressure dressing. In circumstances where there is an object protruding from the wound, apply pressure around the wound.
- If possible, staunch the flow of blood, and then clean and dress the wound.
- Seek medical attention for cuts (including small cuts) and bites, based on the level of risk
- Notify medical staff if a known infection (i.e. animal, virus, etc.) was present.

Major Fire Emergencies

1. In the event of a major fire beyond your control, shout "FIRE, FIRE, FIRE" and pull the nearest fire alarm. Pull stations are usually located in the corridor near an exit/stairway.
2. If safe to do so, attempt to rescue persons in immediate danger while exiting. Do not endanger yourself.
3. Do not attempt to fight a major fire on your own.
4. Close doors but do not them. Leave the building and proceed to the muster point.
5. Call Protection Services at ext. 5411. Provide information about the situation, including the location and details of the fire.
6. Remain available in a safe location in case further information is required.

Small Fire Emergencies

1. Determine if the fire can be safely fought (fight or flight).
2. Identify an exit.
3. Fight a small fire with the appropriate fire extinguishers or suffocate it with sand, water or cover.
4. If the fire escalates, retreat. Follow procedure for Major Fire Emergency.
5. Ensure that the fire is properly extinguished by trained personnel. Notify Protection Services, the facility manager, and/or building wardens
6. Remain available in case further information is required.
7. Complete an *Accident, Incident or Occupational Illness Report*.

Clothing Fires

- Stop (where you are); drop (to the floor); roll (to smother the flames).
- Shout for help.
- Avoid using fire extinguishers on people as much as possible. If a fire extinguisher is absolutely necessary, try to avoid the person's face. After the fire has been extinguished, proceed to the nearest emergency shower and cool the burned areas with a copious amount of water.
- Seek medical attention and bring the safety data sheet (if applicable).

Spills

In most cases, users working with hazardous materials can safely and efficiently clean a spill. Users are required to know the hazardous properties of the materials they use prior to using them and must be prepared for potential spills; as a result, users are probably the most qualified to address the spill. Users and laboratories are equipped with basic spill kits for small spills (i.e. maximum 4L liquid spill).

Users of more hazardous materials, such as mercury and hydrofluoric acid, require specialized spill kits, which are provided directly to users and/or available in centralized locations on campus. Spills of greater volume may require additional interventions, as well as larger kits.

For all hazardous material spills, **determine if you can safely contain, control and clean the spill**.

- If unsure or if the situation is unsafe, call Protection Services at ext. 5411. Do not activate the fire alarm unless there is a fire.
- If the chemical enters a floor or sink drain, immediately block the drain (if safe to do so) and contact Protection Services at ext. 5411. Floor drains can be protected using the granulated absorbent material in the spill kit. Do not allow any hazardous materials (including hazardous waste) to enter lab sinks at any time.
- If hazardous vapours that could escape the local area are present, alert people in the affected area and contact Protection Services at ext. 5411.

When reporting a spill to Protection Services, provide your name, a contact phone number, and exact details of the spilled material, namely:

- Whether anyone has been injured or exposed
- Name of the spilled material (include spelling) and/or CAS number
- Phase of the material (liquid, solid, gas)
- Identifying properties (colour, odour, etc.)
- Location(s) of the spill
- Quantity or volume of spill
- Properties of the spilled material, including (if applicable/known):
    - Concentration
    - Vapour pressure
    - Flash point
    - LEL / UEL
- Associated hazards
- First aid measures taken for those exposed

The caller must remain available in a safe location in the event that Protection Services requires further information. While not recommended, if you must leave the spill scene for any reason, place signage to warn others of the nature of the spill: include your name, direct telephone number and time when you will return.

Once the spill has been absorbed, place all clean-up material (including disposable protective equipment) in a sealable, labelled container. The contents of this container will be considered hazardous waste, and you must apply a uOttawa hazardous waste label to the container. The user must submit the *Accident, Incident or Occupational Illness Report.*

Formal Spill Response Training is available from the Office of Risk Management.

For additional information, check the *Hazardous Materials and Hazardous Waste Directive* or contact the Office of Risk Management.

Chemical Spills

1. Alert all personnel present and evacuate the room. Minimize spread of the spill to the extent possible. Do not remove contaminated material from the spill area. Close the door and post a warning sign that states your name, direct telephone number, date and time, and the following message "no entry – chemical material spill".
2. Restrict access to area to those involved in cleaning the spill.
3. If flammable material is involved, remove all heat sources (including burners, hotplates, etc.). However, if potentially flammable or explosive vapours are present, do not switch any electrical equipment on or off.
4. Quickly block or contain the size and spread of the spill by using appropriate absorbing material (such as sand, vermiculite, inert absorbent, spill pillows, berms, etc.).
5. Ensure the fume hood sash (where applicable) is open to capture or direct the flow of gases and vapours.
6. Ensure that all those who are cleaning the spill are wearing appropriate personal protective equipment, which may include respiratory protection, gloves, protective eyewear and clothing, etc.
7. Clean the spill from its outer perimeter and address obstacles (such as broken glass, physical objects, etc.) as you clean toward the centre. Use forceps or tongs to handle broken materials. A final surface decontamination may be required.
8. Once the spill has been absorbed, place all clean-up material (including disposable protective equipment) in a sealable, labelled container. The contents will be handled as hazardous waste. Apply a uOttawa hazardous waste label to the container.
9. Inform the principal investigator responsible for the lab/research project.
10. Complete an *Accident, Incident or Occupational Illness Report* and a *Hazardous Materials Technical Services Regular Collection Request.*
11. Remain available, in a safe location, to answer questions if further information is required.

Mercury Spills

1. Alert everyone in the room and evacuate the room. Minimize the spread of the spill to the greatest extent possible. Do not remove contaminated material from the spill area. Close the door and post a warning sign that states your name, direct telephone number, date and time, and the following message “no entry - mercury spill.”
2. Restrict access to the area to only those cleaning the spill.

3. Quickly block or contain the size and spread of the spill by using appropriate absorbent material (such as sand, vermiculite, inert absorbent, spill pillows, berms).
4. If the mercury spill is large or releasing vapours (i.e. the mercury is in contact with a hot surface), contact Protection Services at ext. 5411.
5. If the mercury spill is small (i.e., the amount in a broken thermometer), use an aspirator bulb, medicine dropper or mercury sponge to pick up droplets. If available, use a mercury spill kit, available from the Health, Safety and Risk Manager or the Office of Risk Management. Everyone cleaning the spill must wear appropriate respiratory and protective clothing. Clean from the perimeter of the spill inwards; use forceps or tongs to handle broken materials. Place the mercury in a container, cover it with water and/or oil, and seal the container. Label the container for disposal as hazardous waste.
6. If the mercury has broken into many droplets, or if droplets have worked into cracks or other hard-to-clean areas, sprinkle the droplets with sulphur powder or commercial products that will form an amalgam when in contact with mercury. Leave the area for several hours and then collect and place the solid waste into a container, seal it, and label it for disposal as hazardous waste.
7. Complete an *Accident, Incident or Occupational Illness Report* and *Hazardous Materials Technical Services Regular Collection Request*.
8. Remain in a safe location so that you can answer questions if further information is required.

The University of Ottawa runs a mercury thermometer replacement program. For more information, contact the Health, Safety and Risk Manager.

Biohazard Spills

1. Alert everyone present and evacuate the room. Minimize the spread of the spill as much as possible. Do not remove contaminated material from the spill area. Close the door and post a warning sign that states your name, direct telephone number, date and time, and the following message “no entry - biohazardous material spill”. Specify the hazardous agent. If aerosolization is a risk, remove contaminated clothing and leave the area for at least 30 minutes to allow aerosols to settle. Thoroughly wash exposed skin with soap and water.
2. Restrict access to the area to only those cleaning the spill.
3. Quickly block or contain the size and spread of a spill by using appropriate absorbent material available in the lab spill kit, or by using any of the following: paper towels, sand, vermiculite, inert absorbent, spill pillows, berms, etc.
4. Using an appropriate concentrated disinfectant, cover the spill area. Pour disinfectant from the exterior boundary of the spill to the inside. For more hazardous substances, allow the disinfectant to act for 20 minutes.
5. Ensure that everyone cleaning up the spill wears appropriate personal protective equipment; such equipment could include respiratory protection, gloves, protective eyewear and clothing, etc.
6. Clean the spill from the outer perimeter inwards and address obstacles (such as broken glass, physical objects, etc.) as you clean toward the centre. Use forceps or tongs to handle broken materials.
7. All contaminated materials and equipment must be properly decontaminated or properly disposed of as hazardous waste.
8. All adjacent areas should also be disinfected.
9. Remove contaminated clothing by turning the exposed area inward and autoclaving the clothing.
10. Wash all exposed skin with disinfectant soap, following standard washing practices.

11. Inform the principal investigator responsible for the lab/research project.
12. Complete an *Accident, Incident or Occupational Illness Report* and *Hazardous Materials Technical Services Regular Collection Request*.
13. Remain in a safe location so that you can answer questions if further information is required.

For other biohazardous spills (i.e., within a biological safety cabinet, within a centrifuge, during transfer, or spills of blood and bodily fluids), refer to the Biological Spill Response Plan, available from the Office of Risk Management.

Radioactive Spills

1. Alert everyone present and evacuate the room. Minimize the spread of the spill as much as possible. Do not remove contaminated material from the spill area. Close the door and post a warning sign that states your name, direct telephone number, date and time, and the following message "no entry – radioactive material spill". Specify the radioisotope involved.
2. Restrict access to the area to only those cleaning the spill.
3. Prior to vacating the area, remove any contaminated clothing and shoes. If the spill is on the skin, wash it thoroughly with soap and lukewarm water. Multiple washings are better than one rigorous washing; be careful not to abrade/scratch the skin. Monitor the exposed skin for changes after each wash and document any changes.
4. Contain, control, and clean the spill by using appropriate absorbent material.
5. Obtain any additional supplies and/or personal protective equipment (overalls, shoe coverings) required for clean up. **Be careful not to spread contamination in doing so**.
6. Contain and clean the spill by cleaning from its perimeter inward. Use forceps or tongs to handle broken materials. Collect all contaminated material in appropriate containers and/or bag(s); label appropriately.
7. Decontaminate the spill area(s) with appropriate solutions and materials. Monitor for contamination with appropriate detector or wipe test. Document findings.
    a. Re-clean contaminated area if contamination is found. Three cleaning procedures should remove all contamination.
    b. If contamination remains, contact the Risk Management Specialist for Radiation and/or the Office of Risk Management.
8. Complete an *Accident, Incident or Occupational Illness Report* and *Hazardous Materials Technical Services Regular Collection Request*.
9. Remain available in case further information is required.

Leaving the scene:

- While not recommended, if you must leave the scene for any reason, be sure to check for contamination on yourself (especially feet, hands (including gloves), lab coat, etc.) before leaving. Record results.
    - Leave any contaminated items behind. Remove your dosimetry badge and take it with you to avoid data collection errors.
- Lock the door and place a sign on it that states your name, direct telephone number, nature of incident and time you will return.

GENERAL LABORATORY SAFETY GUIDELINES

This document does not address the independent requirements specific to each lab; however, all laboratory users should follow the general safety guidelines specified below. Supervisors are encouraged to expand these general guidelines to suit their individual needs.

Awareness

- Be aware of campus emergency procedures and how uoAlert notifies you and provides information about emergencies on campus.
- Be familiar with the locations and operation of safety equipment and emergency facilities, such as
    - Fire extinguishers
    - Fire alarm pull stations
    - Fire hose cabinets
    - First aid kits
    - Spill kits
    - Emergency wash facilities (eyewashes, showers, etc.)
    - Emergency communication devices, including telephones, panic buttons (stationary and remote)
    - Emergency exit routes – both primary and secondary
- Be aware of conditions in the workplace, including potentially unsafe conditions that may develop
- Promptly report unsafe conditions, accidents, incidents, near-misses and concerns to your supervisor
- Complete mandatory training (including job-specific training)
- Ensure that entry signage (i.e. signs that specify hazards within the lab, responsible party, required personal protective equipment, etc.) is present on doors to the lab

Proper Use of Laboratory Resources

- Keep all workspaces clean and free of clutter (including chemical products, specimens, etc.).
- No smoking, eating, drinking or gum-chewing is allowed in laboratories or workshops
- No running, horseplay, or inappropriate use of lab materials or equipment is allowed
- Keep laboratory and workshop doors closed to maintain proper air balancing in the lab
- Keep clear all exits, passageways, and access to emergency equipment (including eye/face wash stations, emergency showers, fire extinguishers, first aid kits, spill kits and electrical panels) at all times
- Keep lab doors closed – for security reasons and to ensure that engineering controls (i.e. ventilation, fume hoods, etc.) operate as intended.

Conducting Experiments and Performing Work

- Unauthorized work, preparation, or experimentation is prohibited.
- Before starting work, conduct a pre-experiment hazard identification and risk assessment. Implement reasonable measures to reduce hazards for foreseeable tasks.
- Update written experiment protocols to include applicable health and safety information, e.g., identify the special measures needed to mitigate hazards (i.e. inside a fume hood).
- Read and understand the safety data sheets (SDS) that apply prior to using a product. Work with materials only when you are fully aware of their hazardous properties (flammability,

reactivity, toxicity, etc.), handling and storage requirements, their interactions with other substances, and the associated emergency procedure(s).
- Check all equipment for damage prior to setting up experimental apparatus.
- Select a suitable experiment location. Conduct experiments involving hazardous materials within a vented fume hood or other suitable containment systems.
- Notify other users sharing your lab spaces that hazardous experiments are in progress.
- Never leave an experiment unattended. If you must be absent, post suitable warning signs that state your name and the phone number to contact you directly. If an emergency involving or affecting your experiment occurs, uOttawa will try to notify you of the situation; however, University responders will prioritize people, property, and the environment.
- Label reagents and samples according to WHMIS legislation.
- Check the expiry properties (i.e. condition, date, etc.) of hazardous materials.
- Keep the inventory of lab chemicals updated. Do not remove chemicals from the laboratory without updating the chemical inventory (including materials disposed of as hazardous waste).
- Store hazardous materials according to chemical compatibility.
- Store hazardous materials in appropriate locations (i.e. flammable/corrosive storage cabinets).
- Do not store reagent bottles – empty or full – on the floor or in the sink.
- Use secondary carriers or special transport carts to move hazardous chemicals or chemical waste.
- Do not pipette by mouth.
- Conduct your work in an area that is equipped to mitigate the hazardous properties of the material(s) you are handling.
- Clean up spills immediately in accordance with the spill response and recovery procedure applicable to the material. Ensure that clean-up materials are available prior to starting work. If the spill is too large (or unsafe) to handle, or if you are unsure of how to proceed, contact Protection Services at ext. 5411.
- Wear and use applicable personal protective equipment and safety devices.

Leaving the Lab

- Clean your work area before you leave. Return equipment and materials to their proper storage locations.
- Ensure that emergency contact information is up-to-date.
- Perform a safety check at the end of each experiment or work day. Ensure that gas, water, electricity, vacuum lines, air, heaters etc. have been turned off/secured.
- Lower sashes on fume hoods.
- Remove and leave your protective equipment (including gloves and lab coats) in the lab.
- Wash your hands.

INTRODUCTION

All laboratories and workshops can be inherently hazardous places; even the most experienced workers can be at risk. The attitudes and actions of those who work in a laboratory determine their own health and safety, as well as that of their colleagues and, ultimately, of the community. Health and safety standards aim to reduce to an acceptable level the risks inherent in using hazardous materials and exposure to potentially dangerous procedures, practices and/or equipment.

Different standards are set for different levels of risk. High levels of risk require more stringent protocols and procedures than lower levels of risk. Therefore, you must strike a balance to ensure that safety standards lower inherent risks to an acceptable level but do not impede work. Laboratory equipment is now significantly more sophisticated and safer than in the past; however, its safe and proper use still relies on properly trained and competent users, who must remain safety-conscious at all times.

This is the third edition of the University of Ottawa Laboratory Safety Manual. This manual supersedes all previous versions. This document aims to provide basic rules for safe practices in laboratories at uOttawa. Individual principal investigators, lab managers, and supervisors must identify and supplement this document with safe work procedures and training specific to the needs of their laboratory safety programs when this document does not sufficiently address the topic.

In all cases, individual supervisors are ultimately responsible for teaching, implementing, and enforcing safe work practices and must insist upon the use of such procedures to eliminate unnecessary hazards or mitigate unacceptable risks in situations and workplaces under their authority.

Since this document is regularly revised, readers are asked to convey comments, suggestions, errors or omissions to their faculty Health, Safety and Risk Manager or to the Office of Risk Management.

Acknowledgements

The University of Ottawa recognizes the valuable contributions and dedication of those involved in creating and revising this document, including:

- Faculty Health, Safety and Risk Managers
- Senior technical support staff from the faculties of Engineering, Medicine and Science
- the Office of Risk Management
- the Health and Wellness Office (Human Resources)
- Protection Services
- Facilities

Although this document was originally based on similar documents from McMaster University and McGill University, uOttawa's faculties and services have further developed and adapted this document to meet the specific needs of the University of Ottawa.

Please address your questions, concerns or recommendations to your faculty Health, Safety and Risk Manager and/or to the Office of Risk Management.

DEFINITIONS

Combustible liquid – Liquids having a flash point between 37.8°C and 93.3°C. Examples of combustible liquids include toluene, kerosene, etc.

Compressed gas – any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C, or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C.

Corrosive – Substances that, by direct chemical action, are injurious to body tissue or corrosive to metal. A corrosive injury may range from minor irritation to actual physical disruption of body tissues and/or burns. Examples of corrosive materials include acids, bases, bromine, peroxides, acetic, anhydride, etc.

Critical Injury – an injury of a serious nature that

a) Places life in jeopardy;
b) Produces unconsciousness;
c) Results in substantial loss of blood;
d) Involves the fracture of a leg or arm but not a finger or a toe;
e) Involves the amputation of a leg, arm, hand or foot but not a finger or a toe;
f) Consists of burns to a major portion of the body; or
g) Causes the loss of sight in an eye.

Facilities – University service located at 141 Louis-Pasteur that manages the physical infrastructure and utility services. Facilities also operate the 2222 Call Centre. Individual faculties may also have a facilities department or team internal to the faculty; these units are two distinct entities.

Flammable liquid – Flammable liquids have flash points below 37.8°C, and include solvents such as acetone, ethyl alcohol and xylene.

Flash point – the lowest temperature at which vapours of the material will ignite when in the presence of an ignition source.

Hazard – any source of potential damage, harm, or adverse health effect on someone or something.

Human Resources – University service that manages uOttawa employees; located at Tabaret Hall.

Lower Explosive Limit (LEL) – the lowest concentration of a material in air (expressed as a percentage) that can burn or explode. When concentrations of the chemical in the air are below the LEL, the chemical mixture is “too lean” to burn.

Ignitable solids – Solids capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical changes and which, when ignited, burn so vigorously and persistently that they cause a danger. Examples of ignitable solids include charcoal, white phosphorous, magnesium alloys, hexamine, beryllium, hafnium powder, zirconium, sodium, potassium, etc. Ignitable solids that ignite upon contact with water or air are treated as reactive materials.

Office of Risk Management – University service that manages the institution's health and safety, enterprise risk management, and environmental and research safety compliance portfolios.

Pathogen Safety Data Sheet (PSDS) – technical documents that describe the hazardous properties of a human pathogen and recommendations for work involving the agents in a laboratory setting. The Public Health Agency of Canada (PHAC) publishes PSDS as educational and informational resources for laboratory personnel working with infectious substances.

Protection Services – Protection Services (ext. 5411) acts as the University's own emergency response team. To contact Protection Services, dial ext. 5411 on any University phone or 613-562-5411 from a cellphone**.**

Regulatory Agency – an external agency that enforces the requirements of various health, safety and environmental legislation. Examples include the Ministry of the Environment, Ministry of Labour, Canadian Nuclear Safety Commission, etc.

Risk – the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard.

Safety Data Sheet (formerly called "Material Safety Data Sheet") – an information sheet that each manufacturer must prepare for the hazardous products they sell. The information contained in a safety data sheet (SDS) is intended to communicate hazards, properties, handling, storage and disposal guidelines, and emergency response requirements.

Spill – occurs when a material is caused or allowed to fall, flow, or run out of a container and is lost or wasted, especially accidentally or unintentionally. A spill may occur with materials in liquid, solid or gaseous states.

Supervisor – means a person who has charge of a workplace or authority over a worker or another person. Depending on the workplace relation, a supervisor may include, for example, the president, vice presidents, directors, deans, manager, or principal investigator. The determination as to whether a person is a supervisor does not depend on that person's job title; rather, it depends on whether the person has charge of a location (e.g., an office or laboratory) where work is performed, on a paid or unpaid basis, or whether they give direction that covers work performed by others (including workers, students, visitors, volunteers, or learners).

Toxic material – a substance that may cause injury or illness to an individual if the substance is able to enter the body. One common route of exposure is inhalation (i.e. breathing).

Upper Explosive Limit (UEL) – the highest concentration of a material in air (expressed as a percentage) that can burn or explode. When concentrations of the chemical in air are above the UEL, the chemical mixture is "too rich" to burn.

Volunteer – refers to a person who is not a worker or student but who performs work at the University workplace to help out or for other reasons associated with education or training. The minimum age of a volunteer at uOttawa is sixteen (16) years' old.

Worker – means any of the following:

a) A person who performs work or supplies services for monetary compensation. This means a University employee and includes a person who performs work or supplies services for monetary compensation. Students hired by the University to perform paid work-study program duties or co-operative education placement duties for the University are considered workers
b) A high school student who performs work or supplies services for no monetary compensation under a work experience program authorized by the school board that operates the school in which the student is enrolled
c) A person who performs work or supplies services for no monetary compensation under a program approved by a college of applied arts and technology, university or other post-secondary institution
d) Such other persons as may be prescribed who perform work or supply services to an employer for no monetary compensation

RESPONSIBILITIES

The duties and responsibilities presented below aim to summarize and elaborate on those described in two University of Ottawa policies and procedures, namely:

- Policy 72 – Environmental and Sustainability Policy; and
- Policy 77 – Occupational Health and Safety
    - Procedure 14-1 – Internal Responsibility Procedure for Health and Safety Issues

The information presented in this document is not intended as a substitute for these University policies. Individuals who wish to clarify further their responsibilities should review these policies.

Individuals

Each individual is responsible for complying with all policies, procedures, directives and standards established by the authority having jurisdiction, the University, or the individual's specific faculty or department.

In particular, each individual is responsible for conducting activities in a manner that will not endanger themselves or others. Individuals must exercise all reasonable care in activities that may pose a risk. When directed to do so, all University workers (including researchers and, in some cases, students) shall participate in training and information sessions that may be offered. Each individual is responsible for ensuring that he/she has received the requisite training (mandatory, job specific, etc.).

All individuals shall provide assistance and cooperate with University and regulatory authorities (including Joint Occupational Health and Safety Committee members) that conduct inspections, audits or investigations in accordance with specified policies and procedures.

All individuals are required to report all known hazards to their immediate supervisors.

Supervisors

Supervisors are responsible for ensuring compliance with all policies, procedures, directives, and standards established by the authority having jurisdiction, the University, or the supervisor's specific faculty or department. Supervisors shall provide opportunities for personnel under their authority to attend appropriate training or information sessions required by the University or faculty (including mandatory and job-specific training).

Supervisors must also initiate necessary preventive and corrective action to mitigate hazards associated with activities under their authority. Supervisors are required to take corrective action, within the scope of their authority, as soon as they become aware of situations involving non-adherence to policy and procedures, or laws and by-laws. They are to report situations requiring further assistance or intervention to their immediate supervisor for resolution and/or escalation.

Principal Investigators

Principal investigators are considered supervisors and are responsible for ensuring that all those under their authority are diligent in the application of their responsibilities. They are responsible for communicating procedures, standards, and guidelines in the teaching and research activities that they supervise and for ensuring compliance with such procedures, standards and guidelines.

Principal investigators are responsible for developing and establishing specific procedures for activities under their authority (including research), in support of University or faculty directives, and in compliance with external agency requirements. Principal investigators must also initiate necessary preventive measures to manage hazards associated with activities under their authority.

Principal investigators are required to take corrective action, within the scope of their authority, as soon as they become aware of a situation involving non-adherence to policy and procedures, or laws and by-laws. Principal investigators must report situations requiring further assistance or intervention to their department chairs.

Department Chairs

Department chairs are responsible for monitoring compliance with all directives, procedures and standards established by the University, their faculty or by regulatory agencies, at the individual department level.

This includes supporting the implementation and maintenance of faculty directives and monitoring adherence to them at the department level. Department chairs must also initiate necessary preventive measures to control hazards associated with activities under their authority.

Department chairs are required to take corrective action, within the scope of their authority, as soon as they become aware of a situation that involves non-adherence to policy and procedures, or laws and bylaws. Department chairs must report situations requiring further assistance or intervention to their dean.

Deans

Deans are responsible for overseeing compliance with all directives, procedures and standards established by the University, their faculty or by regulatory agencies at the faculty level. The Dean must also ensure that appropriate programs are in place at the faculty level.

This includes developing, establishing and maintaining objectives, plans, directives, guidelines and procedures necessary to manage hazards and to ensure sound management of environmental issues applicable to their faculty. Deans shall allocate or, if necessary, request sufficient resources to ensure the effective operation of these programs. They are also responsible for monitoring adherence with directives, guidelines, procedures and standards established for their faculty.

Deans are required to take corrective action, within the scope of their authority, as soon as they become aware of a situation that involves non-adherence to policy and procedures, or laws and bylaws. Situations requiring further assistance or intervention must be reported to the appropriate University authority.

Enforcement

Personnel working in a lab are responsible for their actions. Supervisors are empowered to manage their workplace and promptly address situations of non-compliance. The enforcement of laboratory practices is governed by the respective collective agreement applicable and/or University policy. Escalation procedures may include:

- Reminder of proper conduct
- Formal warning
- Meeting with supervisor/lab manager
- Meeting with director/chair
- Temporary loss of lab privileges
- Permanent loss of lab privileges

Concurrent enforcement may be applied, as the case warrants.

TRAINING

Users should complete the training required for the work they will conduct before they are allowed to access laboratory spaces. The minimum recommended training for laboratory access is:

- Legislated mandatory training (online/in-class);
- uOttawa Laboratory WHMIS (online);
- Laboratory Safety (in-class);
- Spill Response Training (in-class).

All persons working in laboratory spaces will require additional training, based on their work. Here are some examples of such training:

- Transportation of Dangerous Goods (online)
- Biosafety Training – For Users (in-class)
- Radiation Safety Training – For Users (in-class)
- Principles of Laser Safety (in-class)
- Autoclave Safety (in-class)

If you have further questions or concerns, contact your supervisor, Health, Safety and Risk Manager, or the Office of Risk Management. Refresher training is recommended and may be required in certain circumstances.

OPERATING AND MAINTENANCE PROCEDURES

Hazardous Materials Procurement

To best ensure compliance with legislative requirements on safety data sheets, hazardous materials labelling, and minimum inventories, personnel are asked to purchase hazardous materials through their respective purchasing stores (i.e. the Faculty of Science Store, Engineering Shipping/Receiving, the Visual Arts Store, the Faculty of Medicine Shipping / Receiving, etc.).

While not recommended, if an individual obtains hazardous materials directly (i.e. not through uOttawa) and bring such materials to the workplace, the hazardous products must meet the following requirements:

- they must be properly labelled according to WHMIS legislation
- they must be inventoried (including bar-coded) in the uOttawa chemical inventory
- a current SDS on the product must be available (either online or in print)
- all lab users must be trained on how to access the SDS within the lab (i.e. via paper copy or online).

Minimizing waste

The cost of hazardous waste disposal is of growing concern to the University. Prior to ordering new material, please consider its intended use, properties, quantity and final disposal. Proper management of hazardous materials, which includes following the principles outlined below, will help minimize disposal costs:

- Do not overstock. One of the main sources of laboratory waste is surplus stock, which can be the result of overbuying. It may be tempting to take advantage of lower unit prices by buying in quantity for future use; however, the costs associated with the storage and disposal of surplus (or expired) materials may ultimately nullify any savings realized at the time of purchase. Central purchasing through campus stores can assist in solving these issues; users are able to buy the quantity they need at a competitive price.
- Do not accept donations of materials you do not plan to use. Traditionally, many external organizations and individuals (and in some cases, retiring principal investigators, lab managers, etc.) have donated unwanted reagents, materials and equipment to universities. These materials will eventually require management and disposal, incurring costs. The idea of donating materials may be enticing; however, consider the costs associated with their use and final disposal.
- Whenever possible, recycle materials rather than dispose of them. For procedures and schedules, contact your faculty representative or the Office of Risk Management. For information concerning recycling of non-hazardous materials, contact your facility manager or the Facilities' Recycling Coordinator. The University of Ottawa has established recycling programs for some hazardous wastes, including batteries and fluorescent light bulbs.
- Conserve energy and water to the extent possible. Turn off lights and equipment if not in use.
- Label all waste materials. If hazardous waste is unlabelled, it will require assessment and analysis by lab personnel – or in some cases, specialized contractors – prior to disposal. The cost of identifying the waste and ensuring that it does not present a hazard can be exorbitant and unnecessary. Contact enviro@uottawa.ca for information.

Hazardous Waste Disposal

Note that the following points are general procedures only. If you require detailed information on specific classes of waste, see your respective faculty/service, refer to the directive, or contact the Office of Risk Management.

Waste Pick-Up

To arrange for a pick-up of hazardous waste, a laboratory representative must complete and submit the appropriate hazardous waste collection form:

- **Hazardous Materials Technical Services Regular Collection Request –** used to dispose of hazardous chemicals or materials that are by-products of laboratory activities or to request a new hazardous waste container and/or replacement container and spill kit. All requests are

scheduled for the next available time slot, according to the regular hazardous waste service schedule.

- **Hazardous Materials Technical Services – Special Request** – used for laboratory decommissioning, extremely reactive and/or dangerous hazardous waste (i.e. explosive waste, etc.). The user is encouraged to attach all applicable supporting documentation, including chemical inventory, photos, instructions, etc. These services are scheduled outside of the regular hazardous waste schedule; therefore, it is important to plan ahead since the Office of Risk Management cannot guarantee service in the same week.

Chemical Waste Containers:
All chemical waste containers must be labelled with the University of Ottawa hazardous waste label, which is available from the Faculty of Science or Faculty of Medicine Stores, or the Office of Risk Management.

Biohazard/Sharps Waste Containers:
Biohazard waste containers are puncture-proof and colour coded according to the types of wastes they contain. Yellow containers are for biohazardous sharps; white containers are for all other sharps.

Caution – the use of syringes and needles presents an additional hazard, given the risk of puncture. A needlestick injury – especially those with chemical and/or biological implications – will likely require additional medical care. As a result, make every effort to use safety-engineered needles to minimize the risk of injury. Never bend or recap syringes or needles; immediately disposed of them in the hazard-appropriate waste container.

For more information, contact the Office of Risk Management.

Radioactive Waste Container
Labelling requirements vary, depending on the type of waste. For more information, contact the Office of Risk Management

Waste Collection and Containment

- The individuals in charge of activities that generate waste are responsible for the waste until the hazardous waste technician formally accepts the waste for disposal.
- Do not dispose of hazardous materials down a drain.
- Do not mix incompatible chemical wastes.
- Do not pour active reactions into a waste container. Allow the reaction to complete and then dispose of it in the hazardous waste container. Rinse containers two-to-three (2-3) times and collect the rinse water in the same hazardous waste container.
- Do not allow pressure to build up in waste containers: they should not be completely sealed until they are ready for pick up.
- Be sure to ground metallic waste containers while they are being filled with flammable liquids.
- Hazardous waste technicians will not accept inappropriate waste containers: all waste materials must be safely contained. Use appropriate containers that are clean, leak-proof, and sealed when offered to the hazardous waste technician.
- Hazardous waste technicians will not accept improperly labelled or packaged containers: all hazardous waste containers must be correctly labelled with the appropriate uOttawa

hazardous waste label. Materials still in their original containers must have a label identifying their contents. If these materials are considered waste, they still require the completed uOttawa hazardous waste label.

- Containers are considered full at 75% capacity: overfilled and/or leaking containers will not be accepted.
- Upon receipt of new waste containers, place a small volume of water in the waste container.
- Do not store hazardous waste containers once they are full; request a hazardous waste pick-up by completing a *Hazardous Materials Technical Services Regular Collection Request*.
- Store hazardous waste awaiting pick-up away from sewer access points (i.e. sinks, floor drains, etc.).

Periodic Safety Check

The supervisor's commitment to lab safety includes regular safety checks of the lab, conducted by the lab manager, supervisor, or delegated competent person. The following equipment and materials should be checked once a month, or more frequently if necessary. Those conducting the inspection should report any problems they cannot address to the supervisor or facility manager/building administrator, or the Health, Safety and Risk Manager.

Fire Extinguishers

Check that the fire extinguisher:

- Is in its proper location
- Is accessible
- Is fully charged, as indicated by the gauge or by weight for CO_2 extinguishers
- Is equipped with a pin, which is secured with a clip or breakable tie-wrap.

If the fire extinguisher is deficient, contact Protection Services at ext. 5499 to have the extinguisher immediately replaced.

Chemical Storage Compartments

Check that the contents, including any hazardous waste, is organized by chemical compatibility. Check that expired products are removed and properly disposed of, and that containers are housed in secondary containers in the event of a spill. If the compartment is vented, check for consistent, proper airflow and make sure the cabinet is undamaged and working properly.

Tubing (Water, Vacuum, or Gas)

Check that connections are appropriately secure and that there are no leaks. Regularly check for cracks in rubber tubing.

Glassware

Periodically check a random selection of glassware. Cracking, stars, chips, etc. are all indications that the glassware should be removed from service and repaired or replaced.

Emergency devices

Emergency devices need to work in the event of an emergency. Periodically check that the following emergency devices operate properly:

- Emergency call (panic) buttons – both fixed and mobile; notify Protection Services in advance of any test.
- Emergency stop buttons – both operator-activated and lab/workshop activated.

Procedures for Permanently Vacating Laboratories

When permanently vacating a laboratory area, supervisors must ensure that the lab is left in a safe, tidy, hazard-free condition. The outgoing lab manager/supervisor has the most thorough knowledge of the work that occurred within the lab; therefore, this person is in the best position to mitigate any (potential) remaining hazards before the incoming lab manager/supervisor recommissions the lab. Proper decommissioning will ensure the health and safety of future lab users. For assistance, contact the faculty's Health, Safety and Risk Manager.

After-Hours Work

Working alone in a lab is not a safe practice at any time and is strongly discouraged. However, if you unavoidably must work alone in the lab due to the nature of the work, you must take measures to ensure that others are aware that you are doing so, and to have someone check in with you from time to time, either in person or by telephone.

- Obtain written permission from your supervisor prior to working alone. Determine if special procedures are required (i.e. buddy system).
- Ensure that you carry a University of Ottawa ID card at all times.
- Call Protection Services at ext. 5499 to let them know where you will be working and for how long.
- Call Protection Services again when you leave the area.

For more information, refer to the Working in Isolation guideline, available from the Office of Risk Management.

SAFETY PROTOCOLS AND EQUIPMENT

Personal Protective Equipment

Remember – personal protective equipment does not remove the hazard itself: rather, it is the last line of defence against a hazard.

Legislation requires individuals to wear personal protective equipment when they are exposed to a:

- Head injury hazard (Regulation 851, s. 80);
- Eye injury hazard (Regulation 851, s. 81);
- Foot injury hazard (Regulation 851, s. 82);
- Skin contact injury hazard (Regulation 851, s. 84);
- Fall hazard (more than 3 meters) (Regulation 851; s. 85)

In addition, all individuals must suitably confine long hair, jewellery and/or clothing to prevent entanglement with any rotating shaft, spindle, gear, belt or other source of entanglement (Regulation 851, s. 83).

Personal protective equipment must be appropriate to the circumstances and users must be instructed and trained in its care and use before wearing or using the equipment or device. **The supervisor is responsible for conducting a hazard assessment and determining whether additional (or in rare cases, less) personal protective equipment is required.**

Even if the lab supervisor's hazard assessment does not identify a need for specific personal protective equipment, all laboratory work requires users to wear, as a minimum, the following items:

- Long pants (shorts and Capri pants are not appropriate for laboratory work)
- Lab coat (knee-length with snaps (no buttons))
- Proper footwear (closed-heel and toe)
- Protective eyewear (impact glasses, splash goggles, and/or face shield)
- Gloves (nitrile, leather, vinyl, etc.)

There are many different types of protective equipment for different types of hazards. For example, protective eyewear that is designed to protect from impact will not provide sufficient protection for splashes. Therefore, it is vital that the supervisor identify the level of protection required based on the activities occurring within the laboratory. Remember that not all protective equipment is created equal: different suppliers, hazards, situations, and interactions with other protective equipment can affect the protective factor of any given piece of protective equipment.

Supervisors are responsible for ensuring access to, and use of, the required personal protective equipment within their area of responsibility.

Users are responsible for maintaining in good and useable condition any personal protective equipment assigned to them. The lab manager/supervisor is responsible for maintaining in good and useable condition any generic stock of personal protective equipment for the lab. In any event, if the condition of the protective equipment is in doubt, the user must inform the supervisor and not use the equipment.

Users must leave protective equipment (lab coats, gloves, etc.) inside the lab when leaving the work area. A storage area for protective equipment (i.e. drawer, cabinet, etc.) can provide a hygienic location to safely store protective equipment in a lab. Do not contaminate public hallways and rooms. Wash hands and forearms with soap and water before leaving the work area.

Refer to the uOttawa Guideline on Personal Protective Equipment, available from the Office of Risk Management.

Gloves

Not all gloves are appropriate for all circumstances. A wide variety of gloves are available to protect against chemical exposure. Because the permeability of gloves of the same, or similar, material varies from manufacturer to manufacturer, we cannot provide specific recommendations. Appendix E lists the chemical resistances of some common glove materials. Be aware that no glove offers unlimited protection and that hazardous materials will eventually diffuse through the glove. Since this occurs, the hazardous material may be in contact with the individual's hand longer than expected and thus the individual may be more exposed to the chemical than if the glove had not been worn. This is not to say that gloves should not be worn, only that they must be changed out and disposed of when this occurs.

- Always inspect gloves for cracks or small holes prior to use. Note that nitrile gloves can degrade over time.
- Do not wear gloves in public areas. Remove gloves before leaving the work area and before handling lab equipment such as telephones, doorknobs, writing instruments, and laboratory

notebooks. To maintain worker protection, hazardous materials may be transported over short distances between labs using the “one-gloved approach”.

- Gloves may be reused, cleaned, or discarded, depending on their use and contamination level.

Eye Protection

Eye protection is mandatory in most laboratories where hazardous (i.e., corrosive, flammable, or toxic) materials are used or stored, as well as anywhere near high-pressure vacuum equipment or when carrying out work that can generate dust, spray or other projectiles.

The wearing of contact lenses in a laboratory is also strongly discouraged unless they are combined with chemical splash safety goggles. Vapours can readily enter the space between regular safety glasses and the eyes of those wearing contact lenses; exposure to certain vapours can make removing the contact lenses difficult and further increase the risk of permanent eye damage.

Depending on the protection required for a specific procedure, regular safety glasses, chemical safety goggles, or a full-face shield may be necessary. The supervisor is responsible for identifying the proper type of protective eyewear. Check with your supervisor for additional, lab-specific information.

Hearing Protection

Hearing protection is required if noise levels regularly exceed 85 dBA (decibels). Users are allowed exposure to noise levels greater than 85 dBA for short durations without hearing protection. Personal audio player headsets are not considered adequate hearing protection.

Contact your supervisor, Health, Safety and Risk Manager, the Office of Risk Management or refer to the Hearing Conservation Program for more information. Free, audiometric evaluations are recommended for all at-risk workers and are available from the Health and Wellness Office (Human Resources).

Clothing

Be aware that materials commonly used in personal clothing can present hazards. Cotton is highly permeable. Nylon, polyester and spandex melt easily. Body-hugging materials (such as spandex) will saturate and hold spilled chemicals close to the skin. Evaluate the potential hazards of your activities and wear clothing appropriate to the circumstances of your work. In laboratories where work involves hazardous chemicals, biohazards, or radioisotopes, users should always wear knee-length lab coats, rather than shorter, medical-type lab coats. All lab coats must have snap fasteners, rather than buttons, so that they can be quickly removed in an emergency.

Do not wash contaminated lab coats or clothing with other laundry (i.e. do not wash your contaminated clothing at home).

Respiratory Protection

In some cases, respiratory protection will be required to ensure adequate protection; there may even be situations where respiratory protection is needed in addition to engineered controls (i.e. fume hoods). Not all respiratory protection is created equal. There are various types of tight-fitting face pieces, with different types of cartridges for different types of hazards. Depending on the hazard, supplied air respiratory protection may be required. Respirators must be fit-tested to ensure they fit properly every two years and whenever the user undergoes any major physiological changes (i.e. major weight gain/loss, facial surgery, etc.)

Refer to the Selection, Use and Care of Respiratory Protection guideline, available from the Office of Risk Management.

Laboratory Equipment

General Ventilation in Laboratories

Laboratories are ventilated at a greater rate than regular, office-type environments. For example, most laboratories will experience at least six air changes per hour (i.e., all air in the lab will be replaced least six times over the course of one hour). Depending on the operations conducted within the laboratory, a greater number of air changes may be required. General ventilation is not the same as other hazard controls, such as local exhaust ventilation or fume hoods. Contact the Faculty Health, Safety and Risk Manager if you require assistance in determining hazard controls.

Fume hoods

Fume hoods serve to control exposure to toxic, flammable, or offensive vapours. Fume hoods are not appropriate for disposing of chemicals and are not intended as storage spaces. Storing chemicals in a fume hood can interfere with its efficient operation, and in the event of an accident or fire, every item in the hood may become involved and escalate an otherwise less-hazardous incident. Fume hood users should keep the following basic reminders in mind:

- Be sure the hood is working properly. A continuous monitoring device will provide visual evidence of face velocity. Alternatively, a narrow strip of tissue paper can be a reasonable, short-term indicator of good airflow.
- Minimize storage of hazardous materials in fume hoods and dispose of collected waste promptly.
- Keep only the materials necessary for the on-going experiment in the fume hood. Cluttering the fume hood will disrupt its airflow.
- Place large apparatus inside a fume hood on blocks or legs to allow air to flow underneath it.
- Place equipment as far back in the hood as practical and carry out activities at least 15 cm (6 in.) from the front edge of the fume hood.
- Keep your head outside the fume hood whenever possible. Take measures to prevent drafts (caused by open windows, doors, and even the positions of people at the fume hood) from flowing across the face of the fume hood.
- Keep the sash clean and clear.
- Operate the fume hood with the sash as low as practical.
- Keep the fume hood sash closed when the fume hood is unattended.
- After each use, use an appropriate solution to clean all chemical residues from the fume hood chamber.
- Unless they are certified as explosion-proof, all electrical devices should be connected outside the fume hood to prevent potential sparks from igniting a flammable or explosive material.
- In an emergency (i.e., gas emission or spill), pull the sash down completely and increase fume hood airflow (i.e. press the “+” button, or “purge”). Call Protection Services at ext. 5411 and vacate the lab. Remain available at a safe location for follow-up.
- Report any situation requiring fume hood maintenance or repairs to your supervisor. If immediate repairs are required (i.e., the fan has ceased operating), close the fume hood sash, call Facilities at ext. 2222, and notify your supervisor and other lab users.

Facilities conducts annual maintenance on all fume hoods. Refer to the Fume Hood User Guideline, available from the Office of Risk Management, for more information.

Gloveboxes
A glovebox is a sealed chamber used to carry out air- and water-sensitive chemistry (including chemical reactions) in an inert atmosphere. Normally it is filled with nitrogen, although argon is sometimes used.

Rubber arm gloves are built into the front window of the glovebox to allow the user to work inside the box without compromising its inert environment. One or more antechambers, which can be sealed at both ends to permit their evacuation and refilling with inert gas, are mounted on the side of the box so that materials can be brought in and out of the box without compromising the inert atmosphere. Reactive materials – which might be hazardous outside the glovebox – can be safely manipulated inside the glovebox. Your supervisor will provide additional safe-use procedures for gloveboxes.

Solvent Stills
Users require their supervisor's written permission before they are allowed to operate a solvent still, which should only be used in cases where a commercially available solvent purification system cannot be used and dry, oxygen- free, high purity solvent is needed. In addition to lab-specific training, the Faculty of Science has created an online safety training program for solvent stills, which must be complete prior to first using a solvent still.

Emergency showers
- Be familiar with the location and operation of the emergency shower nearest to your laboratory or workshop.
- The shower area must be readily accessible and be kept clear of obstructions within a one (1) meter radius. Remember, clutter will make accessing the area more difficult in an emergency.
- Rinse the affected area with copious amounts of water for at least 15 minutes.
- Report the use of emergency showers on an accident/incident report form.
- Facilities regularly inspects these installations: **do not activate an emergency shower except in an emergency**.
- Additional information is available on the Emergency Shower Safety Sheet.

Eye/Face Wash Stations
- Be familiar with the location and operation of the eyewash station nearest to your laboratory or workshop.
- The eyewash station area must be readily accessible, and be kept clear of obstructions within a one (1) meter radius. Remember, negotiating clutter will be more difficult in an emergency.
- Flush eyes and/or face with a copious, gentle flow of potable water for at least 15 minutes
- Always report eyewash station use. Use an accident/incident report form.
- Lab users are responsible for regularly inspecting their eyewash stations. Cold-water stations must be tested monthly; warm-water stations (identified by a water-mixing valve) must be tested weekly. Record the inspection on the eyewash inspection form.

Biological Safety Cabinets

A biological safety cabinet (BSC) is used for materials that present biological hazards. A BSC is designed to protect the user from exposure to infectious materials or toxins, to prevent loss of containment, and – depending on the type of cabinet – to protect the research specimen from contamination.

- Biological safety cabinets must be certified at time of installation, annually, and whenever they are relocated. To arrange for certification, contact the Office of Risk Management.
- Do not block the intake or exhaust grills. Keep equipment at least 15 cm (6 inches) inside the cabinet window.
- When transferring viable materials, insert the specimens as deeply into the cabinet as possible.
- Regularly disinfect the interior surfaces of the work area with an appropriate disinfectant, such as 70% ethyl alcohol. Disinfect equipment and device surfaces before removing them from the cabinet.
- Activate the cabinet fan and allow it to run for five minutes before beginning work; this will give the system time to purge any airborne contaminants. Allow the fan to run an additional five (5) minutes after you complete your work.
- Minimize air turbulence both outside the cabinet (e.g. caused by nearby pedestrian movement) and inside (e.g. caused by heat sources). Do not use sustained open flames inside a biological safety cabinet: if you need a heating element, contact the Biosafety Compliance Specialist to discuss alternatives to open flames.
- Do not work inside the cabinet when the germicidal (UV) lamp is on.

Cryostats

Cryostats are used to cut histological slides to micrometer precision, with tissues sectioned as thin as one micrometre. Specimens are mounted in a climate-controlled cabinet whose typical temperature ranges between -20°C to -30°C. The slide is placed inside the cryostat and advanced toward the sharp blade inside. This allows tissues to be sectioned and mounted on slides for use elsewhere. The mounted slide is removed from the cryostat and dried.

The most common hazard with cryostats is contact with the sharp blade of the instrument, which can cause lacerations. Therefore, when changing the cryostat blade or performing routine maintenance (i.e. cleaning), use cut-resistant gloves and/or lock the blade rotation and use tongs or forceps to maintain distance when removing the slide. Your supervisor will provide further safe-use procedures.

Autoclaves

An autoclave is a pressure vessel that uses elevated temperatures and pressures to decontaminate and/or sterilize. Given that this equipment operates under such conditions, it is vital that users fully understate autoclave operating principles and safety features. The University of Ottawa regularly offers Autoclave Safety training, which must be followed by all those who operate autoclaves or who generate materials that someone else will autoclave. A key component of this training is to understand which materials must never be placed in an autoclave, e.g., chlorinated compounds.

Visit the Office of Risk Management website to register for Autoclave Safety training.

Centrifuges
A centrifuge is a motor-driven instrument that spins liquid sample vials at high speed to separate fluids of greater and lesser density. Centrifuges come in different sizes and sample numbers. They must remain carefully balanced: due to their high operating speeds, even a slight imbalance at rest can cause significantly unbalanced forces during operation, which can lead to injury and property damage.

Because centrifuges generate tremendous forces, they must be interlocked, meaning that the device cannot start or operate with the lid open or removed. Always inspect the centrifuge before operating, log its use in the central centrifuge logbook, and maintain it according to its manufacturer's specifications. Another hazard associated with the centrifuge's high speeds is the potential aerosolization of hazardous materials. Special aerosol-tight gaskets are available to use when using a centrifuge at high speeds with hazardous materials. Your supervisor will provide further safe-use procedures.

Fire Safety

Familiarize yourself with the location and operation of the fire extinguishers, emergency exits, evacuation routes, fire alarm systems (including pull stations), and fire suppression systems in your area.

If the fire alarm sounds, follow the evacuation routes established for your area and building. Use stairs that are clear of smoke; never use elevators**.** Be observant and report anomalies (such as fire, smoke, odours) to building wardens (who will be wearing blue vests and yellow hats) or Protection Services. Once outside the building, move away from the doors to allow others to exit. Proceed to your designated assembly (muster) point. Do not re-enter the building until you have been authorized to do so by the Ottawa Fire Department or Protection Services.

Fire Prevention
The most effective means of controlling a fire is to prevent one from occurring. Follow these guidelines to help prevent fires:

- Keep only a minimum of flammable materials on hand.
- Use approved storage cabinets for flammable materials. Keep doors of these cabinets closed and latched at all times. No other materials should be stored within these cabinets.
- Unless necessary for your work, keep flammable materials away from heat, flame, and direct sunlight. Do not weld, solder, or generate sparks or flames near flammable materials.
- Ground any pipes and other apparatus through which flammable liquids flow to prevent the build-up of static electricity, which could spark.
- If flammable or explosive chemicals are spilled and/or evaporating, do not switch any electrical equipment on or off.
- Smoking is forbidden in all buildings or within 9 meters of any entry or building air intake.

Fire extinguishers
Fire extinguishers provide a limited discharge lasting just 10 to 12 seconds and can be used to help users exit a hazardous environment. In most instances, an ABC-type extinguisher will be available near the lab entrance/exit. If the fire is too great, close the door immediately, activate the alarm at the nearest fire alarm pull station, and evacuate the building.

Not all fire extinguishers are created equal; it is important to understand the limitations of each type of extinguishing media. When selecting a fire extinguisher for a laboratory, consider the type of combustible material:

- Class A (H_2O) fires involve ordinary combustible materials such as wood, cloth, paper, rubber and many plastics.
- Class B (CO_2) fires involve flammable liquids and gases, oils, greases, tars, oil-base paints, lacquers and some plastics.
- Class C (dry chemical) fires involve Class A and/or B materials in the presence of live electrical equipment, motors, switches and wires.
- Class D fires involve combustible metals, such as magnesium, titanium, sodium, potassium, zirconium, lithium and any other finely-divided metals, which are oxidizable.
- Class K fires involve oils and grease and are typically kitchen-related fires.

Remember: do not attempt to fight a major fire on your own. If you choose to fight a small fire, always have an escape route available – a small fire may quickly develop into a large fire. All laboratories where flammable materials are used must be equipped with an appropriate fire extinguisher. If the fire extinguisher is malfunctioning (because it is empty or damaged), and you need a replacement or a different type of extinguisher, notify Protection Services at ext. 5499 or the Fire Prevention Coordinator at ext. 6091. You must replace the extinguisher before proceeding to work in the lab.

Fire Safety Training is available from the Office of Risk Management.

Radiation Safety

All users must receive training prior to using radioactive materials and must operate under an active radioisotope permit, issued by the Office of Risk Management. Posters issued by the Canadian Nuclear Safety Commission provide detailed information on radiation safety and are required in all radiation work areas. For further information, training, or questions, contact the Office of Risk Management.

Refer to the Radiation Safety Manual, available from the Office of Risk Management, for additional information.

X-Ray Generators

- Before using the instrument, understand and follow all operational instructions and precautions specified by the supplier.
- Warning signs must be displayed on or near the instrument's main power switch and on the entry door to the location.
- The Ontario Ministry of Labour regulates x-ray safety and all activities must comply with *Regulation 861* made under the *Occupational Health and Safety Act*.
- Contact the Office of Risk Management for more detailed information.

Lasers

- Before using the instrument, be sure to understand and follow all precautions specified by the instrument supplier.
- Warning signs must be posted in laser areas and on doors leading to those areas.
- Specialized protective eyewear for the particular wavelength and power level of the laser may be required.

- Laser beams must be kept at, or below, waist level.
- Never look directly at the beam or pump source.
- Use the image converter to view the beam pattern directly.
- Ensure that there are no unwanted reflective objects in, or along, the path of the beam; even buttons or screw heads can create a beam-scatter hazard. Remove rings, watches and other jewellery.
- If possible, keep the room well lit to avoid pupil dilation.

UV Radiation

- Before using the instrument, be sure to understand and follow all precautions specified by supplier.
- Warning signs must be posted in UV areas and on doors leading to such areas.
- Always wear protective safety glasses with applicable UV filtering lenses.
- Protect all skin from UV radiation.
- Always operate UV sources within an enclosure and ensure adequate cooling to prevent the mercury lamp from exploding and emitting hot mercury vapour.

Microwaves

- Do not attempt to operate microwave instruments with the door open.
- Do not tamper with, or defeat, safety interlocks.
- Ensure that seals around the door are clean and undamaged.
- Loosen lids on containers to relieve the pressure that builds up during heating.
- Do not use metal containers or materials in microwave.
- Only qualified and trained people should alter or modify microwave ovens.
- Label microwave ovens in labs as “no food/drink” or “for laboratory use only”.

Fluxers

A fluxer is an instrument used to prepare samples; it transforms powders made from cements, ores, slag, sediments, soils, rocks, ceramics, pigments, glasses and other materials into either glass disks or acid solutions. Glass disks are typically used in x-ray fluorescence (XRF) analysis, while acid solutions are used in analyses by atomic absorption (AA) or inductively coupled plasma mass spectrometry (ICP-MS). A programmable interface executes each fusion step in a sequential order to obtain a perfect glass disk or solution.

A fluxer should be operated in a fume hood with minimum radial clearance of 30 cm (12 in.) and minimum vertical clearance of 90 cm (36 in). Keep hands away from the arm as the fusion process comes to an end: the arm will abruptly drop onto its bumpers when pouring the molten sample. The fluxer operation may cause some substances to erupt in boiling spurts; therefore, users need to wear appropriate safety equipment, such as adequate eye protection and gloves, when operating the fluxer. Take care when handling the instrument immediately after fusion since some parts of the instrument may still be very hot. Turn the propane gas line’s manual shutoff valve off when the instrument is not in use.

High Magnetic Fields

The high magnetic fields present in magnetic resonance laboratories may pose serious health risks to those with cardiac pacemakers, prosthetic implants, or artificial limbs. Individuals with such implants or prosthetics should check with their physician before entering the vicinity of a high-field

magnet. There is also a risk in handling metallic objects near high field magnets: ferromagnetic objects, such as gas cylinders or metal tools, are extremely attracted to high field magnets, and anyone or anything between the magnet and a nearby heavy ferromagnetic object could be at risk. Post warning signs to indicate areas surrounding NMR magnets (above, below, radially, etc.).

The presence of strong magnetic fields can also result in the loss of magnetically stored data (e.g. bank cards, computer disks, etc.). As a result, such objects should be kept well away from high field magnets. Other devices, such as analog watches, oscilloscopes, video monitors or motorized devices, may not operate properly when located near a high field magnet.

Electrical Safety

Electricity is so common in day-to-day life that we often take it, and its safety, for granted. Lab users should keep the following brief points in mind to stay safe when working with electrical equipment.

- All electrical apparatus must be properly grounded. Never remove the ground pin of a 3-pronged plug.
- All electrical equipment must meet CSA (or equivalent) standards.
- Never use equipment with a frayed or damaged wire or cord.
- Do not use portable space heaters near combustible or flammable material.
- Do not pull on the cords of electrical equipment.
- Ensure that all cords are dry before plugging them into circuits.
- When using equipment inside a fume hood, connect it to electrical outlets outside the fume hood.
- All electrical equipment used in wet locations must be equipped with ground fault circuit interrupters (GFCI).
- Circuit breaker panels must be easily accessible, clearly marked, and kept clear of items within a one-metre radius.
- Do not use extension cords as a replacement for permanent wiring.
- Only qualified and trained personnel shall repair or modify electrical or electronic equipment.

Static Electricity and Sparks

- Under certain conditions, static electricity and sparks can cause fires. Always be conscious of the potential for generating sparks and reduce this potential as much as possible.
- A dry atmosphere promotes the formation of electrical charges.
- Sparks and static electricity may be caused by:
    - Switches and thermostats
    - Electrical contacts (e.g. light switches, thermocouples, refrigerators, etc.)
    - Decanting of organic liquids from one metal container to another
    - Plastic aprons
    - Metal clamps, nipples or wires used with non-conducting hoses
    - Gases released quickly from cylinders under high pressure
    - Etc.

For more information, review the Electrical Safety Guidelines available from the Office of Risk Management.

Glassware

Handling glass rods or tubes

- Fire-polish the ends.
- Lubricate with water, glycerine or other acceptable lubricant when inserting through a stopper.
- Ensure stopper holes are properly sized and are not too small.
- Insert carefully, with a slight twisting motion, keeping hands close together to maintain control and leverage.
- Use gloves or a cloth towel to protect your hands; refrain from using excessive force.

General Glassware Safety

- Protect glass that is subject to high pressure or vacuum. Wrapping glass vessels with cloth tape or plastic wrapping will minimize the possibility of projectiles if the vessel fails.
- Many types of stressors can weaken glass (e.g. heating, bumping, etc.). Be extra careful when handling used glassware.
- Check the integrity of the glassware before using it. Scratched, chipped, cracked or star-cracked vessels cannot sustain normal stresses; repair or discard all damaged glassware. If glassware is contaminated (i.e. chemically or biologically), dispose of it in the proper way. Label the container appropriately.

Cleaning Broken Glassware

- Use a dustpan and brush to pick up broken glass. Do not use your hands, even for large pieces.
- Discard broken glass and Pasteur pipettes in a broken glass container or other rigid container separate from regular garbage. If glassware is contaminated (i.e. chemically or biologically), dispose of it properly. Label the container with the appropriate waste label.

GUIDELINES FOR SPECIFIC CLASSES OF HAZARDOUS MATERIALS

All materials, including hazardous materials, will generate some type of waste. It is important to understand that hazardous waste can be just as dangerous, if not more so, than the original material. Refer to the *Hazardous Materials and Hazardous Waste Directive* for more information on how to dispose of hazardous waste (including biological and radiological waste).

Flammable, Combustible and Ignitable Materials

Storage

Flammable and Combustible Liquids:

- Flammable and combustible liquids in laboratories may only be stored in either a glass container of 4L (1 gallon) capacity or less, or metal or plastic containers of 20L (5 gallons) or less.
- Flammable liquids must be stored in approved flammable storage cabinets. Doors to flammable storage cabinets must be kept closed. Refer to the Flammable Storage Cabinet Safety Sheet, available from the Office of Risk Management.
- Heat-sensitive flammable liquids must be stored in explosion-proof refrigerators. Do not use normal refrigerators or cold rooms to store flammable liquids.
- Do not store reactive chemicals in the same storage cabinet as flammable liquids.
- Purchase and store only quantities actually required for the work. Keep your inventory as low as possible.

Ignitable Solids:

- Store in an airtight container or bottle to prevent dust dispersal. Store under an inert material if necessary.
- Ignitable solids must be stored in approved flammable storage cabinets. Doors to flammable storage cabinets must be kept closed. Refer to the Flammable Storage Cabinet Safety Sheet, available from the Office of Risk Management.

Handling

Flammable and Combustible Liquids:

- Prior to using the product, review its safety data sheet (SDS)
- Use flammable and combustible liquids only in well-ventilated areas.
- Keep away from sources of ignition.
- Always transfer flammable liquids inside a fume hood.
- If transferring flammable liquids between metal containers, both containers must be grounded.
- Users must exercise extra caution when handling certain flammable liquids (e.g. ethers) that can also form peroxide; review these precautions by checking the safety data sheet (SDS) before starting.

Ignitable Solids:

- Prior to using the product, check the safety data sheet (SDS)
- Handle ignitable solids only in well-ventilated areas.
- Keep away from sources of ignition.
- Clean the work area frequently to prevent the accumulation of ignitable dusts.

Solvents

Many solvents are flammable or combustible liquids and should be handled as such. Moreover, some solvents present additional hazards: for example, benzene and many halogenated hydrocarbons are known or suspected carcinogens, and should be considered chronically toxic, while ethers are peroxide formers and should be considered potentially explosive. Take care when handling any hazardous material. Supervisors must provide proper instruction to lab users.

Solvents should be stored and handled as flammable or combustible liquids. Avoid exposure to the liquids and their vapours. Avoid skin contact: absorption may cause skin to dry and crack, which could lead to infection or allergic responses. Additional, substance-specific precautions may be required (e.g. ethers).

Corrosive Materials

Storage

- Do not store acids and bases together (i.e. in the same cabinet or on the same shelf) unless they are protected by secondary containment.
- Store in a cabinet approved for corrosive materials.
- Never store corrosive materials on shelves higher than waist level.
- Store away from high traffic areas.
- Corrosive compressed gases must be stored in a well-vented area (i.e. gas cabinet).

Handling

- Check the safety data sheet (SDS) prior to using the product.
- Never add water to a highly concentrated acid: doing so can cause a violent exothermic reaction that can cause serious injury. Always add acid to water, never the reverse.
- Keep corrosive substances away from heat sources to avoid the production of fumes. Avoid direct contact with fumes.

Reactive Materials

Reactive materials can react violently, spontaneously creating heat and/or gases too rapidly to be safely dissipated. Such reactions can quickly escalate out of control (i.e. vessel ruptures, explosions, uncontrollable release of toxic vapours, flammable gases created, spontaneous ignition of materials, etc.

Reactive materials fall into five broad categories:

1. Explosive (shock and/or heat sensitive) materials
2. Water-reactive materials
3. Air-reactive materials
4. Oxidizers and reducers
5. Peroxide formers

Storage - General

- Keep on hand only the minimum quantities required.
- Completely isolate these chemicals from any sources of heat or moisture.
- Clearly label the area where reactive chemicals are stored.
- Label the container and include the procurement date.

Handling - General

- Exercise extreme caution when handling these materials.
- Always review the safety data sheet (SDS) prior to using the product.

Visual Signs of Instability

The first signs of chemical aging, peroxide formation, or chemical instability are usually visual. To diagnose problems early and prevent an explosion, and potential serious injury, ***visually*** check for:

- Discolouration of the liquid/solution. Refer to the safety data sheet to compare to the material's original properties.
- Crystal formation inside the solution is often an indication of peroxide formation.
- Crystal formation around the cap of the bottle is usually a sign of advanced peroxide formation. **Do not move or handle the bottle**. Immediately report the situation to the Health, Safety and Risk Manager and/or the Office of Risk Management so that the bottle can be safely removed.
- Some materials (i.e. picric acid) are wetted for safe handling and storage, and should appear paste-like. Once these materials dry out, they become extremely shock-sensitive and explosive.

Explosives (Shock/Heat Sensitive) Materials

Hazardous materials can become even more hazardous when changes in their chemical composition occur. Such materials may become more sensitive to friction, shock, or sudden heating. Some can become shock-sensitive when allowed to dry out (e.g. picric acid). Certain azides, diazo compounds,

n-nitro compounds, picrates (especially metal salts), polynitroalkyl compounds, polynitroaromatic compounds, are examples of explosive materials.

Such materials should only be purchased in the smallest quantity available and only when absolutely necessary. Whenever possible, use chemicals with added inhibitors. Date all chemicals when first delivered and opened; log their ownership and location in the chemical inventory. Protect these materials from physical shock, elevated temperatures, light, and ignition sources. Keep them away from other reactive chemicals. Store all explosive compounds in an area far from high-traffic zones and away from other combustible materials. Use a dedicated flammable storage cabinet and clearly label the area where explosives are stored. Be sure to inspect containers regularly for liquid crystallization (e.g. peroxide formation in ethers), discolouration, or drying out.

Water Reactive Materials

These materials must be stored in a cool, waterproof area. They should be properly desiccated whenever possible and never stored close to sources of water (i.e. under a sink) or other reactive materials. Clearly label the area where water reactive materials are stored. Make sure that proper extinguishing media is available. Alkali metals (sodium), organometallic compounds, halides, hydrides, peroxides, carbides, oxides, phosphides, anhydrides, are examples of water reactive materials.

Air Reactive Materials

Metallic dusts (e.g. nickel, titanium) should normally be stored in containers with some moisture. Other air reactive solids should be stored under an inert gas or liquid. Isolate such materials from oxidizing agents. Clearly label the area where air reactive materials are stored. Minimize their exposure to air. Ensure that proper extinguishing media is available.

Oxidizers and Reducers

Minimize, to the extent possible, the possibility of oxidizers and reducers coming into contact with one another; oxidizers and reducers should be stored in separate storage cabinets or shelves. Isolate oxidizers and reducers from other potentially reactive materials. Do not store oxidizers with flammable liquids. Many oxidizers and reducers are also explosive, water reactive or air reactive – be sure you understand the hazards and implement the appropriate precautions for each material.

Perchloric Acid

At standard temperatures, 73% perchloric acid solution reacts as a strong non-oxidizing acid, is relatively stable, and may be stored for extended periods in glass bottles so long as it never comes into contact with oxidizable materials. At higher temperatures (~160°C), perchloric acid becomes a strong and active oxidizing agent and a strong dehydrating reagent (anhydrous perchloric acid). Contact with organic matter or other combustible material may cause fire or explosion. Examples of chemicals incompatible with perchloric acid include plastics (acrylonitrile, nylon, Polyester-Dacron, cellulose based lacquers); metals (copper, copper alloys, perchlorate salts, aluminium, high nickel alloys); other materials (cotton, wool, wood, glycerin-lead oxide).

Purchase or obtain anhydrous perchloric acid (>85%) in the smallest quantity available. Never store anhydrous perchloric acid for more than 30 days; ensure that all chemical containers are dated when they are first delivered and opened. Store the container in a flammable storage cabinet, away from organic materials. Do not allow perchloric acid to come into contact with strong dehydrating agents (such as concentrated sulphuric acid, anhydrous phosphorous pentoxide) or other organic materials.

Check containers regularly for the formation of crystals around the cap, or discolouration of the clear white solution; a yellow discolouration indicates expiry. **Any discolouration of anhydrous acid requires its immediate disposal. If you note any discolouration or crystal formation, do not move bottle or attempt to remove the cap. Contact the Health, Safety and Risk Manager and / or the Office of Risk Management for assistance in disposing of the material.**

You must use appropriate protective equipment and fume hood. Clearly identify any fume hoods used for perchloric acid work: perchloric acid vapours tend to condense on the inside of fume hoods and the inner lining of ducts, eventually forming perchlorate crystals, which are shock-sensitive explosives. Keep the quantities handled to a minimum.

In wet combustion, treat the sample with nitric acid to destroy easily oxidizable matter. Whenever you are using anhydrous perchloric acid (>85%), you must inform a second person that you intend to work with anhydrous perchloric acid. This person must be in the same room with the research worker during the experiment. A lab coat, safety glasses, thick gauntlets and rubber apron must be worn. Only freshly prepared acid may be used. Do not make any more anhydrous perchloric acid than is required for a single day's use.

To dispose of perchloric acid (73% or less), follow the general disposal guidelines for reactive wastes. Do not combine with any other type of waste. Anhydrous perchloric acid (>85%) must be disposed of at the end of each day by dilution and neutralization.

Peroxide Formers

Common laboratory chemicals can form peroxides when exposed to air over time. Peroxides, whether in concentrated solution or as solids, can be treacherously and violently explosive. The University imposes maximum storage times, depending on the group of chemicals. The maximum storage times for typical peroxide-forming chemicals are listed below:

- **Discard after 3 months**: isopropyl ether, divinylacetylene, potassium metal, potassium amide, sodium amide, vinylidene chloride (dichloroethylene).
- **Discard or test after 6 months**: acetaldehyde diethyl acetal, *chloroprene, cumene, cyclohexene, cyclopentene, ether, diethylene glycol dimethyl ether, dioxane, furan, methylacetylene, *styrene, tetrahydrofuran, *vinyl acetate, vinyl ethers, *vinylpyridine.
- **Discard after 12 months**: *butadiene, *tetrafluoroethylene, *vinyl chloride.

*These monomers **must** be stored with a suitable polymerization inhibitor.

Procure ethers and other peroxidizable compounds in the smallest quantities possible to limit the amounts exposed to air. Date all chemicals when they are received and when they are opened. Store materials in airtight, amber glass bottles, in a dark location and under inert atmosphere, if possible. Test all ethers and peroxidizable compounds for peroxide concentration at regular intervals. If peroxide concentrations are acceptable, re-date the container and retest at the next scheduled test date. **If the peroxide concentrations are not acceptable, or if crystals have formed in the bottle or around the cap, do not move the bottle or attempt to remove the cap. Contact the Health, Safety and Risk Manager and/or the Office of Risk Management for assistance in disposal.**

Highly Toxic Materials

A highly (or acutely) toxic material is anything that may cause damage to bodily structure or function when ingested, inhaled, or absorbed in relatively small amounts,. There are many such

biological or chemical substances. A few examples include arsenic trioxide, cyanides, nickel carbonyl, phosgene, tetrodotoxin, etc.

Due to their toxicity, these highly toxic, carcinogenic or mutagenic materials must be locked in specific storage areas (e.g. cabinet or cupboard) with access limited to authorized personnel. These substances must be used only in well-ventilated areas (i.e. within a fume hood).

If a worker is pregnant (or planning to become pregnant), her exposure to these materials must be further assessed; it is very likely that this individual will not be allowed to be in contact with these materials. Review the Pregnant Workers Guideline, available from the Office of Risk Management.

Biohazardous Materials

A biohazard is a generic term used to describe bacteria, viruses, fungi or other infectious agents. These agents are characterized according to the risk they pose to the individual and community. To ensure maximum safety, Health Canada (HC) and the Public Health Agency of Canada (PHAC), the Canadian Food Inspection Agency (CFIA) and other regulators have created standards and guidelines that address these biological hazards.

Moreover, before undertaking new experiments involving biohazardous agents, researchers must obtain the approval of the University of Ottawa Biosafety Committee. To determine the required level of containment, decontamination procedures, training and any other special procedures required, contact the Office of Risk Management. Depending on the hazardous agent, appropriate immunizations may be required.

Follow the general precautions listed below when working with biohazardous materials:

- All personnel must wear protective clothing.
- Tie back or otherwise restrain long hair.
- Wash hands frequently in accordance with hand-washing best practices.
- Remove protective clothing and wash hands before exiting the laboratory.
- Procedures should minimize the creation of aerosols.
- Never pipette by mouth.
- Never bend or recap needles; the use of safety-engineered needles is strongly recommended.
- Follow recommended procedures for decontaminating work surfaces and equipment.

Direct all questions related to biohazardous materials, procedures, and waste to the Risk Management Specialist – Biosafety at the Office of Risk Management.

Radioactive Materials

The Canadian Nuclear Safety Commission (CNSC) regulates the procurement, use, and disposal of radioactive material in Canada. This federal agency exercises its control function through numerous regulations and by conditions appended to the Consolidated Radioisotope Licence issued to the University of Ottawa. In turn, the University ensures compliance with these regulations and conditions through the Radiation Safety Program administered by the Office of Risk Management and the Radiation Safety Committee. No person is allowed to possess or use radioactive material without the express approval of the Assistant Director, Radiation and Biosafety.

Radioactive materials found at the University of Ottawa will generally fall into two categories:

1. **Sealed sources:** these are radioactive materials that are encapsulated within devices (liquid scintillation counters) or within another material that prevents direct contact or dispersal of radioactive material.

2. **Open sources:** these are radioactive materials in a form that permits direct contact and can be subdivided. Common forms of open source radioactive material include:
    - aqueous and non-aqueous radioactive materials;
    - solid radioactive materials (powders or contaminated materials such as pipette tips, Pasteur pipettes, test tubes, petri dishes, gloves, syringes);
    - liquid scintillation cocktails containing dissolved radioactive material.

All users of radioactive materials are required to comply with – at minimum – the requirements below:

- Comply with the requirements of the Canadian Nuclear Safety Commission and the conditions of radioisotope permits.
- Radioactive material must be strictly controlled and managed, in order to track its possession, use, and disposal.
- Use time, distance, and shielding to keep radiation exposure to as low as reasonably achievable (ALARA).
- Keep the laboratory locked and secured when unattended. Unauthorized persons are not allowed in the laboratory at any time.
- Refrain from working with radioactive materials if you have open cuts or abrasions.
- Equipment, trays, floors and working surfaces must be monitored, and if necessary decontaminated, on a regular basis (weekly for a Basic lab, and after each use for an Intermediate lab)
- Use disposable absorbent liners on trays or other work surfaces.
- Wash hands after using radioactive substances and prior to leaving the laboratory.
- Decontaminate laboratory equipment before using it for other purposes.
- Use a fume hood for any work with dry powder or volatile substances.

Personal Protective Equipment

- In addition to standard personal protective equipment (i.e. lab-coat, protective eyewear and disposable gloves), lab users may be required to wear a dosimeter(s) to assess exposure.

Storage

- Label waste containers and storage facilities for radioactive materials with the appropriate signage.
- Store radioactive materials in a secure area.
- Ensure adequate shielding is in place (where required).

Disposal

Direct any questions related to radiological materials, procedures and waste to the Risk Management Specialist – Radiation at the Office of Risk Management.

Cryogenic Materials

Cryogenic materials are primarily characterized by extremely low temperatures. Cryogenic liquids typically have boiling points between -100°C and -270°C. Consequently, they are liquefied under

high pressure and must be kept in Dewar vessels to keep them in a liquid state. These conditions create certain hazards, including:

- Cold boil-off vapour, which will rapidly freeze human tissue. Cold burns and frostbite caused by cryogenic liquids can result in extensive tissue damage.
- Materials such as carbon, steel, plastics, and rubber become brittle or even fracture under stress at these temperatures. Selection of proper materials is important.
- The low temperatures can condense contaminants in the atmosphere. Liquid nitrogen can condense oxygen from the surrounding atmosphere, creating an explosive mixture if organic material is also condensed. Liquid hydrogen can do the same, forming an explosive hydrogen-oxygen solid.
- All cryogenic liquids produce large volumes of gas when they vaporize. For example, liquid nitrogen will expand at a ratio of 696:1 as it vaporizes. If these liquids vaporize in a sealed container, they can produce enormous pressures that could rupture the vessel. For this reason, pressurized cryogenic containers are usually protected with multiple pressure relief devices, usually a pressure relief valve and a frangible (i.e. bursting) disc. In rare and extreme cases, cryogens can condense sufficient moisture from the air (i.e. ice) to block pressure relief valves in storage vessels, creating the potential for dangerous pressure build-up.
- The vaporization of cryogenic liquids (except oxygen) in an enclosed area (i.e. elevators, small labs, etc.) can cause asphyxiation. Vaporization of liquid oxygen can produce an oxygen-rich atmosphere that will support and accelerate the combustion of other materials. Vaporization of liquid hydrogen can form an extremely flammable mixture with air.

Personal Protective Equipment

- Protect skin from contact. Wear a lab coat, protective eyewear, face shield, and loose-fitting, cryogenic gloves.

Storage

- Store and use cryogenics in well-ventilated areas.
- Store in a well-insulated container designed to minimize loss of product from boil-off (i.e. Dewar vessel).

Handling

- Do not wear metallic objects, such as watches, rings, bracelets or other jewellery.
- Use only approved containers that can withstanding extreme cold without becoming brittle (i.e. Dewar vessel).
- Perform the following tasks slowly to minimize boiling and splashing:
    - Charging or filling a warm container with cryogenic liquid
    - Inserting objects into a cryogenic liquid
    - Pouring a cryogenic liquid into smaller containers
- Use tongs to withdraw objects immersed in a cryogenic liquid
- Never touch uninsulated pipes or vessels containing cryogenic liquids.

Most cryogenic materials will evaporate under normal atmospheric conditions. For any further assistance, contact your Health, Safety and Risk Manager and / or the Office of Risk Management.

Compressed Gases

Compressed gas cylinders should be purchased from the uOttawa compressed gas supplier, which has a cylinder return program to recycle empty (or unwanted) cylinders.

Storage and Set Up

- All gas cylinders, full or empty, must be properly secured at all times. Always store gas cylinders in the upright position.
- The valve protection cap must be attached when a cylinder is not connected to a regulator.

While in Use

- Use only in well-ventilated areas.
- Use properly functioning systems to contain and exhaust toxic, flammable, and corrosive gases
- Flammable gas cylinders, lines, and equipment must be bonded and grounded.
- Do not connect full and empty cylinders in series: connecting an empty cylinder to a pressurized system can cause significant backpressure.
- Never tamper with safety devices in valves or cylinders. Do not use adaptors or Teflon tape to attach regulators to gas cylinders. Do not lubricate.

Handling

Transportation:

- To move cylinders, use only an approved cylinder cart. Avoid collisions with other objects.
- The weakest part of a compressed gas cylinder is the valve stem. Do not move cylinders without installing the protective valve cap.
- Never attempt to lift or move a cylinder by holding onto the valve stem at the top of the cylinder. The collar is not welded onto the cylinder and may dislodge.
- Do not allow a cylinder to drop.
- Special transportation services are available for transfers across campus/streets, etc.

While in Use:

- Never use a cylinder that is not properly identified.
- Never subject any part of a compressed gas cylinder to high temperatures or flames.
- When discharging gas into a liquid, you must use a trap or suitable check valve to prevent liquid from re-entering the cylinder or regulator.
- Never direct high-pressure gas (including compressed air) at a person.
- Avoid running flammable gas lines near heat sources or open flames.
- Do not try to extinguish the flame of a highly combustible gas until the gas source has been shut off.

Disposal

- Return cylinders promptly to the supplier, even if only partially used.
- When returning empty cylinders, close the valve before shipment. Leave some positive pressure in the cylinder – approximately 10% of original capacity is recommended.
- Replace any valve outlet and protective caps originally shipped with cylinder.
- Lecture bottles are considered hazardous waste and should be disposed of in accordance with the *Hazardous Materials and Hazardous Waste Directive*.

Refer to the Compressed Gas Guideline, available from the Office of Risk Management, for additional information.

Additional Hazardous Materials Requiring Special Handling, Storage and Disposal Procedures

Reactive Metals

- Do not dispose of such metals down the drain or sewer.
- Check for complete oxidation before preparing the material for disposal. If only surface oxidation has occurred, the metal might still be salvageable. Otherwise, prepare a waste container for waste metals, identified with hazardous waste labels.
- Most metals may be stored in glass or plastic bottles, in a regular storage cabinet or on storage shelves.
- Finely divided metals, such as zinc, barium or magnesium, can be highly pyrophoric (i.e. may ignite spontaneously in air at or below 55°C) and should be stored under nitrogen or an inert gas and in a flammable storage cabinet.
- The same container can be used to dispose of compatible waste metals. Once the container has reached 75% capacity, seal the container and list the contents on the hazardous waste label.

Batteries

- Wear gloves if the outer casing of a battery is damaged or leaking.
- Used lithium batteries are reactive waste that should be stored separately from regular household batteries or mercury and cadmium batteries.
- Tape the live ends of batteries to prevent accidental contact in the recycling receptacle.
- Waste batteries are considered toxic metal waste and therefore should not be disposed as regular waste. Most buildings have waste stations that feature battery recycling receptacles (small white buckets on the side of the waste station). For more information on the recycling process, contact Facilities.

Transporting Hazardous Materials

This service is designed to transfer or dispose of hazardous materials for uOttawa activities held off site. A few examples of this service include:

- Disposal of wastes generated off site by transporting waste from field stations to campus for disposal
- Relocating research materials from an off-site location to uOttawa

*** Costs **not** covered by Risk Management.*

We recommend that you plan, well in advance, any special transfer requests because the logistics involved in transporting hazardous waste and hazardous materials requires significant resources. To request the transportation of hazardous materials, send an email to enviro@uottawa.ca.

Use care and protective equipment when transferring hazardous materials between labs on campus, or from Shipping and Receiving to a laboratory. Although they may be in a “contained state”, such materials are still hazardous. Users may require secondary containment and personal protective equipment.

Reproductive Hazards

Certain laboratory materials (specifically those classified as *teratogens*) have the potential to affect human reproductive systems or cause birth defects. All persons can be at risk. Working with certain hazardous substances, or under certain working conditions, can lead to abnormal reproductive health. Many substances used in research labs are potentially toxic for reproductive systems and require strict control measures. In some cases, the link to reproductive toxicity has not yet been definitively established; therefore, it is vitally important that you fully understand the actual and potential hazards of a particular product or process in order to implement suitable measures to control hazards.

Pregnant individuals

Individuals who work in a laboratory environment and are pregnant, or considering pregnancy, require special consideration. The *Ontario Human Rights Code* requires the accommodation – without penalty – of any pregnant worker in cases where pregnant workers are exposed to risks that may not otherwise be present. The University and the pregnant worker have a duty to cooperate and respectfully discuss the situation as soon as possible to develop, implement and maintain appropriate accommodation measures to ensure the health and safety of the pregnant worker and unborn child. These discussions may involve the University, the pregnant worker and the workplace bargaining unit, if/where applicable.

The University has an obligation to offer reasonable accommodation measures and to make reasonable efforts to eliminate barriers to a pregnant worker. Reasonable accommodation measures may refer to a change to the work, work methods, or workplace in order to enable the person to satisfy the bona fide occupational requirements of the job and to achieve the outcomes or deliverables of the job. An accommodation is not an entitlement program; it is a method of enabling a worker to deliver the results required of the job.

Refer to the Pregnant Laboratory Workers guideline, available from the Office of Risk Management.

PROJECT RISK ASSESSMENT

Research, by its nature, is risky. The expected outcome(s) of a laboratory research project or experiment may not be fully achieved. In many cases, the situation may not be hazardous; however, it is important to be prepared for unexpected (and potentially dangerous) situations that may occur during a project. For this reason, the University of Ottawa has developed a Project Hazard Identification and Risk Assessment form that research project supervisors must complete.

The Project Risk Assessment aims to help identify hazards associated with each phase of the project. The supervisor is responsible for identifying hazards, estimating the risk associated with each hazard, and evaluating control measures to eliminate or mitigate the effects of the hazard. The Hazard Identification and Risk Assessment is available on the Office of Risk Management website. The supervisor is responsible for completing and maintaining the Project Risk Assessment.

APPENDIX A – UNIVERSITY OF OTTAWA SAFETY SERVICES

Protection Services

Protection Services (ext. 5411) acts as the University's own emergency response team. Contact Protection Services, which has offices on every campus (main campus, Roger Guindon and Lees), immediately if an on-campus emergency occurs. Dial ext. 5411 on any University phone or 613-562-5411 from a cellphone**.** If your office is located off campus (i.e., where Protection cannot immediately respond in the event of an emergency), call 911. When it is safe to do so, report the matter to Protection Services.

Fire Prevention Coordinator

Protection Services provides the services of the Fire Prevention Coordinator, who oversees the execution of regular fire drills; the installation, maintenance, training and inspection of fire extinguishers; and the investigation of incidents involving fires. In addition, the Fire Prevention Coordinator inspects buildings and provides recommendations with regards to fire safety. Direct all fire safety-related questions to the Fire Prevention Coordinator at ext. 6091.

Office of Risk Management

The Office of Risk Management (ext. 5892) provides technical support to the University community to ensure that activities are carried out in a healthy, safe and environmentally conscious manner. Its mandate includes the development, coordination and implementation of University-wide health, safety, risk and environmental management policies, procedures, plans and programs encompassing hazardous substances, biosafety and radioactive materials. In addition, it provides specialized services, such as coordinating the disposal of biohazardous, chemical, and radioactive materials; providing information and training; and conducting assessments, inspections and audits.

Health, Safety and Risk Managers (HSRMs)

Five officers are dedicated to providing full-time support on risk, environment and health and safety issues to specific faculties and services and their individual faculty/service managers. HSRMs serve the faculties of Science, Medicine, Engineering, Arts, Education, Health Sciences, Law, School of Management and Social Sciences, and with Facilities and Housing services.

Human Resources

Human Resources provides staffing, training and development, workshop registration, information systems, and health and wellness services.

Health and Wellness Office

The Health and Wellness Office promotes safe and healthy working conditions for all employees at the University. Their services are primarily preventative rather than curative, and aim to supplement rather than replace medical services available to employees through their personal physician and community clinics, such as the University of Ottawa Health Services. The Office also promotes and monitors compliance with provincial legislation on matters pertaining to worker compensation.

Health Services

Although Health Services is open to all, this University-based clinic prioritizes the needs of students. Some of its services are exclusive to students and funded by the University through student fees. It

provides medical services to students, staff members and the community at large. Physicians include family practitioners as well as specialists in gynaecology, obstetrics, dermatology, and psychiatry. Additionally, the service provides Health Educators and Health Promotion services.

Facilities

The primary mandate of Facilities is to maintain the University's infrastructure and grounds. Facilities is responsible for: heating, ventilation and air-conditioning; electricity and plumbing; campus roads; traffic signs; housekeeping; grounds maintenance (icy conditions); transportation; emergency shower testing; and maintenance of temporary buildings. Facilities also coordinates non-hazardous waste collection and recycling, and implements the University's energy conservation program.

Facilities provides assistance in maintenance emergencies. A maintenance emergency refers to situations where the condition of buildings, grounds and vehicles can affect the safety of users, or can create a dangerous situation (i.e., ventilation failures). Direct all maintenance emergencies to the Facility Manager responsible or in the event of a major emergency, call the Call Centre at 613-562-5800, ext. 2222, which can be reached 24 hours a day, 7 days a week.

Committees

In addition to the services listed above, there are several relevant committees within the University of Ottawa. These include:

- University Joint Occupational Health and Safety Committee
    - Sub committees (Office, Laboratory, Facilities/Protection)
- Biosafety Committee
- Radiation Safety Committee

For additional information on any of these committees, contact the Office of Risk Management at ext. 5892.

APPENDIX B – INCOMPATIBLE HAZARDOUS MATERIAL FAMILIES

The term "incompatible chemicals" refers to chemicals that can react with each other:

- violently
- with evolution of substantial heat
- to produce flammable products, or
- to produce toxic products

Table 1 below contains general classes of incompatible materials. NOTE: This is **not** an exhaustive list: these examples are meant to illustrate some common laboratory chemical incompatibilities.

Table 1 – General Classes of Incompatible Chemicals
Chemicals from Column A must not be combined with chemicals from Column B.

A **ACIDS** **Oxidizing Agents**	**B** **METALS, BASES** **Reducing Agents**
Chlorates Chromates Chromium Trioxide Dichromates Halogens Halogenating Agents Hydrogen Peroxide Nitric Acid Nitrates Perchlorates Peroxides Permanganates Persulfates, Metals	Ammonia Carbon Metals Metal Hydrides Nitrites Organic Compounds Phosphorus Silicon Sulphur

Table 2 provides a more complete list of combinations that can pose reactivity hazards. Chemicals in the left-hand column should be transported, stored, used, and disposed of, such that they do not accidently come into contact with the corresponding chemicals in the right-hand column.

Table 2 – Incompatible Families

This chemical:	**Is INCOMPATIBLE with:**
Acetic Acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetone	Concentrated nitric and sulfuric acid mixtures, chlorinated solvent/alkali mixtures
Acetylene and monosubstituted acetylenes	Chlorine, bromine, copper, fluorine, silver, mercury

Table 2 – Incompatible Families	
This chemical:	**Is INCOMPATIBLE with:**
Alkali, alkaline earth metals such as powdered aluminium, magnesium, calcium, lithium, sodium and potassium	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Aluminium and its alloys (particularly powders)	Acid or alkaline solutions, ammonium persulphate and water, chlorinated compounds, nitrates, and organic compounds in nitrate/nitrite salt baths.
Ammonia (anhydrous)	Mercury (in manometers, for example), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulphur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids
Barium peroxide	Combustible organics, oxidizable materials, and water
Barium rhodanide	Sodium nitrate
Bismuth and its alloys	Perchloric acid
Bromine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Calcium or sodium carbide	Moisture (in air) or water
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates or perchlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials

Table 2 – Incompatible Families	
This chemical:	**Is INCOMPATIBLE with:**
Chlorine	Acetone, acetylene, ammonia, benzene, butadiene butane and other petroleum gases, hydrogen, metal powders, sodium carbide, and turpentine
Chlorine dioxide	Ammonia, hydrogen sulphide, methane, and phosphine
Chloroform	Strong bases, ketones and strong base, alkaline metals, aluminium, strong oxidizers
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids or alkalies
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, halogens
Fluorine	Most materials
Hydrazine	Hydrogen peroxide, nitric acid, or any other oxidant
Hydrocarbons such as benzene, butane, gasoline, propane, etc.	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid or anhydrous hydrogen fluoride	Ammonia (aqueous or anhydrous)
Hydrogen peroxide 3%	Chromium, copper, iron, most metals or their salts
Hydrogen peroxide 30% to 90%	Chromium, copper, iron, most metals or their salts, aniline, any flammable liquid, combustible materials, nitromethane, and all other organic matter.
Hydrogen sulphide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon

Table 2 – Incompatible Families	
This chemical:	**Is INCOMPATIBLE with:**
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Lithium	Acids, moisture in air, and water
Lithium aluminium hydride	Air, chlorinated hydrocarbons, carbon dioxide, ethyl acetate, and water
Mercuric Oxide	Sulphur
Mercury	Acetylene, alkali metals, ammonia, nitric acid with ethanol, fulminic acid, and oxalic acid
Nitrates	Sulphuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulphide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids, potassium or sodium cyanide
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen (liquid or enriched air)	Flammable gases, liquids, or solids such as acetone, acetylene, grease, hydrogen, oils, and phosphorus
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils, and reducing agents
Peroxides (organic)	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Chlorates and perchlorates, nitrates and nitric acid
Phosphorous pentoxide	Organic compounds or water
Phosphorous (red)	Oxidizing materials
Phosphorous (white)	Air (oxygen) or other oxidizing material
Picric acid	Ammonia heated with oxides, or salts of heavy metals and friction with oxidizing agents, or

Table 2 – Incompatible Families	
This chemical:	**Is INCOMPATIBLE with:**
	friction associated with picric acid crystals
Potassium	Air (moisture and/or oxygen), carbon tetrachloride, carbon dioxide, water
Potassium chlorate or perchlorate	Acids and their vapours, combustible materials, especially organic solvents, phosphorus, and sulphur
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, glycerine, and sulphuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid, nitric acid with ethanol
Sodium	As for potassium
Sodium amide	Air (moisture and oxygen) or water
Sodium chlorate	Acids, ammonium salts, oxidizable materials and sulphur
Sodium hydrosulfite	Air (moisture) or combustible materials
Sodium nitrite	Ammonia compounds, ammonium nitrate, or other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulphides	Acids
Sulphur	Any oxidizing materials
Sulphuric acid	Chlorates, perchlorates, permanganates (compounds of light metals, such as sodium, lithium, and potassium)
Tellurides	Reducing agents
Water	Acetyl chloride, alkaline and alkaline earth metals, their hydrides and oxides, barium peroxide, carbides, chromic acid, phosphorous

Table 2 – Incompatible Families	
This chemical:	**Is INCOMPATIBLE with:**
	pentoxide, phosphorous oxychloride, phosphorous pentachloride, sulphuric acid and sulphur trioxide
Zinc Chlorate	Acids or organic materials
Zinc (particularly powder)	Acids or water
Zirconium (particularly powder form)	Carbon tetrachloride and other halogenated hydrocarbons, in peroxides, sodium bicarbonate, and water

APPENDIX C – BIBLIOGRAPHY

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APPENDIX D – RESOURCE LINKS

- Accident, Incident or Occupational Illness Report
- Office of Risk Management
    - Health, Safety and Risk Managers
        - Engineering
        - Facilities
        - Medicine
        - Science
        - All other faculties
- Hazardous Materials and Hazardous Waste Directive
- Hazardous Materials Technical Services Regular Collection Request

APPENDIX E – CHEMICAL RESISTANCES OF COMMON GLOVE MATERIALS

How to Read the Charts

Three categories of data are represented for each Ansell product and corresponding chemical: 1) overall degradation resistance rating; 2) permeation breakthrough time, and 3) permeation rate.

Standards for Color-Coding

A glove-chemical combination receives **GREEN** if either set of the following conditions is met:

- The degradation rating is Excellent or Good
- The permeation breakthrough time is 30 minutes or longer
- The permeation rate is Excellent, Very Good, or Good.

OR

- The permeation rate is not specified
- The permeation breakthrough time is 240 minutes or longer
- The degradation rating is Excellent, Very Good, or Good

A glove-chemical combination receives **RED** if: the degradation rating is Poor or Not Recommended, regardless of the permeation rating.

All other glove-chemical combinations receive **YELLOW**. In other words, any glove-chemical combination not meeting either set of conditions required for Green, and not having a Red degradation rating of either Poor or Not Recommended, receives a **YELLOW** rating.

Key to Permeation Rate

	Simply Stated, Drops/hr Through a Glove (eyedropper-size drops)
E – Excellent; permeation rate of less than 0.9 µg/cm²/min.	0 to 1/2 drop
VG – Very Good; permeation rate of less than 9 µg/cm²/min.	1 to 5 drops
G – Good; permeation rate of less than 90 µg/cm²/min.	6 to 50 drops
F – Fair; permeation rate of less than 900 µg/cm²/min.	51 to 500 drops
P – Poor; permeation rate of less than 9000 µg/cm²/min.	501 to 5000 drops
NR – Not Recommended; permeation rate greater than 9000 µg/cm²/min.	5001 drops up

Note: The current revision to the ASTM standard permeation test calls for permeation to be reported in micrograms of chemical permeated per square centimeter of material exposed per minute of exposure, "µg/cm²/min."

Key to Permeation Breakthrough

>Greater than (time) <Less than (time)

Key to Degradation Ratings

E – Excellent; fluid has very little degrading effect.
G – Good; fluid has minor degrading effect.
F – Fair; fluid has moderate degrading effect.
P – Poor; fluid has pronounced degrading effect.
NR – Fluid was not tested against this material.

NOTE: Any test samples rated P (poor) or NR (not recommended) in degradation testing were not tested for permeation resistance. A dash (–) appears in those cases.

Specific Gloves Used for Testing

	Degradation	**Permeation**
Nitrile	Sol-Vex® 37-145 (11 mil/0.28 mm)	Sol-Vex® 37-165 (22 mil/0.54 mm)
Neoprene Unsupported	29-865 (18 mil/0.46 mm)	29-865 (18 mil/0.46 mm)
Polyvinyl Alcohol Supported	PVA™	PVA™
Polyvinyl Chloride Supported	Snorkel®	Monkey Grip™
Natural Rubber Latex	Canners 392 (19 mil/0.48 mm)	Canners 392 (19 mil/0.48 mm)
Neoprene/Latex Blend	Chemi-Pro 224 (27 mil/0.67 mm)	Chemi-Pro 224 (27 mil/0.67 mm)
Laminated LCP™ Film	Barrier 2-100 (2.5 mil/0.06 mm)	Barrier 2-100 (2.5 mil/0.06 mm)

Single palm thickness is listed in both mil and metric millimeter (mm) for Unsupported Gloves. Supported Gloves are specified by glove weight, not thickness.

Why is a product with a shorter breakthrough time sometimes given a better rating than one with a longer breakthrough time?

One glove has a breakthrough time of just 4 minutes. It is rated "very good," while another with a breakthrough time of 30 minutes is rated only "fair." Why? The reason is simple: in some cases the *rate* is more significant than the *time*.

Imagine connecting two hoses of the same length but different diameters to a faucet using a "Y" connector. When you turn on the water, what happens? Water goes through the smaller hose first because there is less space inside that needs to be filled. But when the water finally gets through the larger hose it really gushes out. In only a few minutes, the larger hose will discharge much more water than the smaller one, even though the smaller one started first.

The situation is similar with gloves. A combination of a short breakthrough time and a low permeation rate may expose a glove wearer to less chemical than a combination of a longer breakthrough time and a much higher breakthrough rate, if the glove is worn long enough.

SPECIAL NOTE: The chemicals in this guide highlighted in BLUE are experimental carcinogens, according to the ninth edition of Sax' *Dangerous Properties of Industrial Materials*. Chemicals highlighted in GRAY are listed as suspected carcinogens, experimental carcinogens at extremely high dosages, and other materials which pose a lesser risk of cancer.

Permeation/Degradation Resistance Guide for Ansell Gloves

The first square in each column for each glove type is color coded. This is an easy-to-read indication of how we rate this type of glove in relation to its applicability for each chemical listed. The color represents an overall rating for both degradation and permeation. The letter in each square is for Degradation alone…

- **GREEN: The glove is very well suited for application with that chemical.**
- **YELLOW: The glove is suitable for that application under careful control of its use.**
- **RED: Avoid use of the glove with this chemical.**

CHEMICAL	LAMINATE FILM BARRIER			NITRILE SOL-VEX			UNSUPPORTED NEOPRENE 29-865			SUPPORTED POLYVINYL ALCOHOL PVA			POLYVINYL CHLORIDE (Vinyl) SNORKEL			NATURAL RUBBER CANNERS AND HANDLERS*			NEOPRENE/ NATURAL RUBBER BLEND CHEMI-PRO*		
	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate
1. Acetaldehyde	■	380	E	P	—	—	E	10	F	NR	—	—	NR	—	—	E	7	F	E	10	F
2. Acetic Acid	■	150	—	G	270	—	E	60	—	NR	—	—	F	180	—	E	110	—	E	260	—
3. Acetone	▲	>480	E	NR	—	—	E	10	F	P	—	—	NR	—	—	E	10	F	G	10	G
4. Acetonitrile	▲	>480	E	F	30	F	E	20	G	■	150	G	NR	—	—	E	4	VG	E	10	VG
5. Acrylic Acid	—	—	—	G	120	—	E	390	—	NR	—	—	NR	—	—	E	80	—	E	65	—
6. Acrylonitrile	E	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Allyl Alcohol	▲	>480	E	F	140	F	E	140	VG	P	—	—	P	60	G	E	>10	VG	E	20	VG
8. Ammonia Gas	■	19	E	▲	>480	—	▲	>480	—	—	—	—	■	6	VG	—	—	—	■	27	VG
9. Ammonium Fluoride, 40%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—
10. Ammonium Hydroxide	E	30	—	E	>360	—	E	250	—	NR	—	—	E	240	—	E	90	—	E	240	—
11. Amyl Acetate	▲	>480	E	E	60	G	NR	—	—	G	>360	E	P	—	—	NR	—	—	P	—	—
12. Amyl Alcohol	—	—	—	E	30	E	E	290	VG	G	180	G	G	12	E	E	25	VG	E	45	VG
13. Aniline	▲	>480	E	NR	—	—	E	100	P	F	>360	E	F	180	VG	E	25	VG	E	50	G
14. Aqua Regia	—	—	—	F	>360	—	G	>480	—	NR	—	—	G	120	—	NR	—	—	G	180	—
15. Benzaldehyde	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	G	10	VG	G	25	F
16. Benzene, Benzol	▲	>480	E	P	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
17. Benzotrichloride	—	—	—	E	>480	E	NR	—	—	—	—	—	—	—	—	NR	—	—	NR	—	—
18. Benzotrifluoride	—	—	—	E	170	G	F	—	—	E	—	—	G	<10	F	P	50	G	—	—	—
19. Bromine Water	—	—	—	E	>480	E	E	>480	E	—	—	—	—	—	—	—	—	—	—	—	—
20. 1-Bromopropane	▲	>480	E	■	23	F	■	<10	P	▲	>480	E	■	<10	F	■	<10	P	■	<10	P
21. Bromopropionic Acid	▲	>480	—	F	120	—	E	420	—	NR	—	—	G	180	—	E	190	—	G	180	—
22. Butyl Acetate	▲	>480	E	F	75	F	NR	—	—	G	>360	E	NR	—	—	NR	—	—	P	—	—
23. Butyl Alcohol	▲	>480	E	E	>360	E	E	210	VG	F	75	G	G	180	VG	E	20	VG	E	45	VG
24. Butyl Carbitol	—	—	—	E	323	E	G	188	F	E	>480	E	E	397	VG	E	44	G	E	148	G
25. Butyl Cellosolve	▲	>480	E	E	90	VG	E	120	F	■	120	G	P	—	—	E	45	G	E	40	G
26. gamma-Butyrolactone	▲	>480	E	NR	—	—	E	190	F	E	120	VG	NR	—	—	E	60	G	E	100	F
27. Carbon Disulfide	▲	>480	E	G	30	F	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
28. Carbon Tetrachloride	—	—	—	G	150	G	NR	—	—	E	>360	E	F	25	F	NR	—	—	NR	—	—
29. Cellosolve Acetate	▲	>480	E	F	90	G	E	40	P	▲	>360	E	NR	—	—	E	10	G	E	15	G
30. Cellosolve Solvent	E	>480	E	G	210	G	E	120	F	—	75	G	P	—	—	E	25	VG	E	20	VG
31. Chlorine Gas	▲	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32. 2-Chlorobenzyl Chloride	—	—	—	E	120	E	P	—	—	E	>480	E	F	65	E	F	20	F	—	—	—
33. Chlorobenzene	▲	>480	E	NR	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
34. Chloroform	E	20	G	NR	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
35. Chloronaphthalene	▲	>480	E	P	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	P	—	—
36. 2-Chlorotoluene	—	—	—	G	120	G	NR	—	—	F	—	—	F	—	—	NR	—	—	NR	—	—
37. ortho-Chlorotoluene	—	—	—	G	120	G	NR	—	—	F	—	—	F	—	—	NR	—	—	NR	—	—
38. Chromic Acid, 50%	—	—	—	F	240	—	NR	—	—	NR	—	—	G	>360	—	NR	—	—	NR	—	—
39. Citric Acid, 10%	—	—	—	E	>360	—	E	>480	—	P	—	—	E	>360	—	E	>360	—	E	>360	—
40. Cyclohexanol	▲	>480	E	E	>360	E	E	390	VG	G	>360	E	E	360	E	E	10	G	E	20	G
41. Cyclohexanone	▲	>480	E	F	103	G	P	—	—	E	>480	E	NR	—	—	P	—	—	P	—	—
42. 1, 5-Cyclooctadiene	—	—	—	E	>480	E	NR	—	—	—	—	—	P	—	—	NR	—	—	NR	—	—
43. Diacetone Alcohol	▲	>480	E	G	240	E	E	140	G	■	150	G	NR	—	—	E	15	VG	E	60	VG
44. Dibutyl Phthalate	—	—	—	G	>360	E	F	<10	F	E	>360	E	NR	—	—	E	20	—	G	>360	E
45. Diethylamine	▲	>480	E	F	45	F	P	—	—	NR	—	—	NR	—	—	NR	—	—	NR	—	—

Note: All numeric designations within the product classifications are denoted in minutes.

▲ A degradation test against this chemical was not run. However, since its breakthrough time is greater than 480 minutes, the Degradation Rating is expected to be **Good** to **Excellent.**

■ A degradation test against this chemical was not run. However, in view of degradation tests performed with similar compounds, the Degradation Rating is expected to be **Good** to **Excellent.**

***CAUTION:** This product contains natural rubber latex which may cause allergic reactions in some individuals.

This Information Applies Only to Ansell Occupational Healthcare Glove Brands

CHEMICAL	LAMINATE FILM BARRIER			NITRILE SOL-VEX			UNSUPPORTED NEOPRENE 29-865			SUPPORTED POLYVINYL ALCOHOL PVA			POLYVINYL CHLORIDE (Vinyl) SNORKEL			NATURAL RUBBER CANNERS AND HANDLERS*			NEOPRENE/ NATURAL RUBBER BLEND CHEMI-PRO*		
	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate
46. Di-Isobutyl Ketone, DIBK	▲	>480	E	E	120	F	P	—	—	G	>360	E	P	—	—	P	—	—	P	—	—
47. Dimethyl Acetamide, DMAC	▲	>480	E	NR	—	—	NR	—	—	NR	—	—	NR	—	—	E	15	G	E	30	G
48. Dimethyl Formamide, DMF	▲	>480	E	NR	—	—	E	40	F	NR	—	—	NR	—	—	E	25	VG	E	40	G
49. Dimethyl Sulfoxide, DMSO	▲	>480	E	E	>240	VG	E	360	G	NR	—	—	NR	—	—	E	180	E	E	150	E
50. Dioctyl Phthalate, DOP	▲	>480	E	G	>360	E	G	>480	E	E	30	F	NR	—	—	P	—	—	E	>360	E
51. Dioxane	▲	>480	E	NR	—	—	NR	—	—	P	—	—	NR	—	—	F	5	F	F	15	F
52. Electroless Copper	—	—	—	E	>360	—	E	>360	—	NR	—	—	E	>360	—	E	>360	—	—	—	—
53. Electroless Nickel	—	—	—	E	>360	—	E	>360	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—
54. Epichlorohydrin	▲	>480	E	NR	—	—	P	—	—	E	300	E	NR	—	—	E	5	F	E	15	G
55. Ethidium Bromide, 10%	▲	>480	E	▲	>480	E	—	—	—	NR	—	—	—	—	—	—	—	—	—	—	—
56. Ethyl Acetate	▲	>480	E	NR	—	—	F	10	P	F	>360	E	NR	—	—	G	5	F	F	10	F
57. Ethyl Alcohol	▲	>480	E	E	240	VG	E	113	VG	NR	—	—	G	60	VG	E	37	VG	E	20	G
58. Ethylene Dichloride	▲	>480	—	NR	—	—	NR	—	—	E	>360	E	NR	—	—	P	—	—	P	—	—
59. Ethylene Glycol	▲	>480	E	E	>360	E	E	>480	—	F	120	VG	E	>360	E	E	>360	E	E	>480	E
60. Ethylene Oxide Gas	▲	234	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
61. Ethyl Ether	▲	>480	E	E	120	G	F	<10	P	G	>360	E	NR	—	—	NR	—	—	NR	—	—
62. Ethyl Glycol Ether	▲	>480	E	G	210	G	E	120	F	■	75	G	P	—	—	E	25	VG	E	20	VG
63. Formaldehyde	▲	>480	E	E	>360	E	E	105	G	P	—	—	E	100	VG	E	10	G	E	15	VG
64. Formic Acid, 90%	▲	>480	—	F	240	—	E	>480	—	NR	—	—	E	>360	—	E	150	—	E	>360	—
65. Furfural	▲	>480	E	NR	—	—	E	30	P	F	>360	E	NR	—	—	E	15	VG	E	40	G-VG
66. Glutaraldehyde, 25%	—	—	—	—	>360	—	E	>480	E	P	—	—	E	>360	E	E	210	VG	E	—	—
67. Gasoline (hi-test)	■	170	E	E	>360	E	NR	—	—	G	>360	E	P	—	—	NR	—	—	NR	—	—
68. HCFC-141b	▲	>480	E	E	92	F	F	33	P	P	—	—	NR	—	—	NR	—	—	NR	—	—
69. HFE 7100	▲	>480	E	E	>480	E	E	>480	E	P	—	—	E	>480	E	E	120	E	—	—	—
70. HFE 71DE	▲	164	E	F	10	F	F	<10	F	F	>480	E	NR	—	—	NR	—	—	NR	—	—
71. Hexamethyldisilazane	▲	>480	E	E	>360	—	E	15	—	G	>360	—	P	—	—	F	15	F	F	40	F-G
72. Hexane	▲	>480	E	E	>360	E	E	40	F	G	>360	E	NR	—	—	NR	—	—	P	—	—
73. Hydrazine, 65%	—	—	—	E	>360	—	E	380	—	NR	—	—	E	>360	—	E	150	VG	E	>360	—
74. Hydrobromic Acid	▲	>480	—	E	>360	E	E	>480	—	NR	—	—	E	>360	E	E	>360	E	E	>360	E
75. Hydrochloric Acid, conc.	▲	>480	—	E	>360	—	E	>480	—	NR	—	—	E	>300	—	E	290	—	E	>360	—
76. Hydrochloric Acid, 10%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—
77. Hydrofluoric Acid, 48%	E	>480	—	E	334	—	E	>480	—	NR	—	—	G	155	—	E	190	—	E	153	—
78. Hydrogen Fluoride Gas	▲	>480	E	■	<15	P	—	—	—	—	—	—	—	—	—	E	<15	F	■	<15	F
79. Hydrogen Peroxide, 30%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	G	90	—
80. Hydroquinone, saturated	—	—	—	E	>360	E	E	140	F	NR	—	—	E	>360	E	G	>360	E	E	>360	—
81. Hypophosphorus Acid	—	—	—	E	>480	—	E	>480	—	—	—	—	—	—	—	E	>480	—	—	—	—
82. Isobutyl Alcohol	▲	>480	E	E	>360	E	E	470	E	P	—	—	F	10	VG	E	15	VG	E	45	VG
83. Iso-Octane	▲	>480	E	E	360	E	E	230	G	E	>360	E	P	—	—	NR	—	—	P	—	—
84. Isopropyl Alcohol	▲	>480	E	E	>360	E	E	<10	VG	NR	—	—	G	150	E	E	20	VG	E	40	VG
85. Kerosene	▲	>480	E	E	>360	E	E	170	P	G	>360	E	F	>360	E	NR	—	—	P	—	—
86. Lactic Acid, 85%	▲	>480	—	E	>360	E	E	>480	—	F	>360	E	E	>360	E	E	>360	—	E	>360	—
87. Lauric Acid, 36%/EtOH	—	—	—	E	>360	—	E	>480	—	NR	—	—	F	15	—	E	>360	—	E	>360	—
88. d-Limonene	▲	>480	E	E	>480	E	P	—	—	G	>480	E	G	125	G	NR	—	—	NR	—	—
89. Maleic Acid, saturated	—	—	—	E	>360	—	E	>480	—	NR	—	—	G	>360	—	E	>360	—	E	>360	—
90. Mercury	—	—	—	▲	>480	E	—	—	—	—	—	—	▲	>480	E	▲	>480	E	—	—	—

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91. 1-methoxy-2-acetoxypropane	▲	>480	E	E	200	F	G	37	F	E	>360	E	P	—	—	G	13	F	G	18	F
92. Methyl Alcohol	E	>480	E	E	198	VG	E	65	G	NR	—	—	G	45	G	E	20	VG	E	20	VG
93. Methylamine	▲	>480	E	E	>360	E	E	140	G	NR	—	—	E	135	VG	E	55	VG	E	80	VG
94. Methyl Cellosolve	E	440	E	F	11	G	P	—	—	G	30	G	P	—	—	E	20	VG	E	20	VG
95. Methylene Bromide	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—
96. Methylene Chloride	E	20	VG	NR	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—
97. MDI (Isocyanate)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	▲	>480	E
98. Methyl Amyl Ketone	E	>480	E	F	53	F	F	10	F	E	>360	E	NR	—	—	F	<10	F	F	<10	F
99. Methyl Ethyl Ketone, MEK	E	>480	E	NR	—	—	P	—	—	F	90	VG	NR	—	—	F	5	F	P	—	—
100. Methyl Glycol Ether	▲	>480	E	F	11	G	P	—	—	G	30	G	P	—	—	E	20	VG	E	20	VG
101. Methyl Iodide	▲	>480	E	NR	—	—	NR	—	—	F	>360	E	NR	—	—	NR	—	—	NR	—	—
102. Methyl Isobutyl Ketone	▲	>480	E	P	—	—	NR	—	—	F	>360	E	NR	—	—	P	—	—	P	—	—
103. Methyl Methacrylate	▲	>480	E	P	—	—	NR	—	—	G	>360	E	NR	—	—	P	—	—	NR	—	—
104. N-Methyl-2-Pyrrolidone	▲	>480	E	NR	—	—	NR	—	—	NR	—	—	NR	—	—	E	75	VG	F	40	G
105. Methyl t-Butyl Ether	E	>480	E	E	>360	E	P	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—
106. Mineral Spirits, rule 66	▲	>480	E	E	>360	E	E	100	F	E	>360	E	F	150	VG	NR	—	—	G	20	F
107. Monoethanolamine	—	—	—	E	>360	E	E	260	E	F	>360	E	E	>360	E	E	50	E	E	50	E
108. Morpholine	▲	>480	E	NR	—	—	P	—	—	G	90	G	NR	—	—	G	20	G	E	30	F-G
109. Muriatic Acid	▲	>480	—	E	>360	—	E	>480	—	NR	—	—	E	>300	—	E	290	—	E	>360	—
110. Naphtha VM&P	▲	>480	E	E	>360	E	G	100	F	E	>420	E	F	120	VG	NR	—	—	NR	—	—
111. Nitric Acid, 10%	▲	>480	—	E	>360	—	E	>480	—	NR	—	—	G	>360	—	G	>360	—	E	>360	—
112. Nitric Acid, 70%	E	>480	—	NR	—	—	E	>480	—	NR	—	—	F	104	—	NR	—	—	G	90	—
113. Nitric Acid, Red Fuming	▲	>480	—	NR	—	—	NR	—	—	NR	—	—	P	—	—	NR	—	—	NR	—	—
114. Nitrobenzene	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	F	15	G	F	40	G
115. Nitromethane, 95.5%	▲	>480	E	F	30	F	E	60	G	G	>360	E	P	—	—	E	10	G	E	30	VG
116. Nitropropane, 95.5%	▲	>480	E	NR	—	—	E	<10	F	E	>360	E	NR	—	—	E	5	G	E	10	G
117. Octyl Alcohol	—	—	—	E	>360	E	E	218	E	G	>360	E	F	>360	E	E	30	VG	E	53	G
118. Oleic Acid	—	—	—	E	>360	E	F	13	G	G	60	E	F	90	VG	F	>360	—	G	120	—
119. Oxalic Acid, saturated	—	—	—	E	>360	—	E	>480	—	P	—	—	E	>360	—	E	>360	—	E	>360	—
120. Pad Etch 1(Ashland Chem.)	—	—	—	F	>360	—	E	>480	—	F	34	—	E	>360	—	E	>360	—	E	>360	—
121. Palmitic Acid, saturated	—	—	—	G	30	—	E	>480	—	P	—	—	G	75	—	G	5	—	E	193	—
122. Pentane	E	>480	E	E	>360	E	G	30	G	G	>360	E	NR	—	—	P	—	—	E	13	G
123. Pentachlorophenol, 5%	—	—	—	E	>360	E	E	151	F	E	5	F	F	180	E	NR	—	—	—	—	—
124. Perchloric Acid, 60%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	F	>360	—	E	>360	—
125. Perchloroethylene	▲	>480	E	G	300	VG	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
126. Phenol	▲	>480	E	NR	—	—	E	353	G	F	>360	E	G	75	VG	E	90	—	E	180	—
127. Phosphoric Acid, conc.	▲	>480	—	E	>360	—	G	>480	—	NR	—	—	G	>360	—	F	>360	—	G	>360	—
128. PMA Glycol Ether Acetate	▲	>480	E	E	200	F	G	37	F	E	>360	E	P	—	—	G	13	F	G	18	F
129. Potassium Hydroxide, 50%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—
130. Propane Gas	—	—	—	▲	>480	E	▲	>480	E	—	—	—	■	7	VG	—	—	—	—	—	—
131. Propyl Acetate	—	—	—	F	20	G	P	—	—	G	120	VG	NR	—	—	P	—	—	P	—	—
132. Propyl Alcohol	▲	>480	—	E	>360	E	E	323	E	P	—	—	F	90	VG	E	20	VG	E	30	VG
133. Propylene Oxide	▲	>480	—	NR	—	—	NR	—	—	G	35	G	NR	—	—	P	—	—	P	—	—
134. Pyridine	▲	>480	E	NR	—	—	NR	—	—	G	10	F	NR	—	—	F	10	F	P	—	—
135. Rubber Solvent	—	—	—	E	>360	E	E	43	F	E	>360	E	NR	—	—	NR	—	—	NR	—	—

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136. Silicon Etch	—	—	—	NR	—	—	E	>480	—	NR	—	—	F	150	—	NR	—	—	P	—	—
137. Skydrol hydraulic fluid	E	>480	E	NR	—	—	NR	—	—	F	—	—	NR	—	—	NR	—	—	NR	—	—
138. Sodium Hydroxide, 50%	E	>480	—	E	>360	—	E	>480	—	NR	—	—	G	>360	—	E	>360	—	E	>360	—
139. Stoddard Solvent	▲	>480	E	E	>360	E	E	139	F	E	>360	E	F	360	E	NR	—	—	G	10	F
140. Styrene	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—
141. Sulfur Dichloride	—	—	—	G	>480	E	NR	—	—	—	—	—	—	—	—	NR	—	—	—	—	—
142. Sulfuric Acid, 95%	E	>480	—	NR	—	—	F	105	—	NR	—	—	G	70	—	NR	—	—	NR	—	—
143. Sulfuric Acid 120%, Oleum	▲	>480	E	—	—	—	F	53	G	—	—	—	F	25	G	—	—	—	—	—	—
144. Sulfuric 47% battery acid	—	—	—	E	>360	—	E	>480	—	NR	—	—	G	>360	—	E	>360	—	E	>360	—
145. Tannic Acid, 65%	—	—	—	E	>360	E	E	>480	—	P	—	—	E	>360	E	E	>360	—	E	>360	—
146. Tetrachloroethene	▲	>480	E	G	300	VG	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
147. Tetrahydrofuran, THF	▲	>480	E	NR	—	—	NR	—	—	P	90	G	NR	—	—	NR	—	—	NR	—	—
148. Toluene, toluol	▲	>480	E	F	10	F	NR	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—
149. Toluene Di-Isocyanate (TDI)	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	P	—	—	G	7	G	—	—	—
150. Triallylamine	▲	>480	E	—	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
151. Trichloroethylene, TCE	▲	>480	E	NR	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
152. Trichlorotrifluoroethane	—	—	—	E	>360	E	E	240	E	G	>360	E	NR	—	—	NR	—	—	NR	—	—
153. Tricresyl Phosphate, TCP	—	—	—	E	>360	E	G	<10	P	G	>360	E	F	>360	E	E	45	E	E	>360	E
154. Triethanolamine, 85%	—	—	—	E	>360	E	E	<10	G	G	>360	E	E	>360	E	G	>360	E	E	—	—
155. Turpentine	▲	>480	E	E	30	E	NR	—	—	G	>360	E	P	—	—	NR	—	—	NR	—	—
156. Vertrel MCA	▲	>480	E	E	110	G	E	20	F	F	>480	E	G	13	F	G	<10	F	G	<10	F
157. Vertrel SMT	E	<10	G	P	—	—	F	<10	P	G	17	G	G	<10	F	F	<10	F	P	—	—
158. Vertrel XE	E	105	E	E	>480	E	E	47	G	F	40	VG	G	303	E	E	17	VG	E	43	VG
159. Vertrel XF	E	>480	E	E	>480	E	E	>480	E	F	387	VG	E	>480	E	E	337	VG	E	204	VG
160. Vertrel XM	E	120	E	E	>480	E	E	105	E	F	10	G	P	—	—	E	23	VG	E	30	VG
161. Vinyl Acetate	▲	>480	E	F	18	F	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
162. Vinyl Chloride Gas	▲	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
163. Xylene, Xylol	▲	>480	E	G	75	F	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—

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NOTE:

These recommendations are based on laboratory tests, and reflect the best judgement of Ansell Occupational Healthcare in the light of data available at the time of preparation and in accordance with the current revision of ASTM F 739. They are intended to guide and inform qualified professionals engaged in assuring safety in the workplace. Because the conditions of ultimate use are beyond our control, and because we cannot run permeation tests in all possible work environments and across all combinations of chemicals and solutions, these recommendations are advisory only. The suitability of a product for a specific application must be determined by testing by the purchaser.

The data in this guide are subject to revision as additional knowledge and experience are gained. Test data herein reflect laboratory performance of partial gloves and not necessarily the complete unit. Anyone intending to use these recommendations should first verify that the glove selected is suitable for the intended use and meets all appropriate health standards. Upon written request, Ansell will provide a sample of material to aid you in making your own selection under your own individual safety requirements.

NEITHER THIS GUIDE NOR ANY OTHER STATEMENT MADE HEREIN BY OR ON BEHALF OF ANSELL SHOULD BE CONSTRUED AS A WARRANTY OF MERCHANTABILITY OR THAT ANY ANSELL GLOVE IS FIT FOR A PARTICULAR PURPOSE. ANSELL ASSUMES NO RESPONSIBILITY FOR THE SUITABILITY OR ADEQUACY OF AN END-USER'S SELECTION OF A PRODUCT FOR A SPECIFIC APPLICATION.