The University of British Columbia
Health, Safety and Environment

Laboratory Pollution Prevention And Hazardous Waste Management Manual

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By Environmental Services Facility
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About This Manual

This manual has been prepared by Health, Safety and Environment (HSE) to provide UBC hazardous waste generators with information regarding pollution prevention and waste minimization, as well as detailed hazardous waste disposal procedures.

Section A of this manual – Laboratory Pollution Prevention and Waste Minimization, is a guideline document designed to support your waste minimization efforts and to promote the sustainable reduction of UBC's research footprint on the environment.

Sections B & C of this manual – Laboratory Hazardous Waste Management, contain detailed procedures describing the proper methods for the disposal of hazardous waste.

Emergency Numbers

UBC Campus - Okanagan

Fire, Police, Ambulance **911**
Emergency / First Aid / Security .... **250 80(7-8111)**
Health, Safety and Environment .... **250 80(7-8111)**
Hazardous Materials Response **911**
Poison Control **1-800-567-8911**

Non-Emergency Numbers

Parking, Transportation and Campus Security (Non-Emergency) .... **250 80(7-9236)**
UBC Health, Safety and Environment, Okanagan .... **250 80(7-9236)**
UBC Health, Safety and Environment, Vancouver **604.822.2029**
Facilities Management .... **250 80(7-9272)**
Health & Wellness (students) .... **250 80(7-9270)**
R.C.M.P. (Non-Emergency) **250.762.3300**
Fire Department (Non-Emergency) **250.469.8801**
Kelowna General Hospital Emergency Department **250.862.4485**
Employee and Family Assistance program (EFAP) **1-800-663-1142**

Ensure all relevant emergency information (i.e. nature of emergency, building name and address, phone number, and exact location of the emergency in the building) is provided to the operator and do not hang up until instructed to do so.

Situations requiring immediate emergency response may include:

- First aid emergency;
- Hazardous materials spill;
- Bomb threat;
- Fire;
- Civil demonstration; and
- Natural disaster (e.g. earthquake, flood).

In the event of an emergency, contact the appropriate response agency (using phone numbers from this manual) and initiate response activities if it is safe to do so.

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Section A – Laboratory Pollution Prevention and Waste Minimization

1. Introduction to Waste Minimization and Pollution Prevention

1.1 Introduction

Waste minimization is any action that reduces the amount and/or toxicity of chemical wastes that must be shipped off-site for disposal as hazardous waste. Every member of the University's community needs to be aware of the environmental and financial impacts of hazardous waste and to actively seek to minimize the amount of waste generated. The success of the University's Waste Minimization efforts is dependent on the participation of every individual at the University.

This guide was designed to provide hazardous waste generators with information that will support their laboratory waste minimization efforts and research endeavours. Using this guide, generators can adopt specific procedures for their particular laboratory setup.

This guide explains how you can minimize the hazardous wastes and other chemical pollution generated by experiments.

Specifically, this guide will help you to:

- Generate less waste and pollution
- Save money by purchasing chemicals effectively.
- Design experiments with waste minimization in mind.
- Design a lab specific waste minimization plan.
- Save water and energy.

This guide deals primarily with hazardous materials that are used in a chemistry or biology laboratory.

1.2 Environmental Ethics and Green Research

In the laboratory, an environmental ethic means taking responsibility for the by-products of research and teaching, and the waste that is generated. A researcher conducts green research when they understand the environmental impacts of their work and minimize it where and when they can. Take the following steps to 'green' your laboratory:

- Train new personnel in chemical and environmental safety, including methods of pollution prevention and waste minimization
- Prepare for leaks and spills
- Review the chemicals in use to understand their hazards
- Design your experiments with waste minimization in mind
- Use the information in this guide and develop and implement a waste minimization plan for your laboratory
- Dispose of waste in a responsible manner by following documented protocols

1.3 The Waste Management Hierarchy

There are varieties of methods to deal with the problem of hazardous wastes. The waste management hierarchy addresses these methods in order of preference. The most preferable option on the hierarchy is to **reduce** the amount of waste that is produced in the first place. This approach is known as source reduction. This is the cornerstone of pollution prevention.

Unfortunately, not all waste can be eliminated, and the waste that is generated must be dealt with. **Reuse** of materials within a lab for a second purpose is the next best option. If a product can be used more than 1 time, then it is less resources and energy intensive than the next best option for managing this waste which includes **recycling**, refining, or **recovering** the waste so that new raw materials are not required and resources are conserved, so that waste pollutants never reach the land (e.g., a landfill), the water, or the atmosphere.

If that is not possible, the next best option would be to **treat** the waste to reduce its toxicity and its potential for harming the environment. Occasionally, some wastes are used as fuels for other industrial processes, but as this still releases toxic or dangerous components into the environment, it is less desirable than the earlier options. The least preferred management method for hazardous wastes (and non-hazardous wastes) is shipping to a certified waste facility or incineration.

While each of these options may be necessary for managing waste at certain times, at the top of the hierarchy, source reduction should be the focus of waste management efforts.

1.4 The 4 "R"s of Waste Minimization

Simple laboratory practices can minimize laboratory hazardous waste, and reduce the environmental impact of research. Implement the 4 "R"s of waste minimization.

Rethink and Replace

- Improve or change laboratory processes to reduce waste
- Include detoxification or neutralization steps in your experiments
- Design for energy efficiency. Conduct experiments at ambient temperature and pressure
- Monitor reactions closely, add chemicals only as necessary
- Purchase electronic equipment free of lead, mercury, and other hazardous substances that complies with the **RoHS** (Restriction of Hazardous Substances in Electrical and Electronic Equipment) and **WEEE** (Waste Electrical and Electronic Equipment) guidelines
- Consider the quality and quantity of waste produced when purchasing new equipment; purchase the type that produces less waste

Reduce

- Reduce the scale of laboratory processes
- Control chemical inventory
- Take care to minimize spills
- Keep volatile chemicals capped and sealed
- Use catalysts as opposed to stoichiometric reagents

Reuse

- Use the UBC Chemical Exchange program, get free surplus chemicals, unused and in good condition.
- Find second purposes for materials used in the lab. For example, glass solvent bottles can be used to hold and transport wastes. The back side of printer paper can be bound and used as lab note paper. Acetone from 1 experiment can be used to clean the labels off of glassware.

Recycle

- Use UBC recycling programs
- Silver Recovery Program
- Battery Recycling
- Paint and oil recycling

2. Source Reduction of Laboratory Waste

2.1 Source Reduction in the Laboratory

Changing practices and processes to prevent pollution at its source is referred to as source reduction. Source reduction methods include Process Modification, Operational Improvements, Material Substitution, and Administrative Steps.

Redesign and Modify Laboratory Processes

Pollution can be prevented or reduced by changing the laboratory process in which the pollution is created.

- Reduce the scale of laboratory processes
    - Do micro scale work
    - Reduce the amount of materials used
    - Scale reduction also has the benefits of reduced cost, quicker runs, and reduced risk and severity of accidents
- Assess the possibility of including a detoxification or waste neutralization step in your experiments
- Avoid the use of reagents containing heavy metals such as barium, arsenic, cadmium, chromium, lead, mercury, selenium, and silver
- Consider the quantity and type of waste produced when purchasing new equipment; purchase equipment that produces less waste
- Check if equipment modification is possible to reduce waste
- When solvent is used for cleaning purposes, use spent solvent for initial cleaning and fresh solvent for final cleaning
- Use computer simulations and modeling which eliminate all environmental impacts when substituted for wet laboratory experiments
- Review method and technique for potential change in operating conditions (temperature, pressure)

Improve Laboratory Operations

Pollution can be prevented by improving laboratory operations:

- When using chemicals keep volatile chemicals capped and sealed
- Careful and neat operations reduce waste
- Take care when weighing or transferring chemicals between containers to minimize spills
- Chemical releases and inappropriate disposal affect the environment. Take steps to minimize fume hood emissions, sewer effluents, and chemical wastes
- When possible to be done safely, seal and contain processes to prevent the escape of fumes or leaks to the environment
- Regularly review your laboratory chemical stocks and dispose of surplus
- Storing excess chemicals increases the risks of a fire or spill. Some chemicals become reactive or explosive with age
- Fugitive emissions from stored chemicals can lead to harmful exposures
- Storage of surplus takes up valuable laboratory space

- Segregate your waste

Substitute with a Safer Chemical

- One of the most successful ways to reduce pollution is by substituting hazardous materials with safer chemicals.

Take Administrative Steps

- Control your laboratory chemical inventory
- Improve purchasing techniques by ordering the absolute minimum required to complete the experiment with in a short time period
- Provide lab specific training
- Develop incentive programs

Once all source reduction options are reviewed and implemented, assess and implement appropriate **reuse and recycle measures**.

2.2 Reduce Your Solvent Waste Stream

Organic solvents can be poisonous, carcinogenic, ozone-depleting and/or smog-forming[1]. To minimize these health and environmental impacts, substitute hazardous solvents with ones that show better environmental, health and safety properties.

Use "green solvents":

- Bio-solvents, to avoid petro-chemically fabricated solvents, fossil resource use, and fossil fuel and CO_2 emissions to the environment
- Solvents produced from renewable resources such as ethanol produced by fermentation of sugar, starch, or cellulose based materials
- Ionic liquids which are non-volatile, non-flammable, and have high thermal stability, low vapour pressure and thus less emission to air
- Solvent-less reactions in which the reagents serve as the solvent as well, or conduct reactions in the solid state

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[1] **Solvents: Health and Environmental Hazards**
Many organic solvents are poisonous if swallowed or inhaled in sufficient quantity. High concentrations of most solvents can cause narcosis (dizziness, nausea, fatigue, loss of coordination, and coma). Some organic solvents are carcinogens (e.g., benzene, carbon tetrachloride, trichloroethylene), reproductive hazards (e.g., 2-ethoxyethanol, 2-methoxyethanol, methyl chloride), and neurotoxic (e.g., n-hexane, tetrachloroethylene, toluene).

Many Chlorofluoro Carbons (CFC's) are ozone depleting chemicals (trichlorofluoromethane) causing degradation of the earth's stratospheric ozone layer and its ability to shield ultraviolet radiation from the earth's surface. The more reactive Volatile Organic Compounds (VOC) combine with nitrogen oxides to form smog, a toxic inhalant.

- Water-based solvents; water is the environmentally benign solvent
    - Note, however, that some water-soluble substances are very hazardous
    - Also, product separation and by-product formation may render effluent more hazardous than conventional solvents

The ideal solvent will:

- present minimal health and safety hazard (low toxicity and flammability, low peroxide formation, lower vapour pressure)
- have minimal environmental impact (increased biodegradability, reduced ozone depletion potential, reduced toxicity, less air emission)
- have the reactivity that fits the reaction
- allow for control of phase (easy precipitation/separation of product)
- safely degrade/evaporate after use

Substitute with less hazardous solvents. Examples:

- Substitute benzene with xylene or hexane (many solvent uses)
- Substitute carbon tetrachloride with cyclohexane (qualitative test for halides)
- Substitute halogenated solvents with non-halogenated solvents (extractions and other uses)

Review the Swiss Federal Institute of Technology tool for Environmental, Health and Safety Assessment of Solvents http://www.sust-chem.ethz.ch/tools/ehs/ehs_tool

Prevent hazardous emissions to air

- Keep volatile chemicals capped and sealed
- Scrub, filter hazardous emissions generated by your experiments

Commercially available "greener solvents':

Both InTech Environmental and Aldrich Chemistry offer green solvent products. For more information related to solvent assessment refer to "What is a green solvent? A comprehensive framework for the environmental assessment of solvents."

2.3 Reduce Your Chemical Waste Stream

Take the following measures to reduce your chemical waste stream:

- Segregate hazardous from non hazardous waste
- Reduce the scale of your experiment

Inventory Control

- Get surplus free chemicals by using the UBC Chemical Exchange Program
- Keep an up-to-date inventory of your lab chemicals (mandatory WHMIS requirement)
- Rotate stock; follow the principle of first-in, first-out

- Keep track of expiration dates and storage times, especially for peroxide-forming and other degradable chemicals; write expiration dates on bottles when they are opened
- Keep track of emptied containers and waste disposal to remove chemicals from the inventory
- Purchase only the chemicals and amounts you need in the immediate future
- Borrow small amounts from other labs
- Purchase smaller containers that are easier to handle; large containers often become waste when half full
- Accept only gifts or samples you plan to use in the immediate future, do not accept more than you need

Materials Substitution

Substitute hazardous with less hazardous chemicals.

- MIT Green Wizard http://web.mit.edu/environment/academic/purchasing.html
- EPA Expert System http://www.epa.gov/gcc/pubs/gces.html

Add a neutralization/detoxification stage to your experiments (i.e. neutralization of corrosives, ethidium bromide destruction with bleach), for more information refer to the in-lab waste treatment section of this manual

Avoid mercury and its compounds.

Mercury is a toxic metal that is difficult and costly to dispose of safely. Mercury waste from broken thermometers and manometers is commonly generated from labs in UBC.

- Use alternatives to mercury thermometers: alcohol (red liquid) thermometers, thermocouples and other electronic temperature devices
- Consider using Teflon coated thermometers that will contain the mercury in the event the capillary is broken

Formalin & formaldehyde solutions:

- Minimize the volume of waste generated by eliminating any unnecessary dilution
- Do not mix with any other waste streams
- Use "Formalternate" (Flinn Scientific) or ethanol as an alternative to formaldehyde for the storage of biological specimens

Do not use chromic acid solution for glass cleaning.

Chromic acid solution is a strong corrosive and strong oxidizer that reacts violently when combined with oxidizable materials. It contains chromium (VI), which is a known human carcinogen and is toxic to humans, and the environment. It is used to clean laboratory glassware. Try the alternatives to chromic acid solutions listed below (in increasing hazard).

- Non-hazardous cleaning solutions (e.g. ultrasonic baths; Alconox or similar detergents; Pierce RBS-35 or similar detergents; biodegradable surfactants)

- Strong corrosive solutions (e.g. potassium hydroxide/ethanol solutions; dilute hydrochloric acid
- Strong oxidizing acid solutions not containing chromium or other toxic metals (e.g. potassium persulfate & sulfuric acid; aqua regia)

Lecture Bottles of Hazardous Gases

Lecture bottles are small compressed gas cylinders, typically 2-3 inches in diameter and 12-18 inches in height. While many gas suppliers offer lecture bottles for purchase, most will not accept the empty or partly full cylinders back for disposal. Before purchasing new lecture bottles try to share the ones available in your department. In order to avoid costly disposal fees, purchase only returnable lecture bottles or small size cylinders.

These vendors offer returnable lecture bottles/small size cylinders:

Company	Details	Contact
Linde Gas LLC	Offers EcoCyl portable refillable calibration gas cylinder. ○ Extremely low, highly consistent flow rate. ○ Controlled by cylinder main valve. ○ Does not require researcher to stand over valve to monitor and adjust flow rate. ○ Eliminates hazardous waste disposal charge of $300 per lecture bottle.	Bryan Dierich, Sales Manager: tel 780-989-5990; fax 780-432-4078; cell 780-232-6900; Email: bryan.dierich@linde.com
Praxair Canada	Offers a small size refillable cylinder (N9) which is 4.4 in diameter, 17.4 in height. Refer to Praxair Canada for the type of gases available.	All sales inquiries or information: tel 1-800-PRAXAIR (1-800-722-9985)
Spectra Gases	Offers a lecture bottle 2 in diameter, 12 in height (not including valve). Will take back empty or partly empty lecture bottles.	Spectra Customer Service: tel 1-800-932-0624
Air Liquide Canada Inc.	Accepts small refillable cylinders, size 1A or 2. Small fee to return Calgaz small disposable cylinders.	Glenn Pirie tel: 778-231-9919 Email: glenn.pirie@airliquide.com

Potentially Explosive Materials

Most chemicals that are used in research and teaching laboratories are stable and non-explosive at the time of purchase. Over time, some chemicals can oxidize, become contaminated, dry out, or otherwise destabilize to become Potentially Explosive Chemicals (PEC) (e.g. isopropyl ether, sodium amide and picric acid). PECs are particularly dangerous as they may explode if subjected to heat, light, friction, or mechanical shock. The special care and procedures required for these chemicals result in high disposal costs (more than four hundred dollars for each container). Before ordering new chemicals, review the chemical's MSDS. If the material you are about to purchase is a potentially explosive material:

- Consider substituting it with less hazardous material
- Purchase the smallest amount possible
- Limit storage duration
- Share with others
- Check-Test-Timely Dispose
    - Observe expiration dates - certain chemicals deteriorate to a dangerous condition with age
    - Routinely test peroxide forming chemicals for peroxide levels
    - Inspect containers - certain chemicals may explode due to over-pressurized container

Contact UBC's Health Safety and Environment at 250-807-8621 to arrange for special disposal.

2.4 Minimize Biohazard and Biomedical Waste Stream

You can reduce the volume of bio-hazardous, biomedical, and pathological waste and hence reduce environmental impact and disposal costs by implementing the following practices:

Biomedical waste - human anatomical, blood and body fluids:

- Segregate uncontaminated solid waste from hazardous waste
- Items which may go in the uncontaminated solid waste include the following:
    - Uncontaminated gloves used to handle containers of blood or body fluids;
    - Paper towels and bench paper on which containers of blood or body fluids have been placed but did not spill; and
    - Empty specimen containers and tubing (no visible blood contamination)

Solid waste contaminated with ethidium bromide:

- Segregate solid waste from toxic waste: replace ethidium bromide with non-mutagenic non-cytotoxic dyes: SYBR Safe, Gel Green, Gel Red, Eva Green

Biohazard waste - laboratory cultures, stocks of micro-organisms, vaccines, cell cultures, and solid waste contaminated with the above:

- Segregate solid waste from hazardous waste
- Use products with less environmental impact
    - Petri dishes with 35% less plastic
    - Glass Petri dishes are 29 times more expensive than plastic, but can be cleaned and re-used 100s of times.

- Reusable, recyclable products pipette tips reloadable systems. These systems contain less packaging.
- Reusable/recyclable boxes reduce package waste by 50-80

Pathological waste - animal carcasses, tissue, fungi, insects, parasites:

- Segregate any non- hazardous solid waste from biological waste.
- Dispose non- biological solid waste through the trash.
- Pack all biological materials for incineration according to approved protocol.
- Contact HSE at 7-8621 if you have fresh uncontaminated carcasses.

2.5 Radioactive Waste Reduction

Segregate uncontaminated solid waste from radioactive waste (i.e. uncontaminated: gloves, paper towels, bench paper, empty containers and tubing)

Minimize the mixing of chemical and radioactive waste

- Substitute the chemical or the radioactive source contributing to the mixed waste.
- Use 2.5-ml scintillation vials ("minivials") rather than 10-ml vials.
- Eliminate the use of acetic acid/methanol mix for electrophoresis gel fixing when not required
- Line lead containers with disposable plastic or use alternative shielding materials, to prevent lead contamination by radioactivity.
- Use the minimum activity necessary and select the radionuclide with the most appropriate decay characteristics.
- Substitute with shorter-half-life radionuclides such as ^{32}P ($t_{1/2}$ = 14 days) for ^{33}P ($t_{1/2}$ = 25 days) in orthophosphate studies, or ^{33}P or ^{32}P for ^{35}S ($t_{1/2}$ = 87 days) in nucleotides and deoxynucleotides. In many uses, ^{131}I ($t_{1/2}$ = 8 days) can be substituted for ^{125}I ($t_{1/2}$ = 60 days).
- Use nonignitable scintillation fluid (e.g., phenylxylylethane, linear alkylbenzenes, and diisopropylnaphthalene) instead of flammable scintillation fluid (e.g., toluene, xylene, and pseudocumene).
- Use nonradioactive substitutes such as:
  - Scintillation proximity assays to substitute for ^{32}P or ^{35}S sequencing studies or ^{3}H cation assays
  - Enhanced chemiluminescence (ECL) as a substitute for ^{32}P and ^{35}S DNA probe labelling and southern blot analysis.

3. Reuse, Recycle, and In-Laboratory Treatment of Wastes

3.1 Segregation of Non-Hazardous and Non-Regulated Waste

Many laboratories do not distinguish between waste that is hazardous and waste that neither poses a hazard nor is regulated as hazardous. If these different types of waste are combined, then the total must be treated as hazardous waste and the price for disposal of the non-hazardous portion increases markedly.

When safe and allowed by regulation, disposal of ***non-hazardous*** waste via the normal trash or sewer can substantially reduce disposal costs. Additionally, treating non-hazardous wastes through the hazardous waste streams wastes energy and materials. This kind of waste segregation makes economic as well as environmental sense.

The common wastes usually not regulated as hazardous include certain salts (e.g., potassium chloride and sodium carbonate), many natural products (e.g., sugars and amino acids), and inert materials used in a laboratory (e.g., non-contaminated chromatography resins and gels).

These materials can be disposed of safely and legally in the normal trash. This includes waste that is not regulated because it does not exhibit any of the hazardous characteristics (ignitability, corrosivity, reactivity, or toxicity) as defined by BC Hazardous Waste Regulations, 2009, and is not listed as restricted or prohibited by the Kelowna Sewer Use By-law.

3.2 Reuse - find new use for old chemicals, share what you no longer need

UBC Chemical Exchange Program

The Chemical Exchange Program was developed to identify chemicals on campus that are no longer of use to the original user and to divert them from disposal. Instead, these chemicals are tracked and marketed to other potential users on campus. The latest list of available chemicals will be available on the HSE website in the spring of 2010 www.ubc.ca/okanagan/hse/environment/hazardousmaterials/chemicalexchange. Keep this site bookmarked as it will be updated as new chemicals become available.

The Chemical Exchange Program is a free service provided to the campus and not only reduces purchasing costs, but also reduces disposal costs. We encourage all labs to participate in this program.

Should you have any excess chemicals in usable condition that could potentially be utilized elsewhere on campus, please forward the chemical name, amount, grade, manufacturer to Dave Cavezza and it will be picked up during the next hazardous materials run.

HSE **cannot** accept chemicals that are:

- Open

- Past their expiry date
- Explosive
- Radioactive, or
- Required to be refrigerated

3.3 Recycle - convert used items back into raw materials, which can be used

The Okanagan Campus does not currently have a campus level recycling system for solvent wastes. If you would like to set up a lab level recycling program, or if you have any suggestions on chemicals that may be potential candidates for recycling, please contact HSE.

3.4 Implement In-Lab Chemical Waste Treatment (*)

Concerns about environmental impact, bans on landfill disposal of hazardous waste, and limited access to sewer disposal have encouraged the development of laboratory hazardous waste reduction strategies.

The small-scale treatment and deactivation of products and by-products as part of the experiment plan is one approach that can be used by researchers to address this problem at the laboratory level. In-lab waste chemical treatment reduces transport and handling risks, and reduces the cost of collecting, storing and disposing of chemical wastes.

Below are some treatment suggestions for use in the laboratory. Refer to the link at the end of this document for the full procedures. Use only the procedures specific to the waste you intend to neutralize.

With the exception of neutralization, these processes are intended for treatment of small quantities, not more than a few hundred grams. Larger quantities should be treated only in small batches*.* The generator must ensure that the procedure eliminates the regulated hazard before the products are disposed of as non-hazardous waste. In addition, if the procedure suggests disposal of the product into the sanitary sewer, it must comply with the Kelowna Sewer Use By-law (6618-90).

3.4.1 In-Lab Chemical Waste Treatment

Acids and Bases

- In most laboratories, both waste acids and waste bases are generated.
- Collect them separately and neutralize one with the other.
- If additional acid or base is required, sulfuric or hydrochloric acid and sodium or magnesium hydroxide, respectively, can be used. If the acid or base is highly concentrated, first dilute it to a concentration below 10%.
- Non-toxic neutralization products may be disposed of through the sanitary sewer.

- Toxic products such as ones containing heavy metals and toxic ions such as cyanide and sulphide should be disposed of according to approved protocols.

Thiols and Sulfides

- ☐ Small quantities of thiols (mercaptans) and sulfides can be destroyed by oxidation to a sulfonic acid with sodium hypochlorite.

Acyl Halides and Anhydrides

- ☐ Acyl halides, sulfonyl halides, and anhydrides react readily with water, alcohols, and amines. They should never be allowed to come into contact with waste that contains such substances. Most compounds in this class can be hydrolyzed to water-soluble products of low toxicity.

Aldehydes

- ☐ Many aldehydes are respiratory irritants, and some (formaldehyde, acrolein), are quite toxic. They can be oxidized to the corresponding carboxylic acids, which are usually less toxic and less volatile.

Amines

- ☐ Acidified potassium permanganate efficiently degrades aromatic amines. The mixture is then flushed down the drain.

Organic Peroxides and Hydroperoxides

- ☐ Peroxides can be removed from a solvent by passing it through a column of basic activated alumina, by treating it with indicating Molecular Sieves®, or by reduction with ferrous sulfate. (These procedures do not remove dialkyl peroxides, which may also be present)

Metal Hydrides

- ☐ Most metal hydrides react violently with water with the evolution of hydrogen, which can form an explosive mixture with air. Some are pyrophoric. Most can be decomposed by gradual addition of methyl alcohol, ethyl alcohol, n-butyl alcohol, or t-butyl alcohol to a stirred, ice-cooled solution or suspension of the hydride in an inert liquid, under nitrogen. Although these procedures reduce the hazard of reactive metal hydrides, the products from such deactivation may be hazardous waste that must be treated as such on disposal.

Inorganic Cyanides

- ☐ Inorganic cyanides can be oxidized to cyanate using aqueous hypochlorite. Hydrogen cyanide can be converted to sodium cyanide by neutralization with aqueous sodium hydroxide, and then oxidized.

Metal Azides

- □ Heavy metal azides are explosive and should be handled by trained personnel. Sodium azide is explosive only when heated to near its decomposition temperature (300°C), thus heating it should be avoided. Sodium azide should never be flushed down the drain since the azide can react with lead or copper in the drain lines to produce an azide that may explode. Azides can be destroyed by reaction with nitrous acid.

Alkali Metals

- □ Alkali metals react violently with water, common hydroxylic solvents, and halogenated hydrocarbons. The metals are usually destroyed by controlled reaction with an alcohol. The final aqueous alcoholic material can usually be disposed of in the sanitary sewer.

(*) This information was extracted from: Prudent Practices in the Laboratory (1995), National Research Council. (Online version http://www.nap.edu/catalog/4911.html)

4. Planning and Running Experiments

4.1 Experimental Design with Waste Minimization in Mind

Waste minimization in the laboratory begins at the stage of experiment planning. Measures may range from implementing basic efforts to be more efficient with experimental procedures, to completely re-designing the way experiments are performed.

Here are some ways to set up your experiments with waste minimization in mind:

- ☐ Think about the environmental consequences of your laboratory activities.
- ☐ Design your experiments to use and generate substances that possess little or no hazard to human health and the environment.
- ☐ Consider the kind and quantity of waste that will be generated and adjust the experimental design to minimize it.
- ☐ When possible replace chemicals with less hazardous materials.
- ☐ Use solvents and other hazardous materials sparingly.
- ☐ Monitor experimental reactions closely and add additional chemicals only as necessary.
- ☐ Conserve water by reducing rinse times where possible.
- ☐ Be alert for opportunities to save electricity
- ☐ Where feasible, include - as part of the experiment - a step that destroys or inactivates any hazardous products.
- ☐ If your experiment is designed at a macro scale level, try to scale it down to 1/100th or 1/1000th of the original quantities. For more information refer to:
    - National Microscale Chemistry Center (NMC2) (housed at Merrimack College)
    - National Small Scale Chemistry Center (housed at Colorado State University)
    - If you cannot convert to micro-scale, try decreasing experimental quantities by a third or one half. This can usually be achieved with conventional glassware.

4.2 Develop a Lab Specific Waste Minimization Plan

In order to develop a lab specific waste minimization plan you will need to identify:

- ☐ The type of waste disposed from your lab
- ☐ The quantity of each waste type
- ☐ The processes from which waste was generated, and
- ☐ The available reduction options

You will need to

- ☐ Review forms: your laboratory annual hazardous waste report and chemical waste inventory forms
- ☐ Identify the type and quantity of waste generated
- ☐ Identify sources generating waste: review lab processes, procedures and protocols
- ☐ Assess potential waste reduction options
- ☐ Find opportunities to reuse and recycle for each waste stream and process
- ☐ Determine the feasibility and cost benefit of suggested waste minimization measures
- ☐ Implement the most effective reduction options

4.2.1 Determine the sources of waste generated by your laboratory

Review your lab protocols and processes. For each protocol, process, operation and activity generating wastes, indicate: the waste type, the main components that cause the waste to be hazardous and the frequency and quantity of waste generated.

Lab protocol/process or activity	Waste Type[2]	Main Hazard Components	Estimated Quantity	Frequency of Waste Generation

[2] biohazard risk group 1 & 2, pathological, biomedical, sharps, solvents, chemical waste, non hazardous solid waste, non- hazardous liquid waste

4.2.2 Select waste sources for reduction, and review reduction options

- ☐ Review the above tables and choose protocols and processes for reduction.
- ☐ Look for those generating large quantities of waste or very hazardous waste; these are easy to reduce.
- ☐ Complete the following evaluation table for each process selected.
- ☐ Evaluate the potential waste minimization measures; select those applicable for the specific process.

Process or protocol selected: ____

Evaluation Criteria/ Waste Minimization Measure	Resultant Change in Amount of Hazardous Waste	Technical Feasibility	Economic Evaluation	Health & Safety Implications	Other Considerations
Process redesign					
Equipment modifications					
Process, method, technique changes					
Change in operating conditions					
Materials change					
Improve operation efficiency					
Training					
Inventory management					
Reuse					
Recycle					

4.2.3 Complete the table below by listing the selected reduction measures for each process and protocol

Protocol or Process Selected	Waste Stream for Reduction	Proposed Waste Minimization Method (S)	Expected/estimated reduction

4.2.4 Develop implementation plan including responsibilities, target dates and required resources

5. Minimize Other Environmental Impacts

5.1 Reduce Laboratory Air Emissions

UBC research can impact air quality through accidental release of toxic chemicals, ozone-depleting chemicals, emissions of volatile organic compounds, and emission of green house gases (primarily CO_2), or acid rain gases (primarily NO_x).

Although laboratory emissions are not regulated at this time, it is reasonable to expect that releases to the atmosphere should be controlled. The release of vapours to the atmosphere, via evaporation in a fume hood, for example, is not an acceptable disposal method. Apparatus for operations expected to release vapours should be equipped with appropriate trapping devices.

Fume hoods, the most common source of laboratory releases to the atmosphere, are designed as safety devices to transport vapours away from the laboratory in case of an emergency, not as a routine means for volatile waste disposal. Units containing absorbent filters have been introduced into some laboratories, but have limited absorbing capacity, and the air from these units can not be reintroduced into the laboratory.

Simple laboratory practices can minimize air emissions:

- ☐ Keep containers of volatile chemicals tightly capped .The best container seals have an even rim on the bottle and an appropriate fitting cap with polyethylene or Teflon liner.
- ☐ Minimize the number of volatile chemicals in your lab; order and store only what you need in the immediate future.
- ☐ Do not store chemicals in the fume hood.
- ☐ Keep laboratory experiments involving volatile chemicals as self-contained as safely possible.
- ☐ Redirect fume hood vapours to a common trapping device to eliminate discharge into the atmosphere.
- ☐ Keep waste solvent collection containers capped at all times, unless you are adding waste.
- ☐ Keep the amount of waste solvents in your lab to a minimum.
- ☐ Do not dispose of any chemical by evaporation; it is illegal to evaporate hazardous chemical waste for the purpose of disposal.
- ☐ Do not dispose of hazardous gases by venting. Scrub or filter experiments' hazardous emissions.

5.2 Prevent Sanitary Wastewater Contamination

Know what you may and may not discharge down the drain by consulting the Sewer Use Bylaw:

- ☐ Make sure containers of liquids are not leaking.
- ☐ Make sure laboratory equipment and experiments that create wastewater do not leak.
- ☐ Make sure liquids are stored in secondary containment: trays, sealable containers or segregated (dammed) areas, with no floor drain so that spills are contained.
- ☐ Do not dispose of any waste into a storm sewer
- ☐ If a laboratory process is connected to a water supply, do not connect it to a sewer or use contaminated or toxic liquids unless a backflow prevention device is included.
- ☐ Control and contain spill to prevent any hazardous materials from entering the sewer

5.3 Energy Saving in the Laboratory

Energy is used in nearly every process performed in the laboratory including heating, cooling (water condensers, water circulators), distillation, running of the equipment, facilitating photochemical and microwave reactions, and more. Recommendations regarding energy saving measures are listed below

Chemical Processes

- ☐ Know the actual time and temperature needed to run your reactions. Many reactions are run overnight for convenience potentially wasting energy, reagents and water.
- ☐ Determine the time required for the reaction to go to completion or to get to a maximum yield.
- ☐ Whenever possible, conduct synthetic methods at ambient temperature and pressure.
- ☐ Consider using microwave energy to power your reaction. Studies have shown microwave energy to be very efficient, using lower amounts of energy with high yields.
- ☐ Changes to process design can reduce energy input requirements (mechanical and thermal)
- ☐ Using new solvents such as supercritical carbon dioxide, greatly affects the ease of separation, lowering energy input.
- ☐ Using a catalytic system rather than a stoichiometric process lowers the activation energy required for the reaction.

Refrigeration

- ☐ Combine contents of laboratory refrigerators and freezers. Unplug unused refrigerators or freezers.
- ☐ Set temperatures as low as necessary for current lab work
- ☐ Dust coils on back of refrigerators and clean the door seal
- ☐ Replace deteriorating door seals
- ☐ Defrost units regularly

Fume hoods

A typical fume hood uses 3.5 times more energy than an average home.

- Operate hoods with sash at proper height for safety.
- Close sashes when fume hoods are not in active use.

Lab Operations

- Wait until you have a full load before running glassware washers or autoclaves.
- Turn lights off when rooms are not in use and take advantage of natural light where possible.
- Turn equipment off when not in use.
- Keep the lab door and windows shut; it helps keep the building air system in balance.
- Use energy efficient pumping systems.[3]
- Adjust blinds and window coverings on windows that receive direct sun.
- Electrical devices draw energy 24/7, even when switched off. Plug all radios, cell phone chargers, fans and other personal electronics into a power strip that can be turned off when not in use.

Purchasing Decisions that have Big Energy Impacts

- Consider adding flow restrictors to lab faucets to minimize water use (especially hot water).
- Replace old, large refrigerator/freezers with smaller, newer refrigerator-only units where appropriate.
- Purchase energy-efficient equipment. Look for the ENERGY STAR®[4] label or ask your vendor for energy usage information.

[3] Go to http://ateam.lbl.gov/Design-Guide/DGHtm/pumpingsystems.htm for more information on the efficiency of laboratory pumping systems.
[4] Go to http://www.energystar.gov/ for information on the Energy Star Program.

5.4 Water Saving in the Laboratory

Most laboratory buildings use significantly more water per square foot than standard commercial buildings do, primarily to meet their larger cooling and process loads. This greater need also provides laboratories with more opportunities to make cost-effective improvements in water efficiency.

Each of the following conservation tips can have an impact on resource conservation. Many tips cost nothing, only requiring a change in occupant behaviour.

General

- Consider reusing water where appropriate in lab processes.
- Consider recycling water from some lab machines into appropriate processes.
- Establish procedures for sampling, testing and clean up that minimize the amount of water required. Post these procedures and emphasize compliance.

Faucets

Install more efficient faucets. Consider:

- ☐ Aerators,
- ☐ Vacuum pumps rather than aspirators,
- ☐ Pressure-reducing valves, and
- ☐ Automatic sensors.

Washing and Cleaning

- ☐ Only run full loads in dishwashers.
- ☐ Consider replacing an old dishwasher with a new, more efficient model.
- ☐ Minimize the use of hoses as a cleaning tool; as an alternative, use dry cleaning method (sweep instead of hosing).
- ☐ If hoses are used, equip them with water-efficient low flow, high-pressure nozzles.
- ☐ Establish cleaning procedures that minimize the amount of water required. Post these procedures and emphasize compliance.

Equipment

- ☐ Replace old lab equipment with new, more efficient models.
- ☐ Reduce water use for laboratory equipment.
- ☐ No domestic water at a flow rate greater than 2 gallons per minute shall be used "once-through" for any laboratory equipment.
- ☐ Use closed-loop cooling water for equipment cooling instead of open-loop (once-through).
- ☐ Use vacuum pumps instead of aspirator fittings at cold-water faucets.
- ☐ Evaluate the necessity of water heaters and water softeners.
- ☐ For necessary water heaters and softeners, set backwash frequency to a lower setting.

☐ Turn off ice machines when they are not needed.

5.5 Order Green

You can reduce your environmental impact simply by the way you place your laboratory orders.

Consolidate orders

Combine purchases so that each order is $500 or more.

- Reduces multiple deliveries and greenhouse gases on campus
- Minimizes freight charges
- Saves time

Purchase multiple-item packs instead of singles

- Reduces waste from packaging materials

Increase item lines per order

- Saves paper and energy
- Reduces multiple shipments

Purchase as many lab supplies as possible from one source

e.g. buying PCR enzymes, bundle with tubes, pipette tips, bench covers, etc.

- Provides a way to consolidate orders

Place orders/do transactions online / save receipts electronically

- Eliminates paper waste
- Reduces order processing time
- Minimizes ordering mistakes

Support institutional supplier consolidation initiatives

☐ Avoid multiple shipments from multiple vendors
☐ Eliminates loss of potentially hazardous materials via common couriers

Avoid air shipments where possible

☐ Reduces CO_2 emissions
☐ Avoids expensive freight charges

Support our Partners in Sustainability

☐ In turn, they support the university in providing green alternatives and funding to green research initiatives.

6. Appendices

6.1 Waste Minimization Checklist

The following checklist is designed to help you minimize the amount of waste generated in the laboratory. The list is not all-inclusive, but should serve as a starting point for your efforts.

Purchasing Chemicals

Develop a purchasing strategy for chemicals and other hazardous materials.

- ☐ Purchase chemicals in smaller container size.
- ☐ Standardize chemical purchases across classes or laboratories.
- ☐ Designate a single person to be responsible for purchasing chemicals and monitoring inventories.
- ☐ Link purchasing requests into an inventory system so that excess chemicals in stock can be used before buying more.

Managing Chemical Inventories

- ☐ Have an up to date chemical inventory of your lab chemicals.(Mandatory WHMIS requirement)
- ☐ Designate a centralized place for chemical storage and another for waste storage, with spill containment.
- ☐ Organize your chemical and waste storage systematically to keep like chemicals together.
- ☐ Use a first-in/first-out policy.
- ☐ Return expired material to supplier.
- ☐ Perform regular inventory audits to identify chemicals that aren't being used.

Preventing Spills and Leaks

- ☐ Keep chemicals and waste containers closed to prevent spills.
- ☐ Install spill and leak protection in chemical storerooms.
- ☐ Anchor storage cabinets to walls and floors.
- ☐ Periodically inspect stored chemicals for signs of leakage (liquid or vapour), poor storage practices, or any other problems.
- ☐ Keep a record of spills and leaks and note why they happened and how they can be avoided in the future.

Scaling Down Experiments

- ☐ Reduce scale of experiment (and associated quantities of chemicals) where possible.

Substituting Materials

- ☐ Substitute hazardous materials with safer chemicals.
- ☐ Use non-halogenated rather than halogenated solvents.

Finding Alternatives to Wet Chemistry

- ☐ Substitute computer simulations, videos, etc. for actual experiments.
- ☐ Use alternatives to solvent-based extraction.
- ☐ Use instruments in place of wet chemistry (e.g., chromatography, spectrophotometry, NMR, X-ray).

Reusing and Recycling

- ☐ Set up an internal surplus chemical exchange.
- ☐ Reclaim solvents in the lab
- ☐ Recycle or re-use solvents when possible. Look for common use of chemicals where the use of partially spent chemicals will not affect the final outcome.

Set up experiments with waste minimization in mind

- ☐ Use solvents and other hazardous materials sparingly.
- ☐ Monitor reactions closely and add only what's needed.
- ☐ Conserve water, electricity and other general resources.
- ☐ Use spent/recovered solvents for an initial rinse and fresh solvents for a final rinse.

Include final steps in experiments to destroy or inactive hazardous substances

- ☐ Neutralize acids and bases.
- ☐ Perform chemical conversions to non-hazardous substances.
- ☐ Use laboratory detergents rather than hazardous cleaning baths
- ☐ Filter spent solvent for reuse
- ☐ Distil spent solvents on-site.

Segregate Individual Waste Streams

- ☐ Keep organic waste separate from inorganic waste.
- ☐ Keep different groups of solvents separate (e.g., halogenated vs. non-halogenated solvents).
- ☐ Keep incompatible materials separated (ignitable and oxidizers; acids and bases; oxidizers and reducers, etc.).

Develop and Implement Lab Specific Waste Minimization Plan

- ☐ Review operations, implement reduction measures appropriate to your lab waste streams
- ☐ Attend the annual Green Research Workshop
- ☐ Review the quarterly Green Research news letter
- ☐ Apply for the Green Research award

Section B – Laboratory Hazardous Waste Management

1. Introduction

This manual has been prepared by the UBC Department of Health, Safety and Environment (HSE) and modified in the Okanagan to reflect the local environment. It provides information on the proper methods for the disposal of hazardous waste. Improper disposal of hazardous wastes can be harmful to the environment and humans, and is therefore governed by strict local, provincial, and federal regulations as well as UBC policies and procedures.

HSE in the Okanagan manages and handles the hazardous waste generated by UBC core research, education and operational activities in accordance with local, provincial, and federal regulations. For more information, please visit the HSE website at www.ubc.ca/okanagan/hse; further contact information is also available on our site.

1.1 Disclaimer

This manual is intended for use by those who produce hazardous waste as a result of their work at the University of British Columbia. The material contained in this manual is correct to the best of knowledge of the UBC Department of Health, Safety and Environment. The disposal procedures are compliant with applicable local, provincial, and federal legislation.

Updates to procedures are made occasionally. If you use procedures older than two years, please check with HSE for the most current update.

1.2 Health, Safety and Environment Contacts

Shelley Kayfish	Manager, Health Safety & Environment	250.807.8621
Dave Cavezza	HSE Associate	250.807.8821
Cherie Michels	HSE Advisor	250-807-8656

1.4 Hazardous Materials Management at the Okanagan Campus

HSE cannot manage or handle the following, and therefore, this procedure does not include:

- Unknown solid or liquid chemicals (Refer to "Disposal of Unknown Chemicals" UBC.HSE.ENV.017.PRO for further instructions);
- Compressed gases, send returnable cylinder to supplier, contact HSE for further information on disposal of lecture bottles.
- Explosives and potential explosives (Refer to "Disposal of Explosive Chemicals" UBC.HSE.ENV.005.PRO)
- Radioactive chemicals (please refer to Appendix E for further instructions)

1.5 Permissible Generators

HSE only handles and manages materials which originate from generators and independent companies affiliated with UBC activities. Waste generators must register with HSE. Approved waste generators will be assigned a waste generator number that is to be associated with all shipments of waste originating from their respective locations.

1.6 Acceptable Waste Types

General waste classifications permitted at the facility are as follows:

Class 2.1 – Flammable Gas (propane & butane only)
Class 3 – Flammable and Combustible Liquids
Class 4
  Class 4.1 – Flammable Solid
  Class 4.2 – Spontaneously Combustible
  Class 4.3 – Dangerous When Wet
Class 5 – Oxidizing Substances
  Class 5.1 – Oxidizer
  Class 5.2 – Organic Peroxide
Class 6 – Poisonous (toxic) substances and infectious substances
  Class 6.1 – Toxic
  Class 6.2 – Infectious
Class 8 – Corrosive substances
Class 9 – Miscellaneous products

2. General Waste Procedures

All wastes sent to the facility must be accompanied by waste identification information as summarized below. If you have any questions, please contact HSE or visit our webpage at www.ubc.ca/okanagan/hse.

a. **Flammable Liquids**: All transport of solvent wastes must be accompanied by a serialized Flammable Liquids Disposal tag (obtained from ESF) attached to each container. The generator barcode sticker (obtained from ESF) must be affixed to the tag and the waste composition completed.
b. **Waste Chemicals**: All shipments of chemical wastes must be accompanied by a completed Chemical Waste Inventory Form (approved forms are e-mailed to generators by ESF technician). This inventory must identify the generator, their location, phone number and the chemicals to be disposed and its hazard class.
c. **Bio-hazardous Waste:** All transport of bio-hazardous waste must be accompanied by a Biological Waste Disposal tag (obtained from ESF) attached to each bag. A generator barcode sticker (obtained from ESF) must be affixed to the tag and the waste composition completed.

2.1 Solvent Recovery

Currently, solvents are not recovered at the campus level, but this may change in future. If you would like to recycle or recover solvents in your own lab, please contact HSE for further information.

2.2 Chemical Exchange Program

The Chemical Exchange Program was developed to share chemicals on campus that are no longer of use to the original user and divert them from disposal. Instead, these chemicals are tracked and marketed to other potential users on campus. This is a free service provided to the campus and not only reduces purchasing costs, but also disposal costs.

2.3 Other Recycling Programs

Recycling programs for batteries, oil, and paint, are available through HSE. If you have an idea for recycling or reusing other materials, please contact HSE.

2.4 Hazardous Waste Pickup

HSE picks up hazardous waste weekly, usually on Wednesdays. Due to operational requirements pick-ups are sometimes shifted to other days. Ensure that wastes are clearly labelled, tagged, and packaged appropriately to ensure that they are picked-up. Leave wastes in a prearranged location that is clearly marked and secure from the general public.

If you have waste that requires disposal, please contact Dave Cavezza to ensure that your lab is added to the next waste run.

3. Frequently Asked Questions

1. What types of waste does the HSE handle?

HSE only disposes of hazardous wastes produced by registered waste generators. Non-hazardous wastes (such as garbage, glass, scrap metal and wood, packaging, etc.) are handled by facilities.

2. What are UBC hazardous waste tags and generator barcode stickers and how do I get them?

For solvent and biohazard waste UBC implemented a serialized, color coded, tag system that identify the type of waste and allow for tracking of the specific waste package or container. The barcode sticker is a self adhesive label that must be affixed to the UBC Hazardous Waste Tags on each container of waste. The barcode allows HSE to identify the Hazardous Waste Generators for waste tracking and legal purposes. In order to register as a UBC Hazardous Waste Generator and receive barcode stickers, tags, or waste containers, contact Dave Cavezza at 250-807-8821 or dave.cavezza@ubc.ca.

3. How should I dispose of pharmaceutical drug waste?

HSE does handle pharmaceutical drug waste as per the requirements of Disposal of Biomedical Waste (UBC.HSE.ENV.002.PRO) in this manual.

4. What should I do with **empty** solvent bottles?

Empty bottles should be defaced of their original label and they should be triple rinsed and dried. After defacing there are 2 choices for empty solvent bottles: (1) Use the bottle to collect waste solvents for disposal or (2) notify HSE who can re-use them to collect waste in another laboratory.

5. What should I do with liquid phenol-contaminated waste?

If you need to dispose of phenol-contaminated glass waste, you must triple rinse the glass carefully with an organic solvent and dispose of the glass as laboratory glass waste. However, the rinsate must be put into a solvent waste can and disposed of as an organic solvent according to the procedure outlined in this manual (Disposal of Organic Solvent Waste, UBC.HSE.ENV.012.PRO). If you need to dispose of another material that has been contaminated with phenol, contact HSE.

6. What are the procedures governing the disposal of propane cylinders?

For information on how to dispose of empty propane cylinders, refer to Disposal of Propane and Butane Gas Cylinders (UBC.HSE.ENV.015.PRO) or call HSE.

Section C –Hazardous Waste Disposal Procedures

Information
If you do not have access to any materials, labels or databases listed in this document, please contact HSE. As this is printed information, it will become dated with time. For the most current information visit our webpage on hazardous materials management at www.ubc.ca/okanagan/hse/environment/hazardousmaterials.html.

1.0 Procedures for the Disposal of Biohazardous Waste

1.1 Scope

This procedure applies to biohazardous agents in Risk Groups 1 and 2, which may include the following components:

1. Cultured animal cells and the potentially infectious agents these cells may contain;
2. Micro-organisms including Bacteria, Viruses, Fungi, Rickettsiae and Chlamydiae;
3. Parasites;
4. Allergens;
5. Extracted tissues from experimental animals including animal dander;
6. Plant viruses, bacteria and fungi;
7. Toxins (bacterial or plant); and,
8. Pathological Waste (animals or animal tissue in whole or in part).

With the exception of pathological waste, materials that have come in contact with the above agents may also be considered biohazardous.

This procedure does **NOT** apply to the disposal of **biomedical waste**, which consists of human anatomical parts, or human blood and body fluid and Risk Group 4 agents, as defined in the Laboratory Biosafety Guidelines, 3rd Edition 2004, published by Health Canada. Refer to the "Disposal of Biomedical Waste" procedure in this document

1.2 Purpose

This procedure specifies the safe and proper disposal of the biohazardous materials classified above, in accordance to federal and municipal guidelines.

1.3 Background

- In contrast to chemical agents, infectious biological agents have the ability to replicate, thus giving rise to the potential of large populations in nature when small numbers may be the norm.
- Unlike chemicals, where "safe" levels are often allowed to be released into the environment, there is no "safe" level of an uncontained pathogenic organism. This procedure follows the guidelines set by the UBC Laboratory Biosafety Guidelines. Please consult the Biosafety Guidelines for further details on definitions, procedures and

management of biohazardous materials and Risk Group classifications (or contact the HSE at (250) 807-8656).

- Disposal of untreated biohazardous waste to landfills is prohibited by the BC Hazardous Waste Regulations, 2009 and the Kelowna By-Laws.
- The transportation of untreated biohazardous materials is regulated by Section 5 of the Environmental Management Act, 2003, and by the Transportation of Dangerous Goods Regulations, 2009.
- In general, biohazardous organisms MUST be rendered harmless by autoclaving before being released into the environment.

1.4 Procedure

1. Laboratory waste that is NOT biohazardous, as defined in this procedure, can be disposed of in the regular garbage.
2. Proper segregation of biohazardous versus non-biohazardous waste is essential in reducing the volume and the cost of handling biohazardous waste.
3. Please do not include the following items in the biohazardous waste stream, which requires autoclaving:
   a) Wrappers and packaging material from laboratory supplies
   b) Plastics and lab ware that have not come into contact with biohazardous agents, as defined in the scope of this procedure.
4. Polyvinyl Chloride (PVC) materials produce hydrogen chloride during degradation that may be harmful to the environment. It is highly recommended that substitutes for PVC products be used at all times.

Waste Containing Risk Group 1 Agents

Risk Group 1 Agents are considered by Health Canada to be of low individual and community risk (If you have any questions, please contact the HSE at (250) 807-8656.

1. All Risk Group 1 waste **MUST** be contained in **CLEAR** and **UNLABELLED** autoclave bags. Bags **MUST NOT** be marked with any biohazardous warning symbols or warning labels. The bags **MUST** then be autoclaved sufficiently to render the organism in question harmless. Autoclaved bags **MUST** be leak proof. To prevent leaks and breakage during storage or transportation, **double bagging** with a clear plastic bag is required.
2. Each bag must not weigh more than 10 kg.
3. Do **not** put glass or sharps in with Risk Group 1 waste.
4. After autoclaving, bags must be tagged with the UBC Biological Waste Disposal tag (Red). Affix your waste generator number sticker where indicated. On the tag, check the box marked “Autoclaved Risk Group 1” and notify HSE that you have waste for pick-up on the Hazardous Materials Webpage.

Waste Containing Risk Group 2 Agents

Risk Group 2 Agents are considered by Health Canada to be of moderate individual and limited community risk.

All Risk Group 2 waste **MUST** be contained in **ORANGE** autoclave bags (Bags may be purchased from any laboratory supplies vendor). The bags **MUST** then be autoclaved sufficiently to render harmless the organism in question. Autoclaved bags must be leak proof. To prevent leaks and breakage during storage or transportation, double bagging is required.

1. HSE must be able to package the **ORANGE** bag into a box (length – 22", height – 22", width – 22") from our disposal supplier. Therefore, the maximum size of the bags must be smaller than the aforementioned box dimensions.
2. Each bag must not weigh more than 10 kg.
3. Do not put glass or sharps in with Risk Group 2 waste.
4. Bags must be tagged with the Biological Waste Disposal tag (Red), Affix your waste generator number sticker where indicated. On the tag, check the box marked "Autoclaved Risk Group 2" and notify HSE that you have waste for pick-up on the Hazardous Materials Webpage.

Pathological (Anatomical Animal) Waste

1. Collect anatomical animal waste in a red Biohazard bucket. All tubing, catheters, plastic clips, tags, etc. must be removed from the animal before packaging.
2. Buckets MUST be tagged with the UBC Biological Waste Disposal tag (Red). Affix your waste generator number sticker where indicated. On the tag, check the box marked "Pathological" or "Uncontaminated Pathological Animal" and put in the freezer.
3. Notify HSE that your have waste for pick-up by contacting HSE from the Hazardous Materials Webpage.

2. Procedures for Disposal of Biomedical Waste

2.1 Scope

This procedure describes the handling, packaging and treatment required by the HSE for disposal of your biomedical waste.
Biomedical waste at UBC includes the following components:

- Human anatomical;
- Human blood and body fluids; and
- Blood of other animals.

NOTE: This procedure does not apply to:

- Primate Anatomical Waste. (Refer to Disposal of Non-Human Primate Pathological Waste UBC.HSE.ENV.009.PRO).
- Animal bedding.
- Disposal of Sharps and Needle Waste (Refer to UBC.HSE.ENV.016.PRO).

2.2 Purpose

This procedure specifies the requirements for the handling and disposal of biomedical waste in accordance with legislation and best practice.

2.3 Background

This procedure was adopted from Guidelines for the Management of Biomedical Waste in Canada, written by the Canadian Council of Ministers of the Environment in February 1992. These guidelines define what biomedical waste is, and how it should be handled.

2.4 Procedure

A. Biomedical Waste
The procedure for the disposal of biomedical waste is as follows:

1. All biomedical waste **MUST** be contained in autoclavable **RED** buckets bearing the **biohazard** symbol, which can be obtained from HSE.
2. Biomedical Waste should be frozen until it is picked-up for disposal by HSE.
3. Complete all the required information on the Biological Waste Disposal Tag, affix the barcode sticker, check the appropriate box, and fill out all requested information. Affix the tag to the bucket.
4. Notify HSE that your have waste for pick-up by contacting HSE from the Hazardous Materials Webpage.

3. Procedures for Disposal of Non-Indigenous Species

3.1 Scope

This protocol is applicable to all departments and administrative units with laboratories where non-indigenous species are used for research purposes.

Non-indigenous species can be defined as:

> Species that are not native (indigenous) to an area and have been introduced through human activities either on purpose or by accident. The term includes targeted species of organisms whether from a distant or nearby source. Although a species of organism may occur naturally at a UBC site, the introduction of foreign populations of the same species can have a negative impact on local populations. Therefore, these organisms are also regarded as non-indigenous.

Materials that may contain non-indigenous species include:

- Soils – all types;
- Single pass and re-circulating fresh and saltwater cooling or aquarium systems;
- Animal bedding materials;
- Algae and plants;
- Terrestrials and aquatic plants and animals including those on baits, nets and sampling equipment;
- Cultured organisms, microorganisms, plants and animals; and,
- Cloned and genetically altered organisms – all types.

3.2 Purpose

To provide a series of protocols for the disposal of non-indigenous organisms or material containing or potentially containing these organisms

3.3 Background

Numerous species and clones of microorganisms, plants, soils, animals, and animal bedding materials are used in research projects and in student laboratories at the University of British Columbia (UBC). Many are not native to this area and are classified as "Non-Indigenous" or "Exotic". Currently, there is very limited regulation of non-indigenous species or biological materials (which have the potential to introduce them). Many potential non-indigenous species are tolerated in a wide range of environments and when accidentally or intentionally introduced, have the ability to colonize and displace existing native species. Since indigenous species are essential in maintaining a healthy, balanced ecosystem, non-indigenous species have the potential to cause significant ecological or financial damage.

There are many examples which clearly demonstrate the extensive damage that non-indigenous invaders may have on an ecosystem, such as purple loosestrife and zebra mussels. Purple loosestrife, introduced during the 19th century, made an explosive migration across the continents through marshy environments, displacing many native plants. Zebra mussels introduced in the mid 1980s into Lake St. Claire caused extensive damage by clogging intake and outlet pipes used by municipalities, industries and electrical utilities. Examples such as these have resulted in increased regional, national, and international concern about the effects of non-indigenous species. As a result UBC has established a series of protocols for the disposal of non-indigenous organisms or material containing or potentially containing these organisms.

3.4 Procedure

Disposal of non-indigenous species will be considered as Risk Group 2 Agents with moderate individual and limited community risk.

1. All Risk Group 2 waste **MUST** be contained in **ORANGE** autoclave bags (bags may be purchased from any laboratory supplies vendor).
2. The bags **MUST** then be autoclaved sufficiently to render the organism in question not viable. Autoclaved bags must be leak proof. To prevent leaks and breakage during storage or transportation, double bagging with a clear plastic bag is required.
3. Do not put glass or sharps in with Risk Group 2 waste in these bags.
4. After autoclaving, bags must be tagged with the UBC **Biological Waste Disposal tag (Red).** Affix your waste generator number sticker where indicated. On the tag, check off the box marked "**Autoclaved Risk Group 2**".
5. Notify HSE that your have waste for pick-up by contacting HSE from the Hazardous Materials Webpage. Store bag in a conspicuous and well labelled location until it is picked up.

4. Disposal of Sharps and Needle Waste

4.1 Scope

This procedure applies to the disposal of sharps and needles that may be uncontaminated or contaminated by biohazardous agents.

Sharps and needle disposal may include the following components:
- Sharp metal cutting blades (e.g. scalpels); and,
- Needles.

Additional information is provided below for the disposal of syringe bodies without a needle, but they are not considered sharps.

4.3 Purpose

This procedure specifies the method for proper disposal of sharps and needles to ensure the safety of disposal workers.

4.4 Background

Disposal of sharp and needle waste to landfills is prohibited by the City of Kelowna and under the BC Hazardous Waste Regulation 2009.

4.5 Procedure

<u>1.0 Sharps and Needles</u>
Sharps and needles present both a physical and potentially infectious hazard. To control these hazards, sharps and needles **must** be collected in **APPROVED** red or yellow containers made of a hard impervious plastic that is both autoclavable and acceptable for incineration. They **must** be labelled with a bio-hazardous label on the outside. These containers can be purchased from a laboratory supplier. Only APPROVED containers may be used for these wastes. These containers must not be used for any other purpose. The containers must comply with AS/NZS 4261 [eg. BUNZLE (needles only), or SHARPSAFE types].

Sharps and needles disposal procedures are as follows:
1. Collect all sharps and needles in **approved plastic** "sharps containers".
2. Do not fill the container past the indicated "Full" line.
3. Chemically decontaminate all infectious items prior to disposal into the container or, autoclave the entire container once it is full. Do not autoclave chemically contaminated sharps.
4. Securely close and snap the lid in place.
5. Affix Biological Waste Tag (available from HSE) and check box labelled Sharps.
6. Notify HSE that your have waste for pick-up by contacting HSE from the Hazardous Materials Webpage.

7. Ensure that the container is clearly labelled and left in a secure well labelled location.

   Note: sharps containers MUST NOT be placed into the "Glass Waste Only" cans; they are to be taken to the building's designated area for hazardous waste disposal.

2.0 Disposable Plastic Syringes

1. Syringe bodies (with needles removed) can be collected and treated according to the risk group that they contained (e.g. if the syringe was used to inject or remove blood, it should be treated as a waste contaminated with blood and bodily fluids. A syringe that was used to inject chemicals into a scientific experiment should be treated as a chemically contaminated waste.

5. Procedure for Disposal of Ethidium Bromide Waste

5.1 Scope

The following procedure describes waste disposal and treatment for solid ethidium bromide in gels and ethidium bromide solutions.

5.2 Purpose

Ethidium bromide is considered a mutagen and must be neutralized and/or disposed of properly.

5.3 Procedure

1.0 Solid Waste Contaminated with Ethidium Bromide

1. Collect solid ethidium bromide waste in a thick plastic bag ensuring there is no liquid present
2. Double-bag materials.
3. Place double-bagged waste into heavy duty cardboard or Styrofoam box.
4. Affix Biological Waste Tag (available from HSE) and check box labelled Cytotoxics.
5. Notify HSE that your have waste for pick-up by contacting HSE from the Hazardous Materials Webpage. Store bag in a conspicuous and well labelled location until it is picked up.

2.0 Contaminated Liquid Waste

There are three methods for disposing of liquid ethidium bromide waste. This material is mutagenic and must be handled with care.

Method 1[5]

An aqueous solution is diluted to less than 0.5 mg/ml ethidium bromide. For each 100 ml of diluted aqueous solution, add 20 ml of 5% hypophosphorous acid (made by diluting commercially available 50% hypophosporous acid in water 1:10) and 12 ml of 0.5M sodium nitrate. Stir briefly to mix and leave it to stand for 20 hours. Finally, neutralize with sodium bicarbonate before discarding.

If the ethidium bromide is in an organic solvent like isopropanol, for each volume of ethidium bromide add 4 volumes of a decontaminating solution (e.g., 4.2 g sodium nitrate, 20 ml hypophosphorous acid (50%) in 300 ml H_20). Stir for 20 hours. Neutralize with sodium bicarbonate before discarding. The solution should now be ready for safe sewer disposal.

[5] Lund & Sansone, Anal. Biochem. 162:453-458, 1987.
2 Dr. G. Spiegelman, Waste Watchers (HSE at UBC), vol 1, #1, p.3, June 1994

If the ethidium bromide is in butanol, the same decontaminating solution which was used for isopropanol can also be used, but it must be stirred for 72 hours. Then add 2g activated charcoal for each 100 ml, stir for 30 minutes, and filter. Again neutralize with sodium bicarbonate; separate the layers and discard. The solution should now be ready for safe sewer disposal. **Remember that the solvent containing activated charcoal is a hazardous waste; see above Section 1.0, Contaminated Solid Waste.**

Method 2

Very dilute solutions of ethidium bromide can be destroyed by treatment with household bleach. To convert ethidium bromide to the physiologically inactive product 2-carboxybenzophenone, stir the ethidium bromide solution with household bleach for 2 hours. For a solution containing 0.5 mg/ml of ethidium bromide use 440 ml of bleach for each 100 ml of solution. This should render the solution non hazardous and safe sewer disposal.

Method 3

Specialized filters can be used to extract ethidium bromide and other fluorescent dyes from aqueous solutions. Pour dilute solutions of ethidium bromide into the filter system, and turn the vacuum on. The ethidium bromide solution filters through the cartridge and the hazardous molecules are permanently trapped in the reusable cartridge. The filtered liquid can then be safely disposed of down the drain. When saturated, cap and dispose of the used cartridge and place a new filter into the system.

The used cartridge is still **highly contaminated** and will need to be further treated as contaminated solid waste. Refer to, Section 1.0 Contaminated Solid Waste, for steps on how to properly dispose of used cartridges.

One type of filter is BondEx Ethidium Bromide & SYBR Green Detoxification Cartridges. For more information about this particular filter, contact Clontech Laboratories at 1-800-662-2566.

It has been shown[6] that when ethidium bromide solutions of these dilute concentrations are used, the product solution does not show excess mutagenicity over standards in the Ames test and therefore can be classified as non hazardous.

For more information on liquid ethidium bromide waste procedures contact HSE (807-8621).

[6] Hazardous Waste Minimization in the Academic Laboratory, Dr. M. Armour, Networking News, ACS, Sept 94, vol.8 #2, p.5.

6. Procedure for Disposal of Laboratory Glass Waste

6.1 Scope

This procedure applies to disposal of glass that is contaminated by biohazardous materials, biomedical agents, or other chemical waste.

Glass waste includes the following:
1. Glass bottles
2. Pipettes
3. Other glassware
4. Broken glassware

6.2 Purpose

This procedure specifies the method for proper disposal of glass waste to ensure the safety of disposal and laboratory workers.

6.3 Background

Disposal of contaminated glassware waste to landfills is prohibited by the City of Kelowna, and under the BC Hazardous Waste Regulation, 2009.

6.4 Procedure

Only APPROVED containers may be used for these wastes; containers are supplied by HSE upon request by calling Dave Cavezza at 250-807-8821. These containers must not to be used for any other purpose.

Approved Glass waste containers: white plastic pails and red biohazard buckets. All containers must be clearly labelled as **"Glass Waste Only"**. Unbroken glass bottles and containers do not need to go into the containers unless they are contaminated with risk group 2 biohazardous materials.

Disposal of glass waste is as follows:
- If **contaminated with risk group 1 biological materials**, decontaminate by autoclaving and treat as regular laboratory glass waste;
- If **contaminated with risk group 2 biological materials**, decontaminate by autoclaving and place in red biohazard buckets. Contact HSE if you require a biohazard bucket for this purpose.
- If **chemically contaminated or uncontaminated**, place broken, sharp or small glass pieces in the supplied white buckets. If bottles or containers are unbroken, triple rinse, dry and place next to the white buckets. Be sure to deface the label on

containers placed next to the buckets to indicate that they have been cleaned and are ready for pickup.

In general:

1. Decontaminate as required.
2. Clean completely of residues, including organic vapours and chemicals
   - leave bottles of organic solvents in a fume hood for at least one day
   - rinse other reagent bottles well with cold water
3. Remove or deface all labels and hazard warnings.

6. Once glass waste container is full, notify HSE that your have waste for pick-up by contacting HSE from the Hazardous Materials Webpage. Store bag in a conspicuous and well labelled location until it is picked up.

7.0 Procedure for Disposal of Laboratory Chemical Waste

7.1 Scope

This disposal procedure applies to hazardous laboratory chemicals in solid or liquid form which can be managed by HSE. Hazardous laboratory chemicals may include the following:

- Waste Containing Polycyclic Aromatic Hydrocarbons;
- Flammable Liquids;
- Spontaneously Combustible;
- Dangerous When Wet;
- Oxidizer;
- Waste Batteries;
- Poisonous Substances – Toxic;
- Infectious Substances;
- Corrosives;
- Misc. Dangerous Goods;
- Environmentally Hazardous Substance;
- Waste Containing Tetrachloroethylene;
- Waste Oil;
- Waste Pest Control Products; and,
- Leachable Toxic Waste.

7.2 Purpose

This procedure ensures that chemicals are identified according to their chemical hazards and compatibilities, and then packaged safely for transportation.

7.3 Background

- Chemical packaging classes are based on the Transport Canada Transportation of Dangerous Goods Regulations, 2008, substances classification.
- Chemicals are classified as hazardous or nonhazardous according to the BC Hazardous Waste Regulations, April 1, 2009.
- Disposal of hazardous chemicals in the sewer or landfill is prohibited by is prohibited by the City of Kelowna and under the BC Hazardous Waste Regulation 2009.

7.4 Procedure

IMPORTANT NOTE: HSE cannot dispose of certain chemical substances, and therefore, this procedure does not include:

- Unknown solid or liquid chemicals
- Gas cylinder and lecture bottle
- Radioactive chemicals

HSE reserves the right to refuse handling and disposal of improperly packaged and unidentified chemicals.

1. All chemicals for disposal must be pre-approved for disposal through the Hazardous Materials Webpage. Generator contact information and full chemical names (no abbreviations) listed as percent composition of the waste, must be provided.
2. The waste will then be approved for pick-up by HSE and will be included in the next hazardous waste run.
3. Attach the Flammable Liquid Disposal identification tag for all chemical wastes (even those that are not flammable). Mark the contents on the tag being as specific as possible. Cross out the flammable symbol and the word "flammable" If the chemical is not a flammable.
4. Keep wastes in clearly marked bottles and in a consistent location to ensure that they are picked-up on schedule.
5. At the Okanagan campus, each lab is permitted 25L container size of flammable materials in the lab which includes wastes. Materials stored in a flammable cabinet are excluded from this limit. Store flammable wastes in the flammable cabinet if available.

8. Procedures for Disposal of Mercury Waste

8.1 Scope

This procedure applies to the disposal of mercury waste, such as:

- Thermometers, barometers and manometers (broken or unbroken); and,
- Mercury spill cleanup.

8.2 Purpose

This procedure specifies the proper disposal of mercury waste in order to ensure the safety of workers and staff, and in order to be compliant with the BC Environmental Management Act, 2003 and the BC Hazardous Waste Regulation, 2009.

8.3 Background

Waste mercury is regulated as Class 8 Corrosive and Class 6 Toxic Substance, as defined by the Transportation of Dangerous Goods Regulation, 2009.

The Kelowna Sewer Use Bylaw and the BC Hazardous Waste Regulation, 2009 prohibits the discharge of waste mercury into sewers or landfills.

Any spills of mercury into the outside environment (land, air, water, and sewer) must be reported to the Provincial Emergency Program (PEP). Spills contained within the lab need not be reported to PEP. For more information, see Environmental Reporting Procedures (August 2009).

8.4 Procedure

<u>1.0 Mercury Thermometers (Unbroken or Waste)</u>
If no mercury has spilled and the thermometers are intact, put into a glass or plastic bottle. Label the bottle "Mercury Thermometers for Disposal". Request for disposal through HSE's hazardous materials webpage.

<u>2.0 Broken Mercury Thermometers or Mercury Spills</u>

1. Report the spill to a supervisor; if necessary, contact HAZMAT (911) for immediate assistance and Health, Safety and Environment (250) 807-8821 for further assistance.
2. Evacuate all personnel from the area if spill is large, the room is small, and ventilation is poor.
3. If you are going to participate in the cleanup, wear appropriate personal protective equipment such as lab coat, gloves (rubber, latex, or vinyl), plastic boot protectors, splash goggles and a half-mask respirator with an approved cartridge for mercury vapours (HAZMAT may determine that self contained breathing apparatus may be required if spill is large, temperature is elevated, and/or site of spill is in an enclosed

space with poor ventilation). Note: you must have completed an annual fit test within the last 12 months, and received the proper training in order to wear a respirator.

4. Ventilate area as much as possible (i.e. open all windows).
5. Mark off spill area with signs, barriers, or tape.
6. If spill is on a flat, even, smooth surface, use two pieces of firm, straight edge paper, or plastic and slowly guide the droplets together into a pool.
7. Use a glass pipette with rubber ball to suck up the mercury and collect it in the smallest possible size bottle (glass or plastic) with a tightly fitting lid. Label the bottle "Mercury Waste."
8. For picking up tiny droplets on uneven surfaces, use Merconvap wipes. For tiny droplets in cracks, pieces of metallic zinc rinsed in 10% Hydrochloric acid (HCl) can be used. Run the zinc along the cracks and touch visible droplets directly. Add used Merconvap wipes and zinc pieces to "Mercury Waste" bottle.
9. To neutralize unreachable mercury in crevices, etc., drizzle area with sulfur flour or spray with Merconvap.
7. Ensure that any consumable materials used in the clean-up are contained in a sealed bottle or bag and sent to HSE for disposal. Notify HSE that your have waste for pick-up by contacting HSE from the Hazardous Materials Webpage. Store bag in a conspicuous and well labelled location until it is picked up.
10. List "Waste Mercury" under chemical name when registering waste for pick-up.

9. Procedure for Disposal of Organic Solvent Waste

9.1 Scope

This procedure applies to organic solvent classified as Class 3 Flammable Liquids or Class 6.1 Toxic Substances by the Canada Transportation of Dangerous Goods Regulations, 2009.

9.2 Purpose

Most organic solvents are flammable and toxic. Waste solvents must be contained and segregated properly for disposal such that they do not pose a safety hazard during transportation or storage.

9.3 Background

Organic solvents may be classified as Class 3 Flammable Liquids or Class 6.1 Toxic Substances as defined by the BC Hazardous Waste Regulation, 2009.

The Kelowna Sewer Use Bylaw prohibits the disposal of a hazardous substance (such as organic solvents) in the sewer.

9.4 Procedure

NOTE: The flammable load of a lab cannot exceed 25 litre container size. Wastes are included in this limit. If possible store flammable wastes in a ULC rated flammable cupboard.

1. Wherever possible re-use clean solvent bottles to hold solvent waste. If you need waste bottles please contact HSE.
2. Segregate as much as possible. Diligent segregation reduces costs and unnecessary treatment. Segregation will allow HSE to develop future recycling and re-use programs based on the wastes produced.
    a. If possible, do not mix halogenated and non-halogenated solvents together.
    b. Do not mix oil with the waste solvents.
    c. Do not pour acid, sludge, grit, glass, plastic, paper, or inorganic chemicals, into the waste solvents.
3. Affix the tags to the appropriate containers.
4. Collect detailed information as to the composition of wastes (% of each component – name each chemical). For simplicity record this information on the back of the waste tag and classify wastes for the front once the bottle is full. Identify/classify all materials in the containers.
5. Notify HSE that your have waste for pick-up by contacting HSE from the Hazardous Materials Webpage.

6. Store labelled wastes in a secure and clearly labelled location until it is picked up on the next waste pick-up.

10. Disposal of Photographic Waste

10.1 Scope

This disposal procedure applies to waste solutions of photochemical fixer, stabilizer, and developer.

10.2 Purpose

This procedure ensures that photochemical wastes are segregated and stored properly.

10.3 Background

Disposal of photochemical waste without treatment in the sewer or landfill is prohibited by the Kelowna Sewer Use Bylaw and BC Hazardous Waste Regulations 2009.

Photochemical waste solutions are classed as "corrosive" and may contain levels of silver in excess of BC Hazardous Waste Regulations, 2009.

10.4 Procedure

1. Collect photochemical wastes in a HSE approved container (contact HSE to obtain a container).
2. Separate containers must be used for **fixer** and **developer**.
3. Do not mix solvents with photochemical waste.
4. Cap and seal the container once full. Ensure that there are no chemicals on the outside of the container and that it is not leaking.
5. Attach a hazardous materials label to the front of the container and add the waste generator sticker to the front right hand corner.
6. Notify HSE that your have waste for pick-up by contacting HSE from the Hazardous Materials Webpage. Store bag in a conspicuous and well labelled location until it is picked up.

11. Disposal of Propane and Butane Gas Cylinders

11.1 Scope

This procedure applies only to the disposal of propane and butane cylinders. This procedure does not apply to other gas cylinders and lecture bottles.

11.2 Purpose

This procedure specifies the safe and proper disposal of propane and butane gas cylinders.

11.3 Background

Compressed gas cylinders are not accepted at local landfills. As a result some of the university's compressed gas cylinders designated for disposal (empty or full) may remain in the buildings thereby creating fire or explosion hazards.

Do not dispose of compressed gas cylinders into the regular waste stream. Most reputable compressed gas suppliers will pick up their empty gas cylinders. Consider purchasing your compressed gas from a supplier that offers this service. For compressed gas cylinders that are not returnable to the supplier contact the UBCO Health Safety & Environment office for assistance with disposal.

11.4 Procedure

<u>Propane/Butane containers</u>

1. All propane and butane containers must first be approved for disposal through HSE through the hazardous materials website.
2. Approved processed requests are sent to the generator via e-mail.
3. Package containers in strong cardboard boxes.
4. Once the box is full, tape the box closed.
5. Do not vent propane or butane cylinders through the fume hood

<u>Lecture Bottles and Other Gas Cylinders</u>

1. HSE cannot routinely dispose of lecture bottles.
2. Lecture bottles and other gas cylinders must be returned to the supplier by the purchaser.
3. HSE will make arrangements for disposal of non-returnable cylinders through an approved waste contractor at the generator's expense. Please contact HSE for details.

12. Disposal of Unknown Laboratory Chemicals

12.1 Scope

This disposal procedure applies to hazardous laboratory chemicals in the solid or liquid form that cannot be identified. This procedure does not include gases or lecture bottles.

12.2 Purpose

This procedure specifies the method for the proper disposal of unidentified laboratory chemicals such that hazards are addressed and UBC is in compliance with all legislation.

12.3 Background

Under normal circumstances, HSE cannot accept unknown wastes and chemicals; thus, it is vital that lab users make every effort to clearly label and identify any material in their possession, including those that are not regulated (such as water). Unknown wastes are treated at the highest level; thus increasing overall costs to the University and the Environment.

Disposal of unidentified hazardous chemicals in the sewer or landfill is prohibited by Kelowna Sewer Use Bylaw and by the BC Hazardous Waste Regulations, 2009.

12.4 Procedure

HSE recognizes that on rare occasions, it may be necessary to dispose of unknown chemicals. If thorough research is unable to ascertain the contents of an unknown material, contact HSE and we will work with you to ensure that the waste is handled in an environmentally sensitive manner.

Please note: depending on the circumstances, the generator may have to pay for the cost to dispose of unknown chemicals.

13. Disposal of Waste Batteries

13.1 Scope

This disposal procedure applies to waste batteries and cellular telephones smaller than 5 kg.

Waste batteries include the following:

- Standard/Non-rechargeable Batteries:
- All sizes of regular consumer alkaline batteries (for example, AA and AAA);
- Watch batteries
- Rechargeable Batteries:
  - Nickel-Cadmium batteries (Ni-Cd);
  - Lithium-Ion batteries (Li-ion);
  - Nickel Metal Hydride (Ni-MH);
  - Lead acid (automotive/power supply) batteries (Pb)

For batteries larger than 5 kg, or if you have any questions, please contact HSE.

13.2 Purpose

This procedure specifies the procedure for the proper disposal of waste batteries such that UBC is in compliance with all legislations.

13.3 Background

Because batteries are classified as a special waste, they cannot be disposed of in a landfill according to the BC Hazardous Waste Regulation, 2009.

Waste batteries shall be disposed in accordance with the BC Environmental Management Act, 2003.

All batteries on campus that are put into the brown battery recycling boxes are recycled by Call2Recycle.

13.4 Procedure

Boxes to collect batteries for recycling are located in every building, usually on the ground floor near the recycling station. If you cannot find the recycling station, or a battery box is full, please contact HSE.

1. If batteries are leaking or damaged, wrap in a clear plastic bag prior to bring to the box.
2. The following batteries can be deposited directly in the box without further packaging:
    a. Alkaline
    b. Nickel metal hydride (Ni-MH)
    c. Nickel cadmium (Ni-Cd)
3. The following batteries must be wrapped individually in bags or the leads must be covered with tape:
    a. Rechargeable batteries Lithium ion (Li-Ion), small sealed lead acid (SSLA/Pb)
    b. Lithium primary
    c. Any others not listed
4. Place the batteries in the box.

14. Disposal of Waste Oil

14.1 Scope

Waste oil is defined as a hazardous waste if it is a "refined petroleum product that has become unsuitable for its original purpose owing to the presence of impurities, or a loss of its original properties." This disposal procedure applies to the disposal of waste oil, or a non-hazardous material containing more than 3% by weight of oil.

Types of waste oil include the following:

- Automotive lubricating oil
- Cutting oil;
- Fuel oil;
- Gear oil;
- Hydraulic oil;
- Refined petroleum based oil;
- Synthetic oil;
- Emulsion;
- Crude oil; and,
- Vacuum-pump oil.

IMPORTANT NOTE: *Waste oils must not be contaminated with PCBs (Polychlorinated Biphenyl) or solvents. If waste oils are contaminated by PCBs, solvents, dispose of them as chemical wastes.*

14.2 Purpose

This procedure specifies the requirements for the packaging and disposal of oil or material contaminated with oil, such that UBC is in compliance with all legislation.

14.3 Background

1. Oil reuse and recycle operations must strictly adhere to the BC Hazardous Waste Regulations, 2009.
2. Waste oil is not permitted in sanitary or storm sewers in accordance with the Kelowna Sewer Use Bylaw.
3. Waste oil is not permitted in landfills in compliance with BC Hazardous Waste Regulations, 2009.
4. Any spills that exceed 100 litres and are discharged to the environment must be reported to the Provincial Emergency Program (PEP); for more information see Environmental Reporting Procedures, Appendix D.

14.3 Procedure

The procedure for the collection and disposal of waste oil is as follows:

1. The oil can be collected in three ways;
   a) It can be collected in the supplier's original disposable plastic container if it is in good condition (i.e. not leaking);
   b) Glass waste disposal containers (contact HSE if you need one of these containers); or,
   c) 200 litre metal drums.
2. Do not use red jerry cans for disposal of waste oil.
3. Do not mix different types of oil together.
4. Do not include grit, glass, plastic, paper, sludge, or other chemicals
5. Complete the required information on the Disposal Tag and affix the generator barcode sticker. Write the type of oil in the container (as defined in the Scope) in the line entitled "Other".
6. Make sure that all waste oil containers are properly tagged and identified, with lids tightly closed.
7. Notify HSE that your have waste for pick-up by contacting HSE from the Hazardous Materials Webpage.
8. Place the clearly labelled containers in a designated and easily accessible area.

Do not mix waste oil with other solvents.
Do not overfill containers.

15. Disposal of Waste Paint

15.1 Scope

This procedure applies to the disposal and recycling of waste paint.

15.2 Purpose

This procedure specifies the methods for proper disposal of oil paint waste, latex based paint, and waste water generated from paint brush cleaning.

15.3 Background

Paint waste is a mixture of pigment and solvent. The solvent can be water or a variety of organic solvents; paint waste can be toxic. Users should be aware that the Kelowna Sewer Use by-law prohibits paint waste from being disposed of into the sewer. Paint waste is considered a hazardous waste and is prohibited in landfills.

15.4 Procedure

Waste Solvent Contaminated with Paint

1. Collect in sealed waste container.
2. Affix flammable liquid tag (blue)
3. Indicate non-halogenated solvent on the tag
4. Check the tag's "other" box and indicate - paint contamination
5. Register the waste on the Hazardous Materials Database for pick-up by HSE.
6. Leave the clearly labelled waste in an identified and secure location.

Surplus Paint for Recycling – In Original Container

1. Surplus paint for recycling in original containers are collected and processed by Facilities Management. Please contact Facilities Management.

Surplus Paint for Recycling – Not In Original Container OR Surplus Paint for Re-Use

1. Seal surplus paint to ensure that it is not leaking.
2. Clearly label the paint with the contents, and the name of the person submitting the paint. If there is enough paint in the container for re-use, mark the date originally opened on the top of the can.
3. Contact HSE for disposal of waste paint, by visiting the Hazardous Materials Webpage[7].

Green Tips

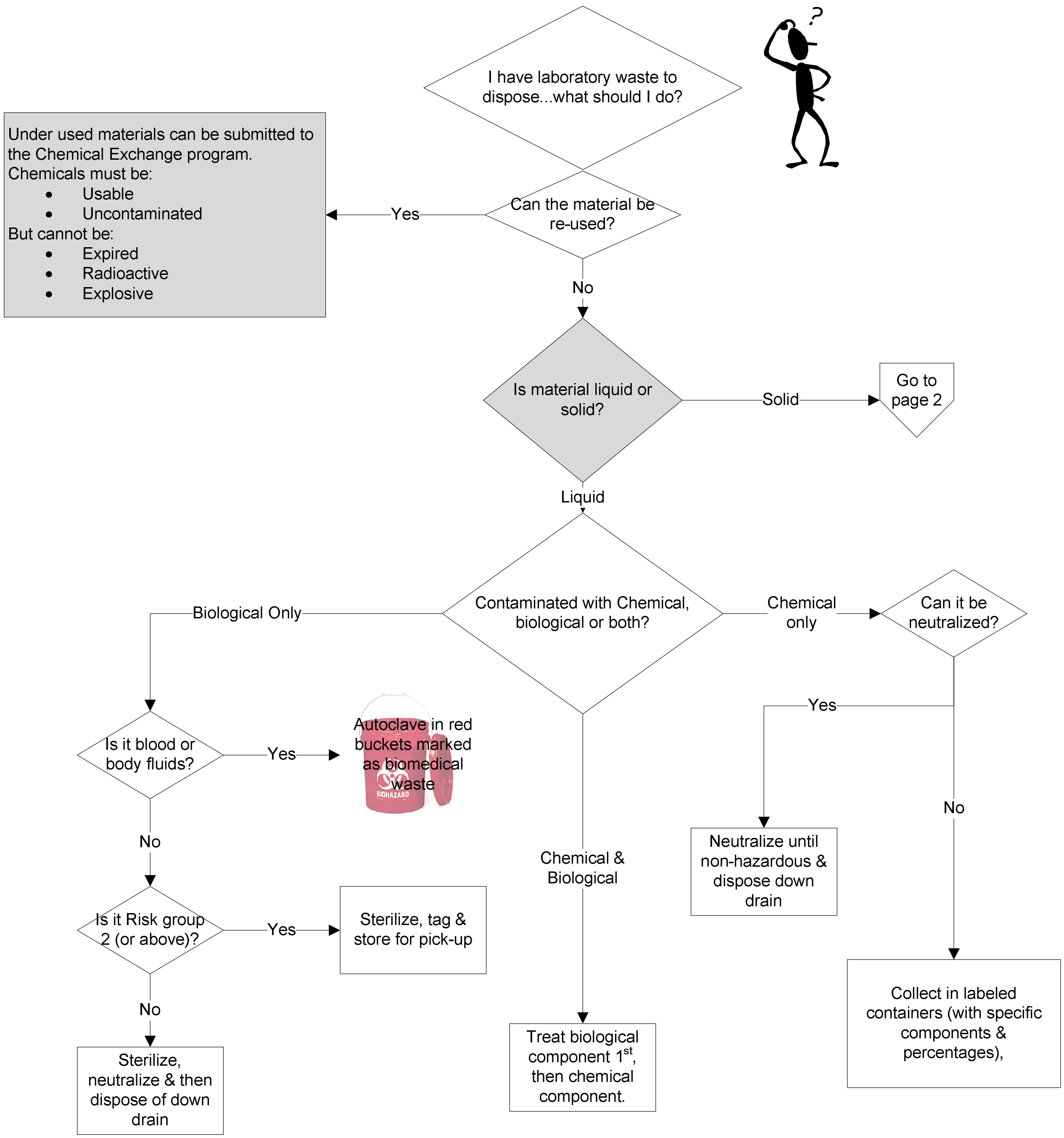
Buy only as much paint as you will need to use in a month.

[7] www.ubc.ca/okanagan/hse/environment/hazardousmaterials.html

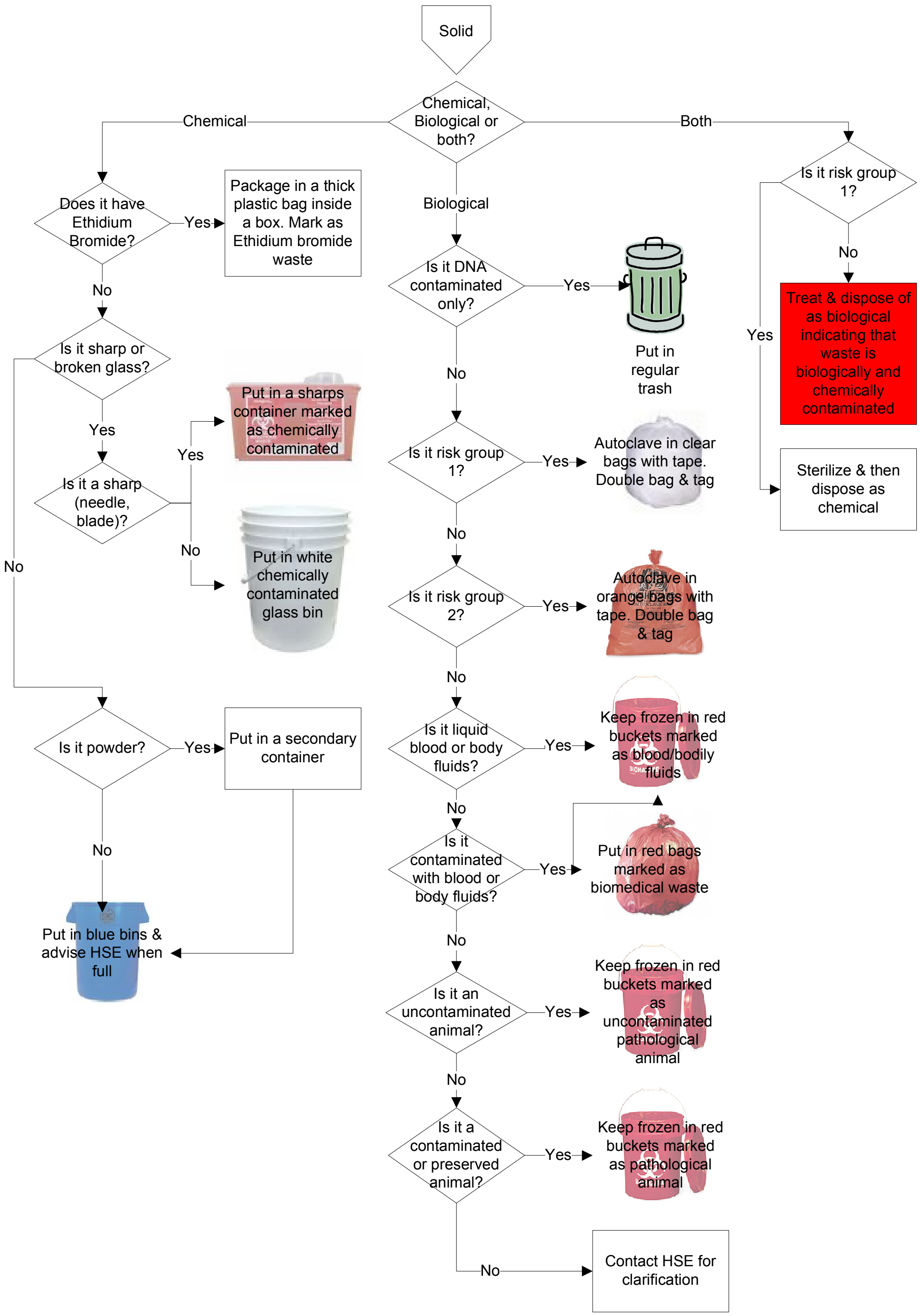
Water base paints are the safest option available.
Latex paints are less toxic than oil based, and also do not need to be cleaned with solvents.

Section E: Appendices

Appendix A: Hazardous Wastes Flow Chart



Store all wastes appropriately and notify HSE that a pick-up is required when needed.



Store all wastes appropriately and notify HSE that a pick-up is required when needed.

Appendix B: Exit Protocol for UBC Principal Investigators

Scope

This protocol is applicable to all departments with laboratories or operations where hazardous materials or equipment are used.

Purpose

To provide a framework for Departmental Heads of units to develop a site-specific exit protocol for research faculty under their supervision. Following clearance by the Department Head and the Principal Investigator, HSE will check the lab for hazards using the attached lab exit protocols.

Background

The advent of WHMIS, provincial and federal environmental regulations, Nuclear Safety and Control Act (2000) requirements, and Health Canada Guidelines for Biohazards have made it critical that principal investigators decommission laboratories to ensure that the legal and ethical expectations associated with such work are met.

Properly applied an exit protocol ensures that:

- Departmental policies and procedures are followed;
- Unsafe conditions are eliminated;
- A proper clean-up is performed;
- Lab equipment is properly disposed/recycled;
- Hazardous materials are properly disposed of/recycled;
- Work surfaces are free of contamination; and
- Regulatory requirements are met.

Notification

When a faculty member informs his or her Department Head of his or her intentions to leave UBC (suggested **minimum** three months notice), the Department Head shall provide a copy of the Departmental Exit Protocol. It is suggested for purposes of due diligence that the date of this information transfer be documented. It is then the responsibility of the Department Head to monitor that the faculty member follows all the steps in the protocol to completion, including all requirements for documentation.

When a faculty member is moving within the UBC community, a lab clearance must also be completed, but as time frames for changes within UBC may not allow for a 3 month notification, the Principal Investigator should notify the Department Head as soon as possible.

Once a Department Head receives notification that a Principal Investigator will be leaving a lab space, HSE should be notified so that a final exit inspection can take place **before** the principal investigator moves.

Checklist

A checklist will provide a simple method for the Department Head to confirm the protocol has been completed. The faculty member shall submit a completed exit protocol checklist to the Department Head prior to departure. The Department Head shall keep a copy and a copy shall also be provided to the faculty member.

Procedure

When the primary researcher or supervisor of a laboratory leaves or decommissions a laboratory, the following procedures shall be followed:

General

1. A current inventory of all hazardous materials must be completed.
2. All unknowns must be identified and appropriately labelled.
3. All chemicals should be removed from the laboratory by transfer to another primary researcher/laboratory supervisor, or by disposal through HSE.
4. A final laboratory exit inspection should be completed by HSE. As the sheet must be signed by the Principal Investigator, they must be present at the time of final inspection

Transfer of chemicals to another primary researcher or laboratory supervisor

All materials transferred must be labelled according to WHMIS requirements and the receiving party must obtain appropriate Material Safety Data Sheets.

Some of the materials may be forwarded to the University Chemical Exchange Program for future use. Contact HSE through the chemical exchange webpage.[8]

Disposal of Chemicals

The identity of all materials must be established before disposal. If there are unidentified materials, contact Health, Safety and Environment to arrange for materials to be classified

[8] www.ubc.ca/okanagan/hse/environment/hazardousmaterials/chemexchange

for waste disposal purposes; there may be a cost associated with identifying and disposing of the materials.

Return compressed gas cylinders to suppliers.

Radioisotope Licence De-Activation & Lab Decommissioning

Required from the Licensee:

1. Memo to Radiation Safety Office (RSO) stating intent to discontinue the isotope license.
2. A complete set of wipe tests of every laboratory licensed for isotope use.
3. Record of proper disposal of all isotopes on hand (this can include a transfer of remaining isotope to another researcher that is licensed for that nuclide).
4. Completion of a yearly isotope inventory (from RSO).
5. If the researcher is leaving the University, or does not intend to re-activate the licence at some future date, all isotope purchase, usage, disposal and contamination control records must be forwarded to the Radiation Safety Office.

Following the completion of the above steps, a Radiation Safety Officer will remove all signs. Thereafter, a letter will be issued to the researcher stating that the licence is no longer active. Decommissioning of laboratory space is not complete until verification by the Radiation Safety Office.

Biohazard Laboratory Decommissioning

1. Notify HSE that biohazard protocols are to be concluded.
2. Record transfer of biohazardous materials to the inventory of another researcher.
3. Terminate all biohazards not transferred to the inventory of another researcher.
4. Decontaminate all working surfaces.

The UBC Policy #9 “Hazardous Materials Management” requires all researchers that finish their research at UBC leave their workplace in a reasonably clean manner.

BENCH TOP

- ❑ Bench top cleaned from spills, glass, paper, research samples, etc.
- ❑ All chemicals from the bench taken to the appropriate storage shelves and labeled properly.
- ❑ Research samples either disposed of or transferred to other researchers for further development. Transferred sample containers labeled. If abbreviation or numbers were used when labeling the samples than a list with the full description must accompany the samples.
- ❑ All glassware cleaned and stored in the proper cupboards.
- ❑ All broken glassware either disposed of or stored safely for repairs.
- ❑ Experimental apparatuses dismounted and pieces cleaned and stored safely.
- ❑ Regulators removed from compressed gas cylinders and protective caps put on.
- ❑ Full red waste containers disposed of; the ones that are still in use are labeled properly.
- ❑ Personal items (e.g. safety eyewear, lab coats, etc) either removed from the lab or placed for common use.

FUMEHOOD

- ❑ Sash of the fume hood cleaned from any writings, objects, etc.
- ❑ Area within fume hood cleaned of spills, glassware, chemicals, experimental apparatuses and research samples.
- ❑ Only items agreed upon with a supervisor or future researcher may be left inside the fume hood.

COMMENTS:

Inspection Date: ____________________ Supervisor: ____________________________

Safety Officer: ____________________ Researcher: ____________________________

Laboratory Exit Protocol

Version OC.1.0

Inadequate decommissioning of a laboratory could result in the laboratory shutdown by Health, Safety and Environment, until the laboratory has been adequately cleaned up. Improper decommissioning may affect the safety of persons moving into a new lab space. For mutual protection, the following must be completed and posted:

- ❑ A current inventory of all hazardous materials has been completed.
- ❑ All unknown chemicals are identified and appropriately labeled.
- ❑ All chemicals are removed from the laboratory.
- ❑ Materials transferred to another principal investigator are labeled according to WHMIS requirements.
- ❑ Chemical inventory form shows final destination of each hazardous material.
- ❑ Research samples either disposed of or transferred to other researchers for further development. Transferred sample containers labeled. If abbreviation or numbers were used when labeling the samples than a list with the full description must accompany the samples.
- ❑ Any equipment on loan has been returned to its owner.
- ❑ HSE has the complete chemical inventory form.
- ❑ Lab area is not contaminated with any potentially hazardous materials.
- ❑ Radioisotopes license has been removed and verified by Radiation Safety Officer
- ❑ Housekeeping is in order

COMMENTS:

Date of Inspection: ________________________

Principal Investigator: ________________________

Safety Officer: ________________________

Appendix C: Spill Response Environmental Reporting Procedures

Scope

Environmental reporting procedures are applicable to all UBC activities and operations. These procedures are specific to the Okanagan campus and may require modification for use at other University locations.

Purpose

To ensure that all spills of hazardous materials are reported to the appropriate authority as required by law.

Background

Many different statutes impose specific legal obligations to report spills to provincial and federal agencies. The primary responsibility of any person who has possession, charge, or control of a hazardous material is to do everything in his or her power to prevent a spill of that material. This includes establishing programs to prevent the escape of the material, such as identifying areas where there are potential risks of spills, adopting procedures and technologies to minimize or eliminate such risks, and ensuring anyone handling the materials is trained in the relevant procedures and technologies.

When a spill does occur, the responsible person must act quickly to stop, contain and minimize the effects of the spill. Courts impose stricter penalties for convictions arising from a spill if there was a delay in responding to or reporting of the spill. A spill is defined as an **external release** to air, water or land. A dangerous good released from its packaging in transit or on arrival is also considered a reportable spill under *Transportation of Dangerous Goods Act 1992 (as amended in 2009).*

In the event of a spill, more than one legislation may apply and more than one agency may require a spill report to be completed. These reports are time sensitive.

Procedure

1. When the potential for a spill exists, programs are to be established to prevent the escape of hazardous materials. This should include identifying areas where there are potential risks of spills, adopting procedures and technologies to minimize or eliminate such risks, and ensuring all personnel involved are trained in the procedures and technologies.

2. In the event of a spill or release of material, persons in the immediate area should act to ensure their personal safety. The responsible person must act quickly to stop, contain,

minimize the effects of and clean up the affected area, where possible and safe - this may include initiating Emergency Response (911).

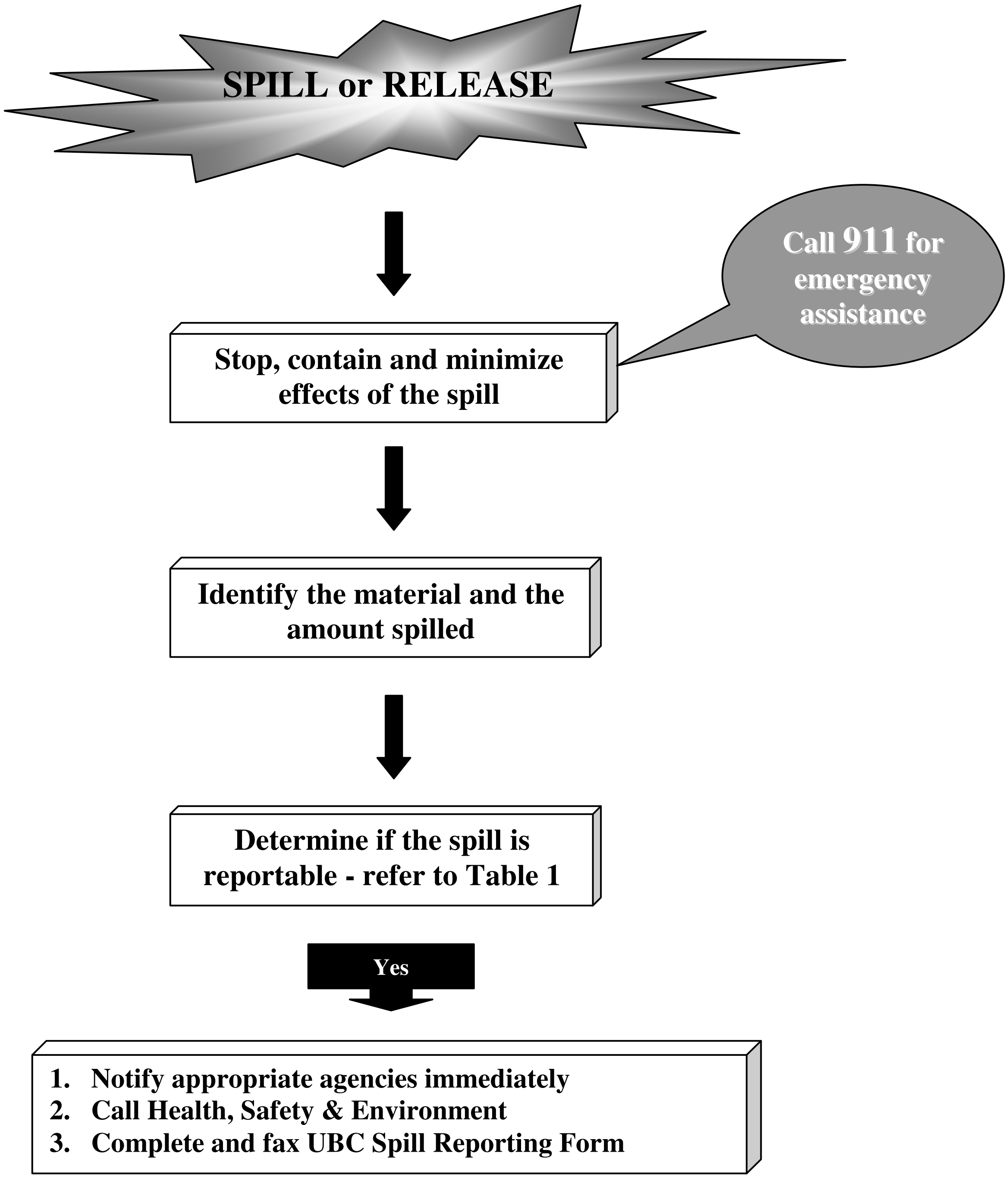
3. Identify the material and the quantity spilled.

4. The responsible person must determine, using Table 1 below, if the spill is reportable and which agencies require notification.

5. The responsible person must notify all applicable agencies immediately and complete the UBC Spill Reporting Form.

6. The responsible person is to keep the original Spill Reporting Form and fax a copy to the Department of Health, Safety & Environment (fax# 250-807-9591) as soon as reasonably possible. The Department of Health, Safety & Environment must also be notified by phone of the spill as soon as possible. A second copy of the form must be forwarded to the applicable Administrative Head of Unit.

Figure 1: Spill Reporting Procedure



Appendix 1 – Determination of Materials and Agencies Requiring Notification
All Classes refer to the Transportation of Dangerous Goods classification, see Appendix 4

Use the following table to determine if a spill is reportable and which agency(ies) should be notified.
1) Find the substance under "Substance Spilled",
2) Compare the actual amount spilled to the "Specified Amount"; if the actual is equal to or greater than the specified amount report the spill to the "Contact Agencies" listed in the final column.

CRITERIA/SUBSTANCE SPILLED	SPECIFIED AMOUNT	Required Contact Agencies
Waste containing a pest control product	**5 kg or 5L**	Pesticide Mgmt Program & PEP
Waste oil	100 litres	PEP
Explosives of Class 1	Any level that can pose danger to public safety or 50 kg	PEP & Transport Canada
Flammable gases of Division 1 of Class 2	Any level that can pose danger to public safety or any sustained release of 10 min. or more	PEP & Transport Canada
Non-flammable gases of Division 2 of Class 2	Any level that can pose danger to public safety or any sustained release of 10 min. or more	PEP & Transport Canada
Poisonous gases of Division 3 of Class 2	Any level that can pose danger to public safety or any sustained release of 10 min. or more, or 5 kg	PEP & Transport Canada
Flammable liquids of Class 3	100 L 200 L	PEP Transport Canada
Flammable solids of Class 4	25 kg	PEP & Transport Canada
Products or substances that are oxidizing substances of Division 1 of Class 5	50 kg or 50 L	PEP & Transport Canada
Products or substances that are organic compounds that contain the bivalent "-0-0-" structure of Division 2 of Class 5	1 kg or 1 L	PEP & Transport Canada
Products or substances that are poisons of Division 1 of Class 6	5 kg or 5 L	PEP & Transport Canada

Organisms that are infectious or that are reasonably believed to be infectious, and the toxins of these organisms (risk group II and above)	1 kg or 1L, or less if waste poses danger to public safety or the environment Any	PEP Transport Canada
Radioactive materials of Class 7	Any quantity that could pose a danger to public safety and at an emission level greater than the emission level established in section 20 of the "Packaging and Transport of Nuclear Substances Regulations"	PEP & Transport Canada
Corrosive materials of Class 8	5 kg or 5 L	PEP & Transport Canada
Waste Asbestos	50 kg	PEP
Miscellaneous products or substances of Class 9	25 kg or 25 L	PEP & Transport Canada
A substance not covered by these items that can cause pollution	200 kg or 200 L	PEP
Natural Gas	10 kg, if there is a breakage in a pipeline or fitting operated at >100psi that results in a sudden release	PEP
One of the 85 materials on the Toxic substances list refer, to appendix 4	Any	Environment Canada
A major release of a toxic or hazardous material	1 The incident resulted in an injury that required immediate medical attention beyond the level of service provided by a first aid attendant or injuries to several workers which require first aid. 2 The incident resulted in a situation of continuing danger to workers, as when the release of a chemical cannot be readily or quickly cleaned up.	Workers Compensation Board
Deleterious substance released into water frequented by fish	Any	PEP
Leachable toxic waste as defined in section 1 of the Hazardous Waste Regulation	25 kg or 25 L	PEP
Waste containing polycyclic aromatic hydrocarbons as defined in section 1 of the hazardous Waste Regulation	5 kg or 5 L	PEP

PCB Wastes as defined in section 1 of the Hazardous Waste Regulation	25 kg or 25 L	PEP
Waste containing tetrachloroethylene as defined in section 1 of the Hazardous Waste Regulation	50 kg or 50 L	PEP
A hazardous waste as defined in section 1 of the Hazardous Waste Regulation and not covered under any of the above	25 kg or 25 L	PEP

Emergency Response	911	Health, Safety & Environment	Ph: (250) 807-8621 Fax: (250) 807-9591
Provincial Emergency Program (PEP)	1-800-663-3456	Canadian Transport Emergency Center CANUTEC	613-996-6666 or *666 on a cellular phone
Integrated Pest Management	(250) 387-9955	Transport Canada Region Manager Transport Dangerous Goods	604-666-2955
Environment Canada	(604) 664-9100	WorkSafe BC	1-888-621- 7233 after hours 1- 866-922-4357

Appendix - Definitions

Environment – "means the air, land, water and all other external conditions or influences under which man, animals and plants live or are developed."

BC Environmental Management Act, 2003

Dangerous Goods – "means a product, substance or organism included by its nature or by the regulations in any of the classes listed in the schedule to the Canada Dangerous Goods Act."

Canada Transportation of Dangerous Goods Regulations, 2008

Deleterious Substance -

1(a) "any substance that, if added to any water, would degrade or alter or form a part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water, or

(b) any water that contains a substance in such quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water,

and without limiting the generality of the foregoing includes
(c) any substance or class of substances prescribed pursuant to paragraph 2(a),
(d) any water that contains any substance or class of substances in a quantity or concentration that is equal to or in excess of a quantity or concentration prescribed in respect of that substance or class of substances pursuant to paragraph 2(b), and
(e) any water that has been subjected to a treatment, process or change prescribed pursuant to paragraph 2(c)."
The Governor in Council may make regulations prescribing:
2(a) substances and classes of substances,
(b) quantities or concentrations of substances and classes of substances in water, and
(c) treatments, processes and changes of water
for the purpose of paragraphs 1(c) to (e) of the definition "deleterious substance" in subsection (1).

Canada Fisheries Act, R.S., 1985

Note that aside from toxic chemicals, deleterious substances have been found to include such things as sediment, which has been shown to impede a fish's ability to catch prey and to affect its gills.

Substance – "means a substance, product, material or other thing listed in column 1 of the Schedule of this regulation."

Responsible Person – "[means] a person who had possession, charge or control of a substance immediately before its spill."

BC Environmental Management Act - Spill Reporting Regulation, 2008

Spill – "means a release or discharge into the environment, not authorized under the Act, of a substance in an amount equal to or greater than the amount listed …"

BC Environmental Management Act - Spill Reporting Regulation, 2008

UBC SPILL REPORTING FORM

Fax to Health, Safety & Environment, (250)807-9591

Copy to be forwarded to Administrative Head of Unit

EMERGENCY RESPONSE INITIATED

YES ☐ NO ☐

Person Reporting Spill

Name ______________________________

Dept. ______________________________

Phone number ______________________________

Address ______________________________

____

Person Causing Spill (if different than above)

Name ______________________________

Dept. ______________________________

Phone number ______________________________

Address ______________________________

____

Material spilled ______________________________

Quantity ______________________________

Location ______________________________

Location surrounding spill (describe)

____

Date and time of spill

____

____

Describe cause of spill

____

____

____

____

Describe response actions taken______________________________

____

____

Further action required

____

____

Agencies attending scene (e.g. Fire Dept. etc)

____

____

____

____

Agencies notified of spill or release:
(e.g., PEP at 1-800-663-3456)

______________________________ Time__________

______________________________ Time__________

______________________________ Time__________

CEPA – List of Toxic Substances

Refer to the Canada *Transportation of Dangerous Goods Regulation, 2008, schedule 1 for a complete list of substances.*
Note: The first number is the class number, the second number is the division number (e.g. 5.2 means class 5, division 2).

Class 1	**Explosives**
1.1	A substance or article with a mass explosion hazard
1.2	A substance or article with a fragment projection hazard, but not a mass explosion hazard
1.3	A substance or article that has a fire hazard along with either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard
1.4	A substance or article that presents no significant hazard – explosion effects are largely confined to the package and no projection or fragments of appreciable size or range are to be expected.
1.5	A very insensitive substance that nevertheless has a mass explosion hazard like those substances in 1.1.
Class 2	**Gases**
2.1	A flammable gas
2.2	Other compressed gases
2.3	A poisonous gas
Class 3	**Flammable and combustible liquids** A liquid with a closed-cup flash point between -18°C and 61°C
Class 4	**Flammable solids, substances liable to spontaneous combustion, and substances that on contact with water emit flammable gases**
4.1	A solid that under normal conditions of transport is readily ignitable and burns vigorously and persistently or that causes or contributes to fire through friction or from heat retained from manufacturing or processing
4.2	A substance liable to spontaneous combustion when in contact with air or liable to spontaneous heating to the point where it ignites when in contact with air
4.3	A substance that on contact with water is liable to become spontaneously flammable or emit flammable gas(es)
Class 5	**Oxidizing substances and organic peroxides**
5.1	A substance that causes or contributes to the combustion of other material by yielding oxygen or other oxidizing substances whether or not the substance itself is combustible
5.2	An organic compound that contains a strong oxidizing agent in the form of the bivalent "-O-O-" structure and, therefore, may be liable to explosive decomposition or sensitive to heat, shock, or friction
Class 6	**Poisonous (toxic) substances and infectious substances**
6.1	A solid or liquid that is poisonous through inhalation of its vapours, by skin contact, or by ingestion
6.2	Organisms that are infectious or that are reasonably believed to be infectious to humans and animals
Class 7	**Radioactive materials**
Class 8	**Corrosive substances**
Class 9	**Miscellaneous products, substances, or organisms dangerous to life, health, property, or the environment**

CANADIAN ENVIRONMENTAL PROTECTION ACT, Schedule 1 – List of Toxic Substances For molecular formulae in this schedule, "n" = number of atoms
1. Chlorobiphenyls that have the molecular formula $C_{12}H_{(10-n)}Cl_n$ in which "n" is greater than 2
2. Dodecachloropentacyclo [5.3.0.0^{2,6}.0^{3,9}.0^{4,8}] decane (Mirex)
3. Polybrominated Biphenyls that have the molecular formula $C_{12}H_{(10-n)}Br_n$ in which "n" is greater than 2
4. Chlorofluorocarbon: totally halogenated chlorofluorocarbons that have the molecular formula $C_nCl_xF_{(2n+2-x)}$
5. Polychlorinated Terphenyls that have a molecular formula $C_{18}H_{(14-n)}Cl_n$ in which "n" is greater than 2
6. Asbestos
7. Lead
8. Mercury
9. Vinyl Chloride
10. Bromochlorodifluoromethane that has the molecular formula CF_2BrCl
11. Bromotrifluoromethane that has the molecular formula CF_3Br
12. Dibromotetrafluoroethane that has the molecular formula $C_2F_4Br_2$
13. Fuel containing toxic substances that are dangerous goods within the meaning of section 2 of the *Transportation of Dangerous Goods Act, 1992* and that
(*a*) are neither normal components of the fuel nor additives designed to improve the characteristics or the performance of the fuel; or
(*b*) are normal components of the fuel or additives designed to improve the characteristics or performance of the fuel, but are present in quantities or concentrations greater than those generally accepted by industry standards.
14. Dibenzo-para-dioxin that has the molecular formula $C_{12}H_8O_2$
15. Dibenzofuran that has the molecular formula $C_{12}H_8O$

16. Polychlorinated dibenzo-para-dioxins that have the molecular formula $C_{12}H_{(8-n)}Cl_nO_2$ in which "n" is greater than 2
17. Polychlorinated dibenzofurans that have the molecular formula $C_{12}H_{(8-n)}Cl_nO$ in which "n" is greater than 2
18. Tetrachloromethane (carbon tetrachloride, CCl_4)
19. 1,1,1-trichloroethane (methyl chloroform, CCl_3-CH_3)
20. Bromofluorocarbons other than those set out in items 10 to 12
21. Hydrobromofluorocarbons that have the molecular formula $C_nH_xF_yBr_{(2n+2-x-y)}$ in which $0<n\leq3$
22. Methyl Bromide
23. Bis(chloromethyl) ether that has the molecular formula $C_2H_4Cl_2O$
24. Chloromethyl methyl ether that has the molecular formula C_2H_5ClO
25. Hydrochlorofluorocarbons that have the molecular formula $C_nH_xF_yCl_{(2n+2-x-y)}$ in which $0<n\leq3$
26. Benzene that has the molecular formula C_6H_6
27. (4-Chlorophenyl)cyclopropylmethanone,O-[(4-nitrophenyl)methyl]oxime that has the molecular formula $C_{17}H_{15}ClN_2O_3$
28. Inorganic arsenic compounds
29. Benzidine and benzidine dihydrochloride, that have the molecular formula $C_{12}H_{12}N_2$ and $C_{12}H_{12}N_2\cdot2HCl$, respectively
30. Bis(2-ethylhexyl)phthalate
31. Inorganic cadmium compounds
32. Chlorinated wastewater effluents
33. Hexavalent chromium compounds
34. Creosote-impregnated waste materials from creosote-contaminated sites
35. 3,3′-Dichlorobenzidine

36. 1,2-Dichloroethane
37. Dichloromethane
38. Effluents from pulp mills using bleaching
39. Hexachlorobenzene
40. Inorganic fluorides
41. Refractory ceramic fibre
42. Oxidic, sulphidic and soluble inorganic nickel compounds
43. Polycyclic aromatic hydrocarbons
44. Tetrachloroethylene
45. Trichloroethylene
46. Tributyltetradecylphosphonium chloride that has the molecular formula $C_{26}H_{56}P{\bullet}C1$
47. Bromochloromethane, that has the molecular formula CH_2BrCl
48. Acetaldehyde, which has the molecular formula C_2H_4O
49. 1,3-Butadiene, which has the molecular formula C_4H_6
50. Acrylonitrile, which has the molecular formula C_3H_3N
51. Respirable particulate matter less than or equal to 10 microns
52. Acrolein, which has the molecular formula C_3H_4O
53. Ammonia dissolved in water
54. Nonylphenol and its ethoxylates
55. Effluents from textile mills that use wet processing
56. Inorganic Chloramines, which have the molecular formula $NH_nCl_{(3-n)}$, where n = 0, 1 or 2
57. Ethylene oxide, which has the molecular formula H_2COCH_2

58. Formaldehyde, which has the molecular formula CH_2O
59. *N*-Nitrosodimethylamine, which has the molecular formula $C_2H_6N_2O$
60. Gaseous Ammonia, which has the molecular formula $NH_3(g)$
61. Ozone, which has the molecular formula O_3
62. Nitric oxide, which has the molecular formula NO
63. Nitrogen dioxide, which has the molecular formula NO_2
64. Sulphur dioxide, which has the molecular formula SO_2
65. Volatile organic compounds that participate in atmospheric photochemical reactions, excluding the following:
(*a*) methane;
(*b*) ethane;
(*c*) methylene chloride (dichloromethane);
(*d*) 1,1,1-trichloroethane (methyl chloroform);
(*e*) 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113);
(*f*) trichlorofluoromethane (CFC-11);
(*g*) dichlorodifluoromethane (CFC-12);
(*h*) chlorodifluoromethane (HCFC-22);
(*i*) trifluoromethane (HFC-23);
(*j*) 1,2-dichloro-1,1,2,2-tetrafluoroethane (CFC-114);
(*k*) chloropentafluoroethane (CFC-115);
(*l*) 1,1,1-trifluoro-2,2-dichloroethane (HCFC-123);
(*m*) 1,1,1,2-tetrafluoroethane (HFC-134a);
(*n*) 1,1-dichloro-1-fluoroethane (HCFC-141b);

(*o*) 1-chloro-1,1-difluoroethane (HCFC-142b);
(*p*) 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124);
(*q*) pentafluoroethane (HFC-125);
(*r*) 1,1,2,2-tetrafluoroethane (HFC-134);
(*s*) 1,1,1-trifluoroethane (HFC-143a);
(*t*) 1,1-difluoroethane (HFC-152a);
(*u*) parachlorobenzotrifluoride (PCBTF);
(*v*) cyclic, branched or linear completely methylated siloxanes;
(*w*) acetone;
(*x*) perchloroethylene (tetrachloroethylene);
(*y*) 3,3-dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca);
(*z*) 1,3-dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb);
(*z.1*) 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC 43-10mee);
(*z.2*) difluoromethane (HFC-32);
(*z.3*) ethylfluoride (HFC-161);
(*z.4*) 1,1,1,3,3,3-hexafluoropropane (HFC-236fa);
(*z.5*) 1,1,2,2,3-pentafluoropropane (HFC-245ca);
(*z.6*) 1,1,2,3,3-pentafluoropropane (HFC-245ea);
(*z.7*) 1,1,1,2,3-pentafluoropropane (HFC-245eb);
(*z.8*) 1,1,1,3,3-pentafluoropropane (HFC-245fa);
(*z.9*) 1,1,1,2,3,3-hexafluoropropane (HFC-236ea);
(*z.10*) 1,1,1,3,3-pentafluorobutane (HFC-365mfc);

(*z.11*) chlorofluoromethane (HCFC-31);
(*z.12*) 1-chloro-1-fluoroethane (HCFC-151a);
(*z.13*) 1,2-dichloro-1,1,2-trifluoroethane (HCFC-123a);
(*z.14*) 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy-butane ($C_4F_9OCH_3$);
(*z.15*) 2-(difluoromethoxymethyl)-1,1,1,2,3,3,3-heptafluoropropane ($(CF_3)_2CFCF_2OCH_3$);
(*z.16*) 1-ethoxy-1,1,2,2,3,3,4,4,4-nonafluorobutane ($C_4F_9OC_2H_5$);
(*z.17*) 2-(ethoxydifluoromethyl)-1,1,1,2,3,3,3-heptafluoropropane ($(CF_3)_2CFCF_2OC_2H_5$); and
(*z.18*) methyl acetate and perfluorocarbon compounds that fall into the following classes, namely,
(i) cyclic, branched or linear completely fluorinated alkanes,
(ii) cyclic, branched, or linear completely fluorinated ethers with no unsaturations,
(iii) cyclic, branched or linear completely fluorinated tertiary amines with no unsaturations, or
(iv) sulfur containing perfluorocarbons with no unsaturations and with sulfur bonds only to carbon and fluorine.
66. Hexachlorobutadiene, which has the molecular formula C_4Cl_6
67. Particulate matter containing metals that is released in emissions from copper smelters or refineries, or from both
68. Particulate matter containing metals that is released in emissions from zinc plants
69. Dichlorodiphenyltrichloroethane (DDT), which has the molecular formula $C_{14}H_9C1_5$
70. 2-butoxyethanol, which has the molecular formula $C_6H_{14}O_2$
71. 2-methoxyethanol, which has the molecular formula $C_3H_8O_2$
72. Tetrachlorobenzenes, which have the molecular formula $C_6H_2Cl_4$
73. Pentachlorobenzene, which has the molecular formula C_6HCl_5
74. Carbon dioxide, which has the molecular formula CO_2

75. Methane, which has the molecular formula CH_4
76. Nitrous oxide, which has the molecular formula N_2O
77. Hydrofluorocarbons that have the molecular formula $C_nH_xF_{(2n+2-x)}$ in which 0<n<6
78. The following perfluorocarbons:
(*a*) those that have the molecular formula C_nF_{2n+2} in which 0<n<7; and
(*b*) octafluorocyclobutane, which has the molecular formula C_4F_8.
79. Sulphur hexafluoride, which has the molecular formula SF_6
83. Polybrominated diphenyl ethers that have the molecular formula $C_{12}H_{(10-n)}Br_nO$ in which 4≤n≤10
84. Perfluorooctane sulfonate and its salts
85. Compounds that contain one of the following groups: $C_8F_{17}SO_2$, $C_8F_{17}SO_3$ or $C_8F_{17}SO_2N$

Appendix D: Disposal of Radioactive Waste

<u>Note:</u> Please refer to the Radiation Safety webpage at HSE Okanagan for updated procedures

Scope

This procedure applies to the disposal of solid waste contaminated with radioactive material.

Purpose

This procedure specifies the requirements for disposal of solid waste that contains radioactive materials, such that UBC is in compliance with all legislation and pertinent regulations.

Background

Researchers using radioisotopes at the University of British Columbia are required to ensure that the radioactive contaminated waste generated from their laboratory is disposed of in a manner to meet the specific disposal criteria set by the Canadian Nuclear Safety Commission for UBC. The criteria are based on the Nuclear Safety and Control Act (2000).

The Canadian Nuclear Safety Commission issues the University of British Columbia a consolidated license that outlines the radioactivity disposal levels that must be met when disposing of solid laboratory waste at UBC. These levels are specific to each different radioisotope and are outlined in Table 5 of the UBC Radionuclide Safety and Methodology Reference Manual.

Procedure

<u>Part A: Radioisotopes with a SHORT half-life (< 90 days)</u>

(Examples: P-32, S-35, I-125)

1. Create a procedure outlining the experimental steps indicating how the radiation will be disposed of at each step and how the lab ensures the disposal criteria are met.
2. Send the written procedure to the Radiation Safety Office for approval.
3. Ensure that all radioactive material is accounted for on an approved inventory form. http://www.hse.ubc.ca/safety/radiation-safety/forms-and-publications

a. Fill out the top section when receiving the shipment of radioactive material.
b. Fill out the middle section when using the radioactive material. This is when the disposal of activity must be completed.
c. Fill out the bottom section when the waste is to be disposed and when the stock vial is no longer in use in the lab.

4. If the activity to be disposed of is equal to or less than the disposal criteria at the beginning of the experiment, laboratory staff will take the waste to the building waste disposal area (dumpster) for disposal immediately following use. Housekeeping staff are prohibited from handling these waste materials. Any "Radiation Material" stickers or labels must be removed or defaced before entering the dumpster. This waste is not considered to be radioactive.

5. If the activity level being used in an experiment is above the disposal criteria, the waste is held for a decay period until the criteria is met. UBC uses a **10 half-life** holding time as a rule of thumb. An accurate holding time can be calculated using the online UBC Decay Calculator. http://www.hse2.ubc.ca/rad/Calc/calcframe.htm

6. The waste being held for decay shall have a "Low Activity Waste" form attached to the waste receptacle. All information on the form must be filled in. http://www.hse.ubc.ca/safety/radiation-safety/forms-and-publications

7. When the decay holding time has elapsed, hold your survey meter at the surface of the waste receptacle to measure the activity "field". If the reading is < 2.5uSv/hr at the surface, remove the "Low Activity Waste Form" and file with your records. If it is not < 2.5uSv/hr, continue to hold in decay.

8. When all acceptable disposal criteria are met, the waste can be removed from the decay area to the building's disposal area (dumpster) as above in step 4, with the removal of all "Radiation" stickers. This waste is not considered to be radioactive.

This combination of decay time + radiation field survey is called the "release limit" and must be met prior to disposal of any radioactive waste. If either of these two requirements is not met, the waste must not be disposed of at that time.

**** Research that uses animals in combination with short half-life radioisotopes follows the procedures above except that waste being held for decay will be held in a freezer. The final disposal step requires that the researcher remove the animal waste as per the appropriate biohazard waste disposal procedure.

Part B: Radioisotopes with a LONG half-life (> 90 days)

(Examples: C-14, H-3, Na-22)

1. Create a written procedure outlining the experimental steps indicating how the radiation is disposed of at each step and how the lab ensures the disposal criteria are met.

2. If animals will be used, the activity/kg limit for the specific radioisotope being used must be known before the experiment initiates.

3. Send the written procedure to the Radiation Safety Office for approval.

4. Ensure that all radioactive material is accounted for on an approved inventory form. http://www.hse.ubc.ca/safety/radiation-safety/forms-and-publications
   a. Fill out the top section when receiving the shipment of radioactive material.
   b. **Fill out the middle section when using the radioactive material. This is when the disposal of activity must be completed.**
   c. Fill out the bottom section when the waste is to be disposed and when the stock vial is no longer in use in the lab.

5. If the activity to be disposed of is equal to or less than the disposal criteria at the beginning of the experiment, laboratory staff will take the waste to the building waste disposal area (dumpster) for disposal immediately following use. Housekeeping staff are prohibited from handling these waste materials. Any "Radiation Material" stickers or labels must be removed or defaced before entering the dumpster.

6. If the disposal criterion is met, hold your survey meter at the surface of the waste receptacle to measure the activity "field". If the reading is < 2.5uSv/hr at the surface, the waste may now be disposed of. This waste is not considered to be radioactive. If it is not < 2.5uSv/hr, you may not dispose of the waste in this manner.

7. The combination of decay time and radiation field survey is called the "release limit" and must be met prior to disposal of any radioactive waste on the UBC Point Grey campus. If either of these two requirements is not met, the waste may not be disposed of at that time. Contact the Radiation Safety Office for assistance if required.

8. If the activity level being used in an experiment is above the disposal criteria, the waste is held in new paint cans, create a running total of the activity added. Segregate the paint cans by radioisotope.

9. Once a paint can is full, laboratory personnel shall contact the Radiation Safety Office to arrange to have the cans temporarily stored prior to shipment to an authorized disposal facility.

10. Do not dispose of lab items that may only have a remote possibility of being contaminated such as gloves and paper towels. The Radiation Safety Office has developed a tool to aid labs in the disposal of commonly used lab items.
http://www.hse.ubc.ca/safety/radiationsafety/wastetips.html

11. Research that uses animals in conjunction with long half-life radioisotopes requires that the radioactivity being used per animal at the beginning of the experiment does not exceed the solid waste disposal criteria (activity/kg)

12. This ensures that the waste that is generated can be disposed of immediately through the UBC animal waste stream. In other words, the maximum activity to be used in animals is set by the acceptable disposal limits.

Examples:

C-14 = 370 kBq/Kg = 10 uCi/kg
H-3 = 3700 kBq/kg = 100 uCi/kg

Please refer to Table 5 of the Radionuclide Safety and Methodology Manual for the allowable solid waste disposal limit for radioisotope you are using. If the information is not available, please contact HSE for assistance.

**** Note: If a researcher needs to use animals with radioactivity in amounts that are greater than the disposal limits, they must first obtain permission from the Radiation Safety Office.

Excerpt from Table 5 of the UBC Radionuclide Safety and Methodology Reference Manual

Isotope	Disposal Limits	
	Solid Activity/kg	
	kBq/kg	µCi/kg
H-3	3,700	100
C-14	370	10
Na-22	1	.027
P-32	37	1
P-33	100	2.7
S-35	37	1
Ca-45	37	1
Cr-51	3700	100
I-125	3.7	0.1

In Summary:

	Radioactive Waste	Biohazard (Animal) Waste with Radioisotope
Low-Activity, Short half-life (<90 days)	Decay if required to acceptable disposal criteria in Table 5. Once at the disposal level, remove all "Radiation" warning labels. Measure waste "field" with a survey meter. (must be <2.5uSv/hr) Waste is taken by laboratory staff directly to the building disposal area (dumpster). This is NOT the responsibility of housekeeping staff.	Decay if required **in a freezer** to the acceptable disposal level in Table 5. Measure waste "field" with a survey meter. (must be <2.5uSv/hr) Once the disposal level is reached, waste is removed following appropriate Biohazard Waste procedure[1].
Low Activity, long half-life	Waste that already meets the acceptable disposal level in Table 5 falls into this category. The waste may be disposed of into the solid waste stream and is removed to the building disposal area (dumpster) by laboratory staff.	Radioactivity level MUST be equal to or less than disposal limit at the beginning of the experiment. Waste is disposed of following appropriate Biohazard Waste procedures[1].
High Activity, short half-life (<90 days)	Decay if required to acceptable disposal criteria in Table 5. Once at the disposal level, remove all "Radiation" warning labels. Measure waste "field" with a survey meter. (must be <2.5uSv/hr) Waste is taken by laboratory staff directly to the building disposal area (dumpster). This is NOT the responsibility of housekeeping staff.	Hold for decay if required **in a freezer** to the acceptable disposal level in Table 5. Measure waste "field" with a survey meter. (must be <2.5uSv/hr) Once the disposal level is reached, waste is removed following appropriate Biohazard Waste procedure[1].

High Activity, long half-life	Waste is segregated by radioisotope and is placed in a new paint can. A running total of activity is maintained by the laboratory. When the paint can is full, arrangements are made with the Radiation Safety Office to have the paint can(s) shipped to Chalk River, Ontario for disposal at an approved disposal facility.	Experiments DO NOT proceed without the approval of the Radiation Safety Office.

[1] Procedures for biohazard waste disposal can be obtained from HSE. For biohazardous/anatomical waste (such as animal carcasses) a "Biohazardous Waste Disposal Tag" must be obtained from HSE. Do not include items such as disposable gloves, paper towels, bench covers, etc., with your shipment of animal waste.

Additional Administrative Requirements

1. The UBC Online purchasing system must be used to purchase and update radioisotope orders.
   http://www.hse2.ubc.ca/rad/Purchasing/login.asp