



CHEMICAL WASTE DISPOSAL MANUAL

Last revised January 22, 2018

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1.0 Overview

Dalhousie University is one of Canada's leading research universities, and as such houses a number of research and teaching laboratories that generate a wide range of hazardous chemical waste. Improper disposal of chemical waste can lead to serious risks to people and the environment. Not only does the inappropriate disposal of chemicals lead to physical harm, it can lead to legal prosecution on federal, provincial or municipal levels. Dalhousie University is committed to the proper and legal disposal of hazardous waste.

The management of chemical waste streams is everyone's responsibility. The co-operation of all members of the University community is essential to ensure that all chemical waste is disposed of in the manner described in this document.

Proper disposal is achieved through the Environmental Health and Safety Office's Hazardous Waste Disposal Program. This document describes how routine and non-routine chemical waste can be disposed of. These processes are in place for the Studley, Carleton, Sexton, and Agricultural campuses.

Please note that this document does not describe the processes for disposing of biohazardous or radioactive waste materials.

2.0 Responsibilities

As per the internal responsibility system, chemical waste management is everyone's responsibility. The following outlines the primary responsibilities that various parties on Dalhousie University campuses bear.

2.1 Deans, Directors, Department Chairs, and Administrators

The above mentioned are responsible for ensuring that all members of the Department are informed regarding the procedures described herein and for ensuring that they are adhered to. They are also responsible for ensuring that all chemical materials have clear ownership and that non-routine chemicals do not accumulate.

2.2 Environmental Health and Safety Office

The Environmental Health and Safety Office (henceforth referred to as “EHS Office”) shall arrange the collection of hazardous chemical waste from generators in a safe and timely manner. This shall be primarily be accomplished through the Chemical Waste Collection. The EHS Office will:

- assist university waste generators with inquiries regarding hazardous chemical safety, storage, and disposal;
- accept feedback from stakeholders on a continuous basis so as to improve the program and ensure its effectiveness;
- coordinate with external contractors to ensure the proper recycling and/or disposal of the chemical wastes;
- ensure that the university chemical waste program is concurrent with all federal, provincial and municipal regulations, and;
- serve as a liaison to regulators on behalf of the University.

2.3 Supervisors, Researchers, and Principal Investigators

Supervisors, researchers, and principal investigators (henceforth referred to as “supervisors”) are responsible for complying with the procedures described in this document and for seeking guidance from the EHS Office as needed.

Supervisors are responsible for:

- prearranging waste handling and disposal methods for laboratory experiments;
- segregating incompatible waste streams, and ensuring that they are stored correctly;
- ensuring that routine waste is transported in a secondary means of containment;
- reducing the volume of chemical waste produced by routine operations, and;
- ensuring that non-routine chemical wastes do not accumulate.

Supervisors are responsible for ensuring that all personnel being supervised (both staff and students) are aware of and adhere to the proper handling, safety procedures, and

disposal methods. Supervisors are responsible for ensuring that all information submitted to the EHS Office is accurate and correct.

2.4 Employee

Employees are responsible for adhering to the procedures described within this document. Employees are responsible for ensuring that their supervisor has provided and/or directed them with the correct training in accordance with the work that they will be carrying out. They are responsible for segregating incompatible waste streams as described. When employees are directed by their supervisor to submit information to the EHS Office, they are responsible for ensuring that the information is accurate and correct.

2.5 Student

Students are responsible for adhering to the procedures described within this document. Students are responsible for ensuring that their supervisor has provided and/or directed them with the correct training in accordance with the work that they will be carrying out.

3.0 Waste Minimization

Waste minimization strategies are crucial to reducing the volume and toxicity of chemical waste that are being disposed from the university. The benefits of waste minimization strategies include reducing potential health hazards, decreasing pollution, decreasing costs for various parties, and reducing potential long-term liabilities for disposal.

Methods that can be used to minimize the amount of chemical waste a laboratory generates include:

- limiting the amount of chemicals that are purchased;
- purchasing only what will be used;
- substitution with less hazardous chemicals in an experiment and/or process;
- practicing waste stream segregation;

- clearly labelling containers to prevent contents becoming unknown;
- reducing the scale of experiments and/or processes to reduce the volume of waste generated;
- purchasing cylinders from manufacturers that will take it back once empty;
- neutralize, quench, or otherwise destroy hazardous by-products as the final step of an experiment's procedure, and;
- actively manage the chemical inventory.

These methods are simple, yet effective in reducing chemical waste at the university. Waste generators are strongly encouraged to actively explore and incorporate waste minimization strategies as a vital role in research and teaching operations.

4.0 Waste Segregation

Clearly defining hazardous and non-hazardous waste streams in a laboratory, and the proper storage of hazardous materials are techniques that aid in maintaining the safety of the university community.

Accidental mixing of chemicals can result in fire, explosion, and/or the release of other chemical and physical hazards. Documents that list incompatible chemicals, such as Safety Data Sheets, can aid in determining which waste stream a material can be categorized in, and how it should be stored.

4.1 Waste Streams

Solvent wastes and solid wastes are to be segregated from one another.

Waste solvent are to be segregated into the following waste streams:

- Aqueous; pH < 6
- Aqueous; pH = 6-9
- Aqueous; pH > 9
- Non-halogenated (i.e. acetone, ethyl acetate, hexanes, etc.)
- Halogenated (i.e. chloroform, dichloromethane, etc.)

- Waste oil (i.e. vacuum pump oil, motor oil, etc.)

The hazardous waste streams listed above are the ones most common at the university, however there are others that may be generated at the university as well. Always use professional judgement when segregating waste streams.

Waste solvents may not contain undissolved solids or solid non-hazardous materials (i.e. disposable pipettes, gloves, glassware, etc.). Immiscible solvents may not be combined in a single container.

It is important to segregate halogenated solvents from those that are non-halogenated. The disposal of one drum halogenated waste solvents costs approximately twice as much as disposing of one drum of non-halogenated waste solvents.

Disposing of hazardous materials via the sewer is not an appropriate disposal method. Examples of dilute solutions for which drain disposal may be appropriate include saline, fructose, and yeast extract.

Solid waste should also be segregated according to their chemical properties.

Sample vials containing small volumes of solid chemical waste must be segregated according to their properties (i.e. keep organic and inorganic materials separate).

Samples vials should not be mixed with other materials, such as chemically contaminated labware.

Refer to Appendix A: Specific Use and Disposal Considerations for more information in regards to hazardous solvent and solid waste streams.

4.2 Storage

It is important to store chemicals based on their chemical properties to avoid unintended reactions. Materials should never be stored based on alphabetical order. Materials should be stored in cabinets designed for the chemical hazards that they present. For example, flammable materials should be stored in a flammable cabinet, acids in an acid cabinet, and so on.

5.0 Chemical Waste Collection

The Chemical Waste Collection is solely for the disposal of chemical waste that is generated as a direct result of routine laboratory operations. The materials that can be accepted include, but is not limited to:

- research solvent waste;
- scintillation vials;
- chemically contaminated sharps, and;
- chemically contaminated materials used to clean up a chemical spill.

Refer to Section 6.0 Non-routine Materials for information on how to dispose of non-routine chemical waste.

5.1 Labelling

All waste containers must have an accompanying label indicating the contents of the container to which it is affixed. The safety of all personnel involved is contingent on the accurate identification of the contents and the labeling of the waste containers. All information must be printed clearly or else the container may be rejected.

Figure 1 provides an example of a completed standard label, known as the Waste Solvent Disposal Form. Despite the name, this form may also be used for solid wastes.

<p> ENVIRONMENTAL HEALTH AND SAFETY OFFICE (For more information call: 902.494.2495)</p> <p align="center"><u>WASTE SOLVENT DISPOSAL FORM</u></p> <p>Name of Submitter: <u>John Smith</u> Supervisor: <u>Dr. Jane Doe</u> <small>please print (first and last names)</small></p> <p>Date: <u>Feb 5, 2018</u> Phone: <u>x1234</u> Building: <u>D-building</u> Room: <u>5678</u> Department: <u>PEAS</u></p> <p>Note: 1 - incomplete or illegible forms will not be accepted. 2 - unknowns will not be accepted. <small>complete reverse</small></p>	<p> ENVIRONMENTAL HEALTH AND SAFETY OFFICE (For more information call: 902.494.2495)</p> <p>Waste Streams (select one): <input type="checkbox"/> aqueous (pH = ___) <input type="checkbox"/> halogenated <input type="checkbox"/> waste oil <input checked="" type="checkbox"/> non-halogenated</p> <table border="1" style="width: 100%;"> <thead> <tr> <th>Components (non-abbreviated names)</th> <th>Percent</th> </tr> </thead> <tbody> <tr> <td>Ethyl acetate</td> <td>20%</td> </tr> <tr> <td>Acetone</td> <td>30%</td> </tr> <tr> <td>Hexanes</td> <td>50%</td> </tr> <tr> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> </tr> </tbody> </table> <p align="right"><small>complete reverse</small></p>	Components (non-abbreviated names)	Percent	Ethyl acetate	20%	Acetone	30%	Hexanes	50%				
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Figure 1: Sample chemical waste label

The first side of the label requires submitter information. The submitter is the individual actually passing the container into the EHS Office's possession. The phone number provided must be one at which a voicemail message can be left and is checked on a minimum of a daily basis during the work week.

Please observe the "Note" at the bottom of the first side of the label. If the label is incomplete, the personnel with possession of the container will be asked to either complete the tag onsite, or to make corrections in time for the following collection date.

The second side of the label requires information regarding the contents of the container. If the contents do not conform to any of the options presented in the "Waste Streams" section, then the section may be left blank.

The "Components" section is where a breakdown of the chemicals is listed in terms of percentage for solvent waste. The breakdown is not to be completed in terms of milliliters or concentration. If the material is solid waste, simply describe the solid waste and the contaminants. For example, one could write "paper towel contaminated with trace amounts of ethanol". Please note that absolutely no abbreviations, acronyms, or structural diagrams may be used on the label. The chemical name must be written in full. Containers with labels containing abbreviations may be rejected at the discretion of EHS staff.

Note that, as a result of chemical reactions, the label communicates what is in the container, not necessarily what was placed in the container. A simple example of this concept is that hydrochloric acid (HCl) and sodium hydroxide (NaOH) in the proper quantities react to form water (H₂O) and sodium chloride (NaCl). As such, water and sodium chloride would be the components identified on the label. Understanding the reaction taking place is critical to accurate labelling and ensuring the safety of all personnel involved.

A simple way to ensure an accurate labelling process is to keep a log of materials placed in each individual container. Once full, the log can then be reviewed to determine the final product(s) in the container, and the breakdown of those components.

5.2 Containers

Chemical waste must be packaged in a manner that permits it to be stored and transported without the danger of leakage, explosion, or escape of hazardous vapours. There are various types of containers that may be used to contain routine chemical waste. Containers may only be filled to 80% of the total volume capacity to allow for vapour expansion and to reduce the potential for spills occurring from moving overfilled containers. Unless waste is being added, all containers must be kept closed and stored in an appropriate location until collection. The containers should be stored based on the hazards of the waste, and away from direct sunlight and ignition sources.

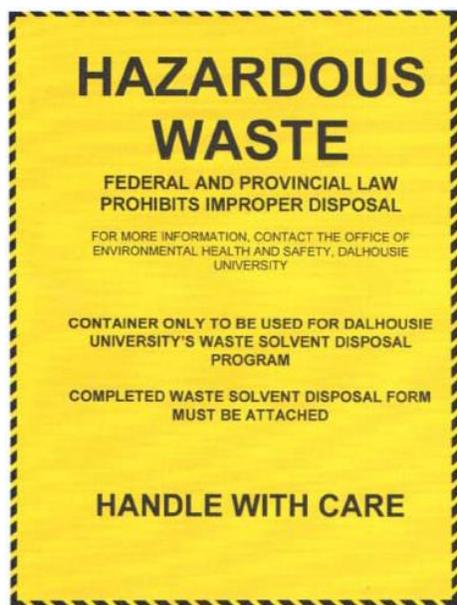


Figure 2: Hazardous waste label

The standard 4 L HDPE plastic containers are provided by the EHS Office, and can be obtained from various stores locations across Studley, Carleton, and Sexton campuses. The 4 L containers are available upon request at the Agricultural campus.

In addition to this, 20 L carboys are available upon request for Studley, Carleton, and Sexton campuses, and are generally only deliverable on collection days. The 20 L containers can be requested when submitting the Chemical Waste Disposal Form in advance of the collection date. These containers are primarily intended for groups

generating large volumes of a particular solvent waste, such as from a HPLC instrument.

Figure 2 shows the label that can be found on both the 4 L and 20 L containers.

If required, sharps containers must be purchased by the supervisor. Sharps may not be placed in non-robust containers that are prone to puncturing.

Thick, clear plastic bags may be used to package items such as scintillation vials, chemically contaminated labware, and sample vials once they have been segregated.

Do not package waste in containers that improperly identify other non-prevailing hazards. For example, chemically contaminated labware cannot be packaged in biohazard bags if no biohazard is present.

If a container is found to be damaged on collection day, EHS staff may ask the submitter to return it to the point of generation for material transfer to a container in good condition.

5.3 Chemical Waste Disposal Form

The Chemical Waste Disposal Form must be completed and submitted via e-mail, or inter-department mail to the EHS Office for receipt at least two days in advance of the collection date. Please refer to the EHS Office website for direction on who to submit the form to, as it differs depending on the campus.

The form is in an Excel file format containing two tabs. The first tab is the form that is to be completed, which includes submitter information and information regarding the chemical waste to be disposed of. The second tab, “Additional Information”, contains instructions and information to assist the Submitter while completing the form. It is recommended that the instructions be read when completing the form for the first time.

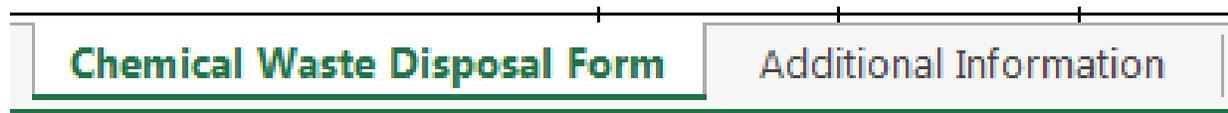


Figure 3: Tabs of Chemical Waste Disposal Form

Submission of the form indicates that the submitter agrees to the “Generator Certification”, and thus takes responsibility for the accuracy of the information recorded on the form.

The submitter will only be contacted if there is an issue with their form, or if their material cannot be accepted.

5.4 Scheduling

The Chemical Waste Collection generally occurs once a month. The most current schedule and list of locations where routine chemical waste will be collected can be found on the EHS Office website. Always refer directly to the schedule online for the most up to date information. Collections may be cancelled due to inclement weather or other scheduling constraints.

5.5 Collection

Chemical waste must be transported by the submitter to the pre-designated pickup location in a means of secondary containment. The submitter must don appropriate personal protective equipment. The chemical waste cannot be left unattended under any circumstances. The submitter will arrive at the time specified on the schedule, and remain with their chemical waste until it is inspected and removed by EHS staff.

5.6 Chemistry Department Collection

The Chemistry Department follows an altered procedure to dispose of their routine chemical waste. Contact the EHS Office for information regarding this procedure.

6.0 Non-routine Materials

Materials that are not generated as a result of routine operations must be disposed of in accordance with the following procedure. Materials that fall into the category of non-routine chemical waste include:

- partially used chemicals (i.e. a container that was opened, and only some of the contents were used in an experiment);

- surplus materials (i.e. too much of a material was ordered);
- unknown materials, and;
- expired materials.

The disposal of non-routine chemical waste is not centrally funded by the University. As such, recovery fees are implemented to cover the cost of disposal, and are to be paid by the supervisor, group, or department coordinating the removal of the material.

6.1 Non-routine Collection Procedure

The EHS Office must be notified of the possession of material that cannot be taken through the Chemical Waste Collection. Please note that the process may take several months, thus it is important to complete this first step as early as possible.

The Chemical Waste Disposal Form must be filled out with all of the non-routine materials that are to be disposed of and submit it either via e-mail, or inter-departmental mail to the EHS Office. In the case of a principal investigator/professor departing the university, it may be permissible to alternatively submit an updated chemical inventory. Once submitted, EHS staff may wish to visit the laboratory to evaluate the condition of the materials and determine the scope of the work.

An estimate will be obtained and provided to the submitter. Please note that the estimate may vary from the recovery fee invoiced due to the condition of the materials, and work completion time. The submitter must then obtain approval to pay approximately that amount, and then communicate the approval to EHS staff. The process cannot proceed until this task is complete.

EHS staff will then propose a date range to the Submitter for the collection of the material based on the routine Chemical Waste Collection schedule. Once the submitter approves, a date will be fixed by EHS staff approximately a week in advance. The date of the non-routine collection may change due to weather or other time constraining factors.

7.0 Post-collection

Following routine and non-routine collections, the chemical wastes are taken to a chemical storage facility where items are sorted and either co-mingled or lab packed according to their chemical properties.

The EHS Office makes every effort to encourage waste minimization, and to lead by example. As a result, many of these materials, such as flammable solvents and lead acid batteries, are recycled. Other materials are sent to a licensed hazardous waste disposal firm.

Over the last 20+ years, more than 150,000 kg of hazardous waste material were removed which corresponds to roughly 30,000 individual items every year.

APPENDIX A: Definitions

Chemical waste: Materials that exhibit hazardous chemical properties that are spent, or expired as a result of routine or non-routine use

Generator: Any individual working with chemicals and/or is responsible for its disposal

Regulator: Individuals or organizations that are empowered by legislation, be it federal, provincial, or municipal, to oversee a given Act

Secondary containment: An object that would contain a material should its primary means of containment should fail. (i.e. a spill tray)

Stakeholder: All university personnel who utilize the services offered through the Hazardous Waste Disposal Program

University: Dalhousie University

APPENDIX B: Specific Use and Disposal Considerations

Aqua regia

Aqua regia is an oxidizer, and will oxidize over time; this will form toxic gases, such as nitrogen dioxide and chlorine. The use of aqua regia at the university is strongly discouraged, and as such solutions will not be accepted through the Chemical Waste Collection.

Chemical containers

Chemical containers which have been emptied by all practicable means (i.e. pouring, pumping, scraping, etc.), are considered trash. The EHS Office recommends triple rinsing empty containers with water before disposing of them. Labels on containers should be defaced, or removed before disposal. It is preferable that glass containers placed in a lined, sturdy box labelled as "Broken Glass". To reduce any uncertainty, laboratory staff should place the box in the dumpster since custodians do not handle chemicals, including nonhazardous laboratory chemicals.

Chromic acid

Chromic acid is a powerful oxidizing agent. It is both toxic and corrosive, and it can also explode on contact with organic materials. Moreover, chromium (VI) is also classified as a carcinogen. Burns to both the skin and clothing may arise from accidents involving chromic acid cleaning solutions.

The EHS Office highly advocates the use of chromic acid alternatives such as "NOCHROMIX", "Alconox", or similar type products which can be ordered through various suppliers such as VWR and MilliporeSigma. Do not attempt to neutralize chromic acid: dispose of chromic acid waste through the Chemical Waste Collection.

Ethidium bromide

Ethidium bromide is a mutagenic chemical that can present a risk due to its ability to modify an organism's genetic material. Deactivation of ethidium bromide waste materials must be incorporated as a last step in the research protocol.

Gas Cylinders

Compressed gases are among the most problematic wastes to handle and dispose. Rent gas cylinders if at all possible so cylinders can be returned to the gas vendors if empty or not routinely used.

Lecture bottles can be a serious disposal problem. If at all possible, return these to the manufacturer or supplier for reuse. Ensure that the label on each cylinder is legible. Keep the valve protection cap on the cylinder when not in use. When the cylinder is in use, keep this valve cap near the cylinder so that it does not get misplaced.

Never dispose of hazardous gases by releasing outdoors or in a fume hood.

Hydrofluoric acid

Hydrofluoric acid is a strong corrosive and highly toxic chemical that causes severe burns from dilute solutions, and exposure to concentrated solutions can be fatal. Hydrofluoric acid must only be used in a fume hood. Personnel using hydrofluoric acid must purchase a tube of calcium gluconate gel, which is used as an initial response to skin exposure of hydrofluoric acid.

The quantities of hydrofluoric acid that are used and stored should be kept to an absolute minimum. Hydrofluoric acid and its waste must be stored in plastic containers due to its ability to etch glass. As a safety precaution, the EHS Office recommends that calcium hydroxide be added to any mixtures or dilute solutions of hydrofluoric acid waste to help bind the fluoride ions.

Labware

Generally, chemically contaminated labware can only be placed into the regular trash if they are non-hazardous, non-ignitable, non-reactive, non-carcinogenic, non-mutagenic, non-infectious, non-radioactive, and the contaminant is not highly toxic. Examples include disposable items such as gloves, bench top coverings, pipettes, and test tubes.

If the normal trash is not an appropriate disposal route for your chemically contaminated labware, then package them in a thick clear plastic bag or leak-proof container and label with a hazardous waste tag as “Chemically Contaminated Labware” with the name and

approximate percentage of chemical contaminants. These can then be disposed of through the routine Chemical Waste Collection.

Lithium metal

Lithium metal reacts violently with water, strong oxidants, acids, and other compounds. It may also spontaneously ignite upon contact with air (as there is moisture in air). Any activity involving lithium metal must take place in a glove box. To safely dispose of lithium metal via the Chemical Waste Collection, it must be placed in a sealable container with mineral oil. The mineral oil must cover all of the lithium metal, plus take up a minimum of an inch of additional headspace.

Mercury

Metallic mercury is collected and sent out for retort and recycling. Packaged mercury in a tightly sealed and leak free container (for instance a vial or bottle with a screw top lid). Broken mercury thermometers should be also placed in a leak proof container or a secured thick plastic bag. Avoid mixing metallic mercury with other chemicals or waste if possible.

Although the practice of adding sulfur in attempt to contain mercury vapors was at one time acceptable, it often results in more hazardous waste being generated. Often times, it may also render the metallic mercury as non-recyclable. Commercially available absorbents such as "Hg Absorb" powder are acceptable.

Mercury is a highly toxic chemical. Any mercury spills, including broken thermometers, have to be cleaned up immediately. The spill debris can then be disposed of through the Chemical Waste Collection. Never use a regular vacuum cleaner to clean up a mercury spill, this will only cause the mercury to vaporize and disperse into the air.

Mixed wastes

In some instances, waste generated from research activities may contain a combination of biological, chemical, and radioactive materials. Waste of this nature present a conundrum for disposal. As such, these types of waste must be treated on a case-by-case basis, and may involve inactivation and disposal.

As a general rule for waste containing combinations of hazardous chemical, radioactive and biological agents, the radioactive hazard should be dealt with first. Following this, the remaining waste can be disposed of as chemical or biological waste.

Nitric Acid

Many reported waste container ruptures and explosions in laboratories involve the accidental mixing of nitric acid with reducing agents (i.e. organic compounds). Avoid creating nitric acid waste mixtures with acetone, acetic acid, acetic anhydride, alkali metals, cyanides, aldehydes, powdered metals organic materials, ammonia, acetonitrile, alcohols, acrylonitrile and other organic matter. Nitric acid is a powerful oxidant and reacts violently, sometimes explosively with liberation of toxic nitrogen oxides. Oxidation is invariably accompanied by more or less gas evolution, usually capable of rupturing closed vessels.

Perchloric acid

Perchloric acid is a corrosive acid, as well as a strong oxidizer. Perchloric acid can react with metal to form shock sensitive metal perchlorates, and can occur when it is used in a regular (non-perchloric acid) fume hood. Due to the reactive nature, do not attempt to neutralize perchloric acid. Dispose of perchloric acid waste through the Chemical Waste Collection.

Piranha solution

When making the solution, the reaction is extremely exothermic. The use of piranha etch solution at the university is strongly discouraged, and as such solutions will not be accepted through the Chemical Waste Collection.

Silica gel

Used silica gel that is contaminated with solvents or other hazardous chemicals must be disposed as hazardous waste. Please ensure that the silica is dry of any solvent prior to disposal. Used silica gel that appears free flowing and dry still may have chemical contamination significant enough to classify it as hazardous waste according to regulations. Only unused silica gel, molecular sieves or desiccants that have not been in

contact with hazardous chemicals may be disposed of in the regular trash within a sealed container.

Unknown material

Chemicals that cannot be identified are considered unknown hazardous waste. Do not bring wastes that are not properly identified to the pickup site. It is the generator's responsibility to identify and properly label all chemical wastes. The disposal company cannot legally transport or dispose of unidentified/unknown waste.

Arrangements for chemical analysis of unknowns can be made through the EHS Office. Prior to contacting the EHS Office, find out as much information as possible about the material (i.e. contact people no longer at the university). Refer to section 6.0 Non-routine Materials for more information.