MANITOBA
School Boards
ASSOCIATION

Rehab the LAB

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This guideline has been prepared by John Elias from materials used by Keith Thomas and John Elias for the Manitoba Rehab the Lab Program.

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INTRODUCTION

Safety in school laboratories has been an ongoing concern in Manitoba for some time. The first major effort was the Department of Education's Safety in Science guideline prepared by the Safety in the Laboratory Committee (SILC) in 1982. In 2010 the program under the guidance of the Manitoba School Boards Association updated the program based on the Rehab the Lab program started by Dave Waddell (dave.waddell@kingcounty.gov).

There are many facets of school laboratory safety. This three part series will walk us through the proper selection and storage of chemicals used in school laboratories. Other parts will review what good chemical storage is, and then look at good chemical management.

We are trying to control unnecessary risks, not eliminate all risks. Eliminating all risks can best be done by using virtual labs. We believe that it is best for students to learn to handle chemicals safely in the controlled teaching environment of a school rather than later in a less well controlled workplace.

Part 1
Eliminate the Hazard

STEP 1- Reduce the Hazards

The first step in controlling any risk is to remove the hazard. In this case, the unnecessary hazards to be removed are those presented by unnecessary chemicals. If the unnecessary hazard is gone, the risk goes with it. Here we define "unnecessary chemicals" are those that are not needed to teach the principles involved. There will still be some residual hazards and risks associated with the chemicals needed to teach. Risk can only be eliminated by removing all hazards. Unfortunately, removing all risks will also remove teaching opportunities. Therefore we must think in terms of acceptable levels of risk.

To control risk, we suggest getting rid of unnecessary chemicals. This does two things. The first effect obviously is to reduce hazards and thus risks. The second effect is to reduce the problem to a more manageable size, reducing hazards and risks again, but also increasing the probability of success.

HAZARD ≠ RISK

Hazard: This is the potential for harm if a person comes in contact with a chemical

Risk: This is the probability that a hazard will come in contact with a susceptible target in sufficient quantity to have an adverse effect.

Get rid of excessive amounts of chemicals.
The first and easiest factor to reduce excessive risk is to reduce the quantity of materials in the school. At this point we are not looking at whether or not a chemical is needed, just how much is available.

Six containers of potassium chlorate, one was 21 years old.

The picture to the left shows six containers of potassium chlorate. One unopened container was purchased in 1989, and another unopened container in 1995. Even if this was not a high risk chemical (strong oxidizer), this would be an excessive amount of any chemical.

Risk increases with the amount of hazardous materials present, even when the hazard is low. If the risk is unnecessary it should be avoided regardless of how low it is.

Also, making repeat orders of the same material is an unnecessary expense, and although seen often it is hard to explain.

How much chemical is on hand can be measured in the number of containers of chemical is on hand, but also the size of the containers. Chemicals should be purchased in the smallest amounts that are reasonably practicable. Often larger sizes are purchased because the cost/gram is lower. This can be a false economy as well as dangerous if the material deteriorates (such as ethyl ether) to become an explosive. If a material will not be used in a reasonable time, buy the smallest amount possible.

As seen in the picture to the right, the materials are compromising the containers. Not only are they becoming dangerous, but they are likely contaminated.

Get rid of unneeded or unused chemicals.
The picture on the right also demonstrates that the material is not often used, or has not been used in a long time. (Or the condition of the container and the quality of the contents has been ignored.)

Example of material where the best-before-date passed before the material was used.

Materials that have not been used in a long time should be removed from the school. If they are not going to be used, their presence is an unnecessary risk in the school.

Where only one teacher is using the chemicals it is relatively easy for that teacher to decide what chemicals are unnecessary. Often materials accumulate over the years from one-time projects, and then sit there until something goes wrong. Often a new teacher coming into the laboratory finds that they have “inherited” many “orphaned” materials. In any case a decision must be made to get rid of these unused chemicals. If there is not a process in place to authorize the removal of such materials one should be developed.

In larger schools where there may be several teachers working out of the same chemical supply, there could be uncertainty as to whether or not a chemical is in fact unneeded. If someone is using what appears to be a forgotten chemical, you do not want to get rid of it. It has been suggested that where there is uncertainty, a piece of tape be placed over the lid of container and the date should be written on the tape. Next year, if the tape is undisturbed, add it to the list for that year’s disposal.

Get rid of dangerous chemicals.
There are some chemicals that are unusually hazardous and present an excessive risk that outweighs the educational benefits that may come from using the chemical. Appendix A is a list of some materials where the risk exceeds the educational utility. These materials should not be in the school, and should be removed as soon as possible.

Mercury: still found in many school labs.

NOTE: See Safety in the Science Classroom (K–12) prepared by Alberta Education, Appendix K for additional information. This can be found at:

http://www.education.gov.ab.ca/k_12/curriculum/bySubject/science/default.asp.

There is a second class of unusually hazardous chemicals that are high risk, but have some educational benefits. Appendix B is a list of such materials. These materials should be purchased in small amounts such that they will be used and then any remaining materials will be immediately disposed of. If any of these materials are present in the storage area, they should be got rid of. If they are to be used in the future small amounts of fresh material can be purchased and when the demonstration as been completed, any remaining material can be properly disposed of.

Make an inventory of remaining chemicals.
Now that the chemicals remaining in the laboratory have been trimmed down to a manageable and acceptable level of risk, an inventory of the chemicals should be made.

Chapter 8 of the Alberta guidelines suggests the following information to be listed in the inventory. The inventory should be kept on a computer so that it is easy to update. The purchase date should also be written on each container of chemicals in the inventory.

Chemical	Quantity	Supplier	MSDS Mo/Yr	Purchase Date	WHMIS Class	Storage Location	Disposal	Disposal Date (Empties)
Acetic acid (glacial)	4 L	Chem North	Nov-03	Dec-03	E,B	Acid cabinet	WF/I	Feb-04
Ethanol	2 L	Chem North	Jan-03	Jan-03	B, D1,D2	Flammables cabinet	A,WF/I	March-04

The inventory should be reviewed at the start of each year to ensure that it is current. The reviewed inventory should be signed and dated by whoever did the review.

STEP 2 - Disposal of Chemicals

In Step 1, we referred to “getting rid” of unwanted chemicals. The unwanted chemicals must be disposed of properly and safely. They are not just poured down the sink and hope for the best. Also, for environmental purposes they should not be put in the nearest landfill. The process must be carefully planned to avoid potential disasters during the attempt to avoid such disasters.

Segregate the Chemicals
Before starting to remove chemicals from the shelves, spend a few minutes planning how this is to be done. Do not just start to remove random bottles and piling them in a corner.

The first thing to do is to identify a location where the unwanted chemicals can be safely stored. This should be away from students, in a warm dry location.

All chemicals should be placed in plastic trays large enough to contain any materials that may spill. Enough plastic trays should be available to segregate incompatible chemicals. Below is a basic system for short-term storage chemicals to be disposed of. It was taken from Safety in the Science Classroom (K–12), Chapter 8, prepared by Alberta Education. That guideline also contains a more detailed storage system for a broader mix of hazardous chemicals.

Oxidizing Agents	General	Flammable Solids
Acids	Bases	Flammable Liquids

The materials should be handled with care to ensure that containers, specially corroded containers, are not broken.

Materials should never be stacked in the tray so that one material is on top of another.
Absorbent materials (asbestos-free vermiculite or diatomaceous earth) should be placed inside the tray to absorb any spill.

Materials should never be mixed. This could result in an unexpected reaction. It will increase the cost of disposal.

Dispose of the Chemicals
The best way to get rid of unwanted laboratory chemicals is to find another user for them. Perhaps there is a nearby school looking for one of the materials you want to get rid of. Giving it to them would save disposal fees for you, and purchase costs for them. Both will come out ahead.

If finding another use for your chemicals is not possible, the safest way to get rid of them is to have a qualified waste handler pick up the materials for proper disposal.

REVIEW

At this point:

1. All chemicals that present an unacceptable risk should have been removed at this time
2. The amount of each chemical should be reduced to reasonable amount.
3. The school should now have a reduced inventory of only necessary chemicals so that the next steps can be easily achieved.

Part 2
Good Storage

INTRODUCTION –

In this part, we want to design a system to store laboratory chemicals that will reduce risk to those in the school. The task has been made easier in Part 1by:

1. reducing the number of chemicals that need to be stored;
2. removing the most hazardous chemicals; and
3. reducing the amount of each chemical to be stored.

The task now is to store the remaining needed chemicals in such a way that the risks they present will be minimized.

Safe chemical storage is often seen as a two related functions:

1. simple safe storage of chemicals; and
2. safe preparation of working materials for the classroom.

These are ideally carried out in the same area, the storage room. However, where conditions are not optimal to do this, preparation often takes place in the classroom where facilities are available and when students are not present. Chemical preparation will not be reviewed as part of chemical storage.

SAFE STORAGE

Many laboratory operations have a large number of chemicals on site. Logistics requires that chemicals be stored on site so that they are readily available when they are needed. Each chemical possesses its own type and degree of hazard. The combination of a large number of chemicals stored on site with each chemical having its own type and degree of hazard makes the safe storage of these products a formidable challenge. Even small amounts of chemicals can present a challenge where resources are not available.

There are many examples of cases where improper storage has resulted in chemical accidents. Proper storage of chemical involves 2 facets:

- the separation and isolation of chemicals from other incompatible chemicals; and
- the use of appropriate storage conditions for the chemical and toxicological properties of each chemical.

Chemicals stored in alphabetical order

For ease of locating chemicals, many storerooms organize chemicals alphabetically. However, chemical storage based upon an alphabetical arrangement of chemicals may inadvertently locate incompatible materials in close proximity. A few examples of this potentially dangerous storage method are demonstrated by the following pairs of incompatible materials:

Examples of Incompatible Pairs of Chemicals and Potential Reactions Caused by Alphabetical Storage of Chemicals

Chemicals	Reaction
acetic acid and acetaldehyde	polymerization of acetaldehyde
copper (II) sulfide and cadmium chlorate	explosive reaction
hydrogen peroxide and iron (II) sulfide	reacts vigorously
sodium nitrite and sodium thiosulfate	explosive when heated

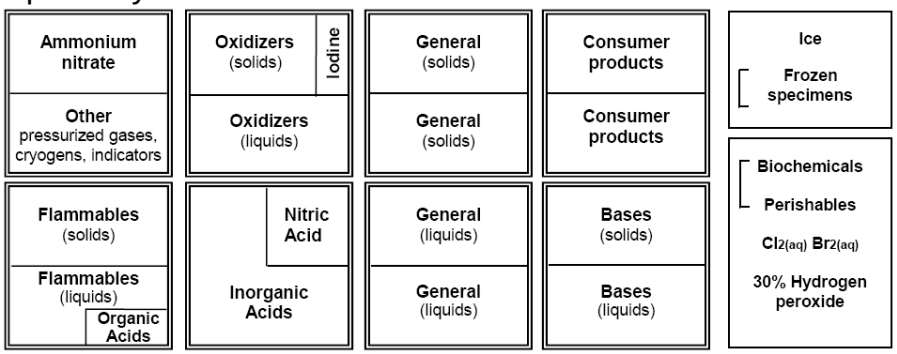
A complete chemical storage program requires more than just proper separation and storage of chemicals. The following steps take us through the five essential aspects of a complete chemical storage program.

STEP 1 - Minimize the Volumes

This step was covered in Part 1 of this series. The first step in ensuring safe chemical storage in your laboratory is to store as little of each chemical as possible. Ideally, your laboratory should have an inventory control system to keep track of all chemicals in storage. If you do need to buy a chemical, use the "just-in-time" system of ordering, i.e., order only what you need over the short term. Mark chemicals that decompose over time with the date they are received, the date they are opened, and if appropriate, the date they should be discarded. A well-managed inventory control system minimizes the amount of chemicals ordered, stored, and disposed of, which saves money and reduces chemical hazards.

STEP 2 - Separate Incompatible Products

The system below provides for adequate separation of chemicals in schools that offer science programs from grades 9 to 12. The system includes provision for refrigerated storage of some chemicals. It was taken from Safety in the Science Classroom (K–12), Chapter 8, prepared by Alberta Education



Definition of storage groups

Group	Definition	Examples	Storage Conditions	Incompatibilities
Flammable Gas	A compressed gas. Forms a flammable mixture in air over a significant range of concentration.	Propane Acetylene	A cool dry ventilated area away from ignition sources. Cylinders should be stored in an upright position. Full and empty cylinders should be separated.	Oxidizers Reactive materials Explosives Heat/ignition sources
Flammable solids or liquids	Can be ignited at normal temperatures. Can cause a fire through friction or retained heat.	Gasoline White phosphorus Metal powders, Carbon, Charcoal	A cool dry ventilated area away from ignition sources. Provide adequate ventilation to avoid buildup of vapours. Explosion proof lighting. Provide grounding to prevent discharge when decanting. Ideally, flammables should be in a special cabinet manufactured for this purpose.	Oxidizers Reactive materials Heat/ignition sources
Nonflammable gas	A compressed gas. Or A dissolved gas. Or A gas liquefied through compression.	Argon Compressed air	A cool dry ventilated area away from ignition sources. Cylinders should be stored in an upright position. Full and empty cylinders should be separated.	Flammables Reactive materials Explosives Heat/ignition sources
Oxidizer	Can cause or contribute to the combustion of other materials by yielding oxygen. Or An organic peroxide	Nitrates Nitrites Hypochlorites Benzoyl peroxide potassium permanganate Iodine solids	A cool dry ventilated area away from ignition sources. Keep out of direct sunlight or rapid temperature changes. Normal firefighting methods may be ineffective.	Corrosives Flammables Organic materials Ignition sources
Acids	pH < 7 Significantly corrodes steel or aluminum. Corrosive to skin.	Hydrochloric Acid Sulfuric Acid	A cool dry ventilated area away from ignition sources. Store in appropriate or approved containers. Shelving should be non-corrosive or metal covered with acid resistant paint. Inspect area for signs of corrosion. Store organic acids above or separate from inorganic acids.	Flammables Oxidizers Organic materials
Bases	pH>7 Significantly corrodes steel or aluminum. Corrosive to skin.	Sodium hydroxide Potassium hydroxide	A cool dry ventilated area away from ignition sources. Store in appropriate or approved containers. Shelving should be non-corrosive or metal covered with acid resistant paint. Inspect area for signs of corrosion.	Flammables Oxidizers Organic materials
General	Not otherwise classified		A cool dry ventilated area away from ignition sources. Toxic materials may be stored separately.	Oxidizers Reactive materials Flammables

If a refrigerator is used for storing chemicals in a laboratory, it should be explosion-proof. Flammable liquids can give off vapours that can be ignited by the electrical components of a standard refrigerator.

Example of a corroded metal storage area.

STEP 3 - Label All Products

Label all chemicals clearly and completely. Each container should bear the components, the hazards, and the disposal date. Use markers that do not smear or run when exposed to the contents of the container. Check the chemical's MSDS to determine the proper storage container for that product, (e.g., one that protects against exposure to light and heat). Be sure to seal it securely and use secondary containment if the chemical presents a serious hazard.

STEP 4 - Shelf Management

Large containers stored on lower shelves,

Practice good shelf management techniques. Cabinets should be clearly marked, with shallow shelves that have lips. Organize containers in staggered rows with the labels facing out. Keep heavy and large items on lower shelves. Don't overload or overcrowd shelves. Keep shelves and cabinets clean and well organized. Use secondary containment (e.g., drip trays) whenever possible. Storage areas should be inspected periodically for leaks, damage to shelving, overcrowding, or expired chemicals.

Large containers should be kept on lower shelves. High shelves should not be used for hazardous materials.

Only non-hazardous items stored on high shelves.

STEP 5 - Emergency Preparedness

Ensure that your emergency response plan is complete and up-to-date. Make sure that staff is adequately trained to deal with chemical spills and that the appropriate spill

cleanup materials and personal protective equipment are readily available.

NOTE: Separating all the incompatible chemicals can take up space that may not be available in all schools. Failure to separate the incompatible chemicals can increase risk to staff and students. Below is a worst case example of inadequate space allocation leading to unacceptable levels of risk. Proper storage could well turn out to be a budgeting item.

Chemical storage cabinet.

(This was not staged)

(Honest)

Proper space must be provided for the safe storage of chemicals.

REVIEW

At this point:

1. The chemical inventory has been reduced to the necessary low hazard materials.
2. A secure temperature controlled and ventilated space is available for chemical storage.
3. The storage area has been divided into separate section for each class of hazard.
4. Where necessary explosion proof cabinets have been provided for flammable materials.
5. Separate ventilated cabinets are available for acids and bases.
6. All chemicals are properly labeled, inventoried and placed in their appropriate section.

OR

Deficiencies have been identified and a remediation plan developed for implementation.

Part 3
Safe Storage Area Management

INTRODUCTION

In this part, we want to develop a program to maintain an inventory of needed chemicals with an acceptable level of risk. This task has been made easier by Part 1 and Part 2 by:

1. reducing the number of chemicals that need to be stored;
2. removing the most hazardous chemicals;
3. reducing the amount of each chemical to be stored; and
4. The storage area has been divided into separate section for each class of hazard.

The task now is to manage the storage system to keep unacceptably high risk chemicals out.

At this time the chemical inventory has by now been pared down to chemicals with acceptable hazards and manageable amounts of each chemical. The chemicals are safely stored away from other incompatible materials in appropriate areas. The task now is to ensure that the system is used properly in the future.

STEP 1 – Check Inventories

A major part of managing the chemicals is knowing what you have, and where it is. An accurate up-to-date inventory is essential for this. In Part 1 an inventory was made of all the chemicals held. Below is a recommended inventory from Chapter 8 of the Alberta guidelines suggesting information to be listed in the inventory. It is important to keep the inventories up-to-date. Any time a chemical is used, the inventory should be immediately updated. There should also be complete inventory reviews from time to time.

Chemical	Quantity	Supplier	MSDS Mo/Yr	Purchase Date	WHMIS Class	Storage Location	Disposal	Disposal Date (Empties)
Acetic acid (glacial)	4 L	Chem North	Nov-03	Dec-03	E,B	Acid cabinet	WF/I	Feb-04
Ethanol	2 L	Chem North	Jan-03	Jan-03	B, D1,D2	Flammables cabinet	A,WF/I	March-04

STEP 1a – Start of school year.
At the start of each school year, the inventory should be checked to determine what is available for the coming year, and what must be purchased to meet the needs of the coming lessons. The points of concern are:

1. How much chemical is in the inventory? Is it enough for the year? Do not get more.
2. Is the material in the proper storage location? If not, put it in the correct location.
3. Has the expiry date passed? If so, remove the material for disposal and go back to Point #1.
4. Does the material still have its label? If not put a proper label on it as described in Part 2 – Step 3.
5. Are there restricted chemicals on the shelf, either unusually hazardous chemicals or excessive risk chemicals? If so, take steps to dispose of them as they should not be here.
6. Are there materials in storage that are not on the inventory? If they are needed, update the inventory and ensure that they are properly labeled. If they are not needed, take steps to dispose of them as they should not be here.
7. If there are chemicals of questionable use (as described in Part 1, Step 1) in storage, and if the dated label over the top of the container is undisturbed, dispose of the chemical as it is unneeded. Update the inventory.
8. Any changes to the chemicals on the shelves should be reflected in the inventory.
9. Make all changes necessary to ensure that the inventory is accurate, sign and date it.

Step 1b – When chemicals must be purchased.
Every time a chemical is to be purchased, the inventory should be checked to make sure that the school is indeed out of that chemical. The shelves must also be checked to ensure that the inventory is correct.

Only after establishing that the chemical needed does not already exist should it be purchased. (See Step 2)

When the chemical has been received, it should be entered into the inventory and a dated label put on it.

STEP 2 – Purchasing Chemicals

Step 1 covers off a main part of the management of chemicals, knowing what you have and where it is. This step addresses control of what is added to the inventory. In Part 1, the inventory was weeded of any chemical that had an excessive hazard, and presented an unacceptable risk when introduced to the school. The two classes of high risk chemicals are addressed below.

Step 2a - Excessive Risk Chemicals
These are chemicals whose risk exceeds their educational utility. Appendix A is a list of such chemicals. Any material on the list in Appendix A should not be purchased.

If it is believed that a chemical on the list is needed to demonstrate a principle, find an alternative safer chemical, or a different way of demonstrating the principle.

This class of chemicals is easy to deal with. DON'T

Step 2b - High Risk Chemicals

These are high risk chemicals; however, there is a balancing benefit to using them if the risks can be controlled. Appendix B is a list of such chemicals. If the user is aware of the risks, they can take steps to reduce them to an acceptable level.

If it is believed that a chemical found in Appendix B is needed. The High Risk Chemical Permit found in Appendix C will help the user to identify the hazards and control the risks. The basis of the Permit is the commonly used Hot Work Permit used by welders. It works.

The permit addresses the following concerns:

Concern	**Comments**
What is the chemical and the main hazards associated with it?	This spells out the main problem.
Who wants to use it?	This is the person requesting the material and who is responsible for the safe use of the material.
What is the demonstration to be done?	What will be achieved by using this chemical?
What are the specific hazards and how will they be addressed?	Each hazard must be identified, and the action that will be taken to reduce the risk to an acceptable level. The form contains some of the most common hazards associated with chemicals. MSDS for the chemical in question or Chapter 9 of the Alberta guide can be used to help identify hazards. http://www.education.gov.ab.ca/k_12/curriculum/bySubject/science/default.asp.
How will the material be disposed of?	These materials are not to be stored in the school; therefore it is important to have a disposal process in place before getting the material.
Who is responsible?	The teacher and supervisor both must sign the Permit attesting to their knowledge of the risks and their approval of the effectiveness of the controls to reduce the risks to an acceptable level.

STEP 3 – Access Control

One identified person must have control over the storage area. An undefended storage area can be quickly filled up with anything that needs a home. This can create unnecessary risks when unknown materials and containers are placed randomly among acids, bases, oxidizers and other chemicals by people unfamiliar with the materials in the room. If not careful, the storage area shown below can be repeated.

To ensure that unexpected hazards are not introduced into the storage area, the following conditions should be avoided.

- No one should bring commercial or residential chemicals into the storage area without the permission of the person responsible. Such materials must have a MSDS and be properly labeled and classified for storage.
- The chemical storage area should not be used for storing materials from other departments. It is a chemical storage area, not an archive for old files.
- Gifts are a problem. A donor may give “free” chemicals to a school, but the materials are not “free”. The donated chemicals must have a MSDS and be properly labeled and classified for storage. When a school accepts donated chemicals, they may be accepting an unwanted responsibility particularly if the gift contains Excessive Risk or High Risk Chemicals.

STEP 4 – Create Policies

Policies or standard operating procedures should be developed to guide everyone associated with the storage of chemicals and the storage area. The guides will help new staff to use the system properly and act as reminders to others who are more familiar with the system. The guides will help prevent slippage in the program with time.

The guides must be in a format that can be changed when conditions change. Input to the guides should be from everyone involved with the program to ensure that the teaching requirements are met within the safety requirements of the school.

Part 4
Safe Disposal of Chemicals

The first three parts outlined a process to identify excess or unnecessary chemicals to be removed from the school. It is assumed that attempts to trade excess or unnecessary chemicals with neighbouring schools have been made. In addition, normal class activities will result in the generation of new wastes that will require proper disposal.

Schools should not store unwanted chemicals or wastes in anticipation of a better time to remove them. Instead, wastes and unwanted chemicals should be properly disposed of on a routine basis as soon as practicable.

The disposal of chemicals should not be the last step in the life-cycle of laboratory chemicals. As discussed with High Risk Chemicals, the disposal of the material is addressed before the chemical is purchased. This should happen with all chemicals, disposal should be addressed at the time of purchase, and a written plan developed.

NOTE: These guidelines not only apply to any chemical purchased or used, but also the product of any chemical reaction created by the use of any chemical.

The guidelines in this Part assume that the amount of materials to be disposed of is small, usually less than 1 kg, often less than 100 g. If the amount of a single material is greater than 2 kg, purchasing policies should be reviewed.

As mentioned in Part 2 the volumes of chemicals should be kept to a minimum for safety reasons. It is also important to keep volumes to a minimum to save disposal costs. It is easier to order additional chemicals than to dispose of unwanted or unused surplus chemicals.

REMEMBER: The disposal cost can be about the same as purchase cost plus travel time.

Waste minimization benefits you, the school and the environment by:

- Significantly lowering costs;
- Reducing potential health hazards;
- Reducing potential long-term liabilities for disposal;
- Promoting environmental ethics; and
- Preventing pollution.

Proper Disposal of Hazardous Wastes

There are many different ways to describe hazardous wastes such as by chemical class (chlorinated hydrocarbons, cyanides, etc.) or chemical properties (acid/base, flammable, toxic, etc.). Here, we have simplified the process. If the chemical is not listed in Addendum A or B it is a hazardous waste for the purpose of waste disposal.

The disposal of all chemicals not listed in Addendum A or B must be disposed of by a hazardous waste management company.

Waste/Used Chemicals

Hazardous waste or used chemicals from class experiments or demonstrations should be collected and held for safe disposal. The following guidelines from NIOSH are offered.

- Store all waste in containers that are in good condition and are compatible with their contents.
- Clearly and permanently label each container as to its contents and label as hazardous waste.
- Store waste in a designated area away from normal laboratory operations and to prevent unauthorized access.
- Store waste bottles away from sinks and floor drains.
- Do not completely fill waste bottles; leave several inches of space at the top of each waste container.
- Cap all waste bottles.

Empty Containers

Any container that contained a hazardous chemical must be treated as a hazardous waste unless it has been properly cleaned. All empty containers that contained hazardous chemicals must be **triple rinsed** before they can be disposed at a sanitary landfill. As mentioned, if they are not triple rinsed, the containers must be treated as hazardous waste. The residue must be collected and handled as hazardous waste.

Labels from chemical containers should be removed before discarding them as waste. There are potential liabilities associated with misperceptions or the improper handling of nonregulated as well as regulated waste. For example, a trash hauler or landfill operator may become alarmed by a laboratory chemical container, even if it contains sucrose.

Mixed Chemicals

Do not mix hazardous and non-hazardous wastes. If this happens, then the mixture must be treated as hazardous waste, and the cost for disposal of the nonhazardous portion may increase.

Release to the Atmosphere

The release of vapors to the atmosphere, by open evaporation or laboratory chemical hood, is not an acceptable disposal method. Chemical hoods, the most common source of laboratory releases to the atmosphere, are designed as safety devices to transport vapors away from laboratory personnel, not as a routine means for volatile waste disposal.

Proper Disposal of Non-Hazardous Wastes

Essentially non-hazardous wastes are aqueous chemicals that are not defined as hazardous wastes and that are simple inorganic salts/organic materials (low toxicity, high water solubility, moderate pH) and can generally be disposed of down the drain in limited and controlled

quantities. For the purpose of this guideline, non-hazardous wastes are only those listed in Addendum A or B. The lists are those developed by the University of British Columbia.

All non-listed materials are considered hazardous wastes and are to be disposed of as described in Step 1.

When safe and allowed by regulation, disposal of non-hazardous laboratory waste via the normal trash or sewer can substantially reduce disposal costs. This kind of lab waste segregation makes economic and environmental sense.

Before any chemical is disposed of via the normal trash or sewer the local authority (the manager of the local waste system) must be consulted to determine if the chemicals exceed the hazardous waste criteria for the local facility. If any material exceeds the local applicable licence or municipal by-law it cannot be disposed of via the sewer for liquids or landfill for solids. This should be done before you have a warehouse full of unwanted chemicals.

NOTE: Do not dispose of any materials or wastes in sinks and drains if your school discharges to a septic tank system.

Chemicals Safe to Throw Out With Your Garbage
Appendix A is a list of chemicals that are deemed safe to throw out with your garbage. The following are some guidelines for the disposal of non-hazardous chemicals.

- Check with local authority to confirm that the material is acceptable for this method of disposal.
- Remove or obliterate labels from containers before placing in a landfill.

Chemicals Safe to Dispose Down the Drain
Appendix B is a list of chemicals that are deemed safe to dispose down the drain. The following are some guidelines for the disposal of non-hazardous chemicals.

- Check with local authority to confirm that the material is acceptable for this method of disposal.
- Pour slowly down the drain with plenty of water to dilute it.
- The amount of water used to wash a chemical down the drain should be enough to dilute it to 1% of its original concentration.
- Wear the normal safety equipment used when handling the chemical in the laboratory
- Rinse containers and remove labels before disposal.

Part 5: Laboratory Hood

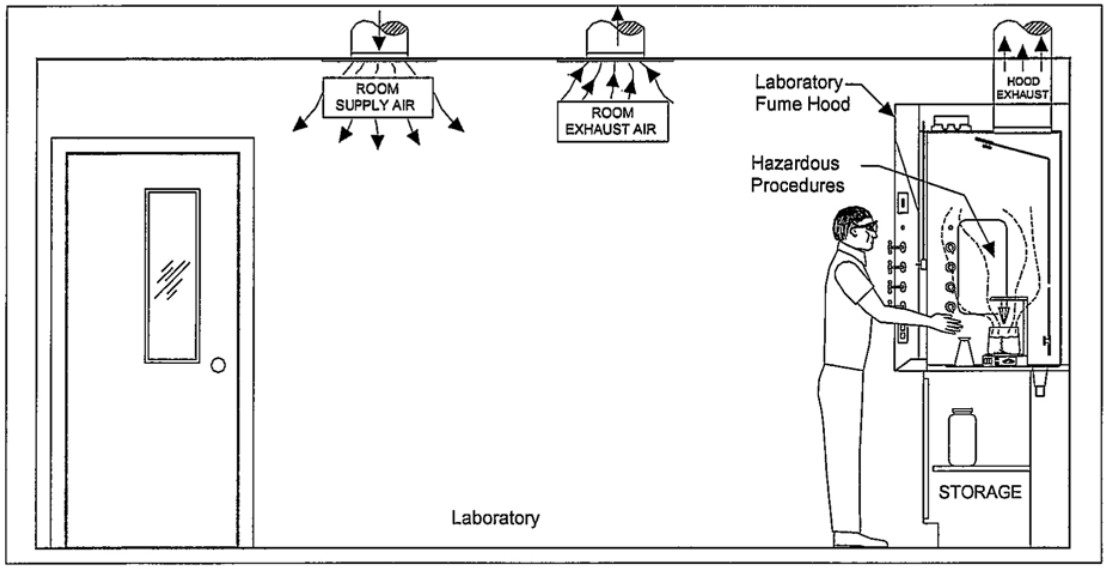
The primary method of contamination control in a laboratory is good ventilation. The laboratory hood plays an important part in this, particularly for the more hazardous chemicals and procedures and can be used in teacher demonstrations and lab preparation. There are three groups of laboratory hoods, chemical hoods, biological safety cabinets, and clean benches. The following discussion addresses the use of chemical hoods, the most common and most needed in schools.

The ideal air velocity in the hood depends on:

1. The design of the laboratory;
2. The design and set-up of the hood; and
3. The use of correct work procedures.

1 - Laboratory Design

The drawing below shows a typical fume hood as used in schools. The laboratory chemical hood should be used when there is a possibility of release of toxic chemical vapors, dust, or gases.



Typical Constant Volume Laboratory Ventilation System

The room design plays an important part in the in the effectiveness of the hood. If the room configuration is not ideal higher air velocities are needed in the hood.

- The velocity of the room air supply should be no more than ½ the velocity of the hood. Supply velocities are usually much higher than this.

- Perforated ceiling panels are preferred over diffuser grills

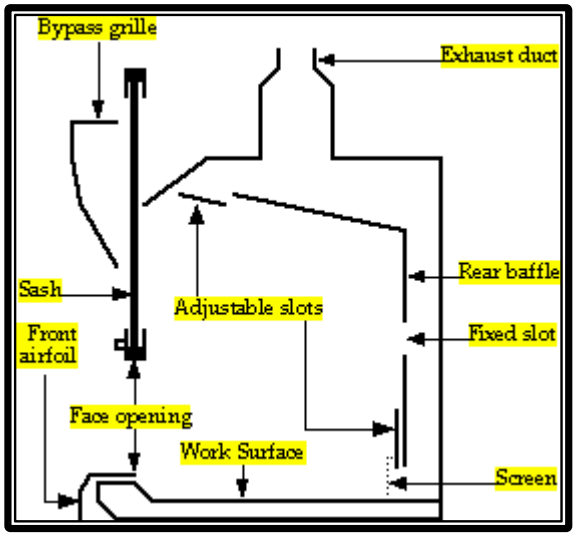
Perforated grill

Diffuser grill

- If a diffuser grill is used, the openings directed at the hood should be blocked.
- Hoods should not be located near traffic areas. People passing near the front of the hood can create turbulence that affects the ability of the hood to function. Locating a hood near a door is acceptable if:
    - There is a second means of egress;
    - Traffic is low; and
    - The door is normally closed.

2 - The Hood

Hoods are usually purchased from a manufacturer. Such hoods should meet or exceed CSA and ANSI standards and have the following:



- An aerodynamic entry so that the air flow into the hood is smooth and without turbulence. This is accomplished with a front airfoil, and if possible beveled side openings.
- There should be a uniform face velocity across the hood. Adjustable slots will allow you to achieve this.
- To maximize the capture of fumes and to protect the user there should be an adjustable sash. The sash should be about 2/3 closed when in use.
- Fume hood controls are located outside the fume hood in an immediately accessible area.

Hood Setup

- There must be a regular maintenance program for the hood and the laboratory air supply system.
- The adjustable slots at the back of the hood should be set so that there is a uniform face velocity across the opening of the hood. This should be set under working conditions.

- The hood exhaust is directed outside the building and is not recirculated within the building.
- The hood must be located to prevent cross drafts or other disruptive forces from affecting the air flow across the operational face of the hood.

Air Velocity Criteria

The air velocity for the hood varies with the room configuration as described above. The recommended ventilation rates are as shown below. Note: The ventilation rate is given in feet/minute. These are the units the standards are in, and the units on the velometer.

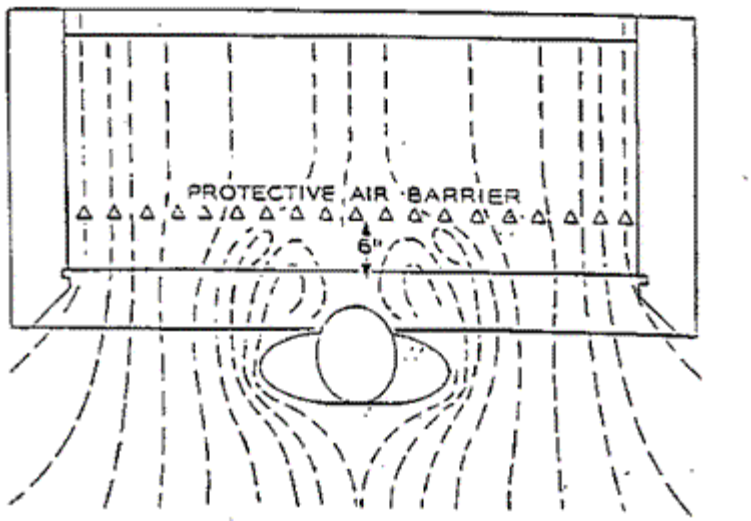
	Condition	**Air velocity (ft/min) Open hood face**
1	Ceiling panels are properly located with an average velocity of < 40 fpm. Hoods are located away from doors and traffic. Work ≥12 inches (30 cm) from the face of the hood.	60
2	Same as above with some traffic past hood. Hoods are located away from doors and traffic. Work ≥ 6 inches (15 cm) from the face of the hood.	80
3	Ceiling panels are properly located with an average velocity of < 60 fpm or ceiling diffusers are properly located. No ceiling diffusers are immediately in front of the hood, the quadrant facing the hood is blocked. Air flow from the ceiling diffuser is < 60 fpm. Hoods are located away from doors and traffic. Work ≥ 6 inches from the face of the hood.	80
4	Same as above, some traffic past hood. Work ≥ 6 inches from the face of the hood.	100
5	Wall grills are possible but not recommended for new facilities.	

It is assumed that a typical laboratory will:

- Have diffuser grills with unknown air velocity;
- The quadrant of the diffuser grill facing the hood is blocked;
- Work ≥ 6 inches (15 cm) from the face of the hood; and
- Extremely toxic materials such as perchloric acid, carcinogenic or radioactive materials are not used

Such a laboratory hood should have a face velocity of 80 – 100 fpm (0.4 – 0.5 m/s) with the hood sash fully open.

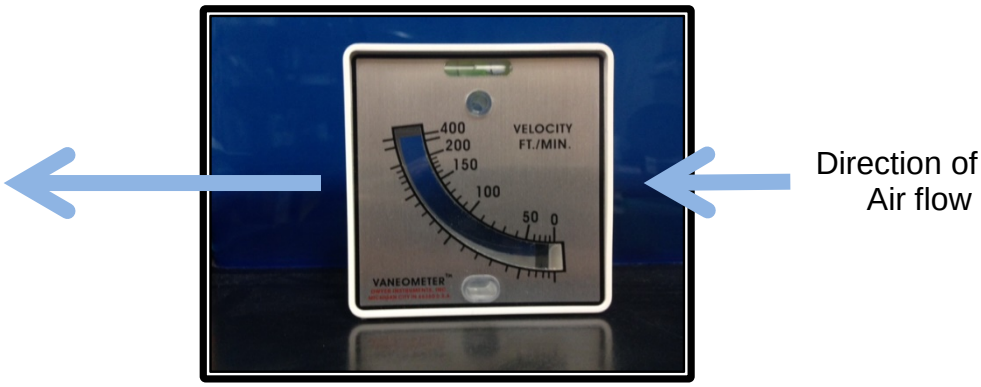
NOTE: Excessive air velocity is not desirable. When the air velocity rises above 115 ft/min excessive turbulence is created that will draw vapours out of the hood into the breathing zone.



Air Velocity Measurements

The velocity of the air entering the hood can be measured with a simple velometer as shown below. This model is the Dwyer Instruments Vaneometer as provided by the Manitoba School Boards Association. The following steps should be followed.

1. If a vane has not been installed in the meter, a vane should be installed according to the instruction packed in the box. There are two vanes in the box. (Note: the cardboard envelope holding the vane contains a spare.)
2. Check to ensure that the vane is not damaged and moves freely inside the meter.
3. The meter must be held so that the air moves through it as shown below.



4. The meter must be held parallel with the airflow, and with the vane pointing straight down when there is no air moving through it. The meter has a spirit level (the bubble level) to help with this.
5. The air velocity in ft/min can be read from the scale where the vane crosses it.
6. The velocity should be measured with the sash fully open.
7. The velocity should be measured at six locations across the face of the hood. Divide the face of the hood into six equal areas as shown below and take the measurement in the middle of each area as indicated by the “x”.

x	x	x
x	x	x

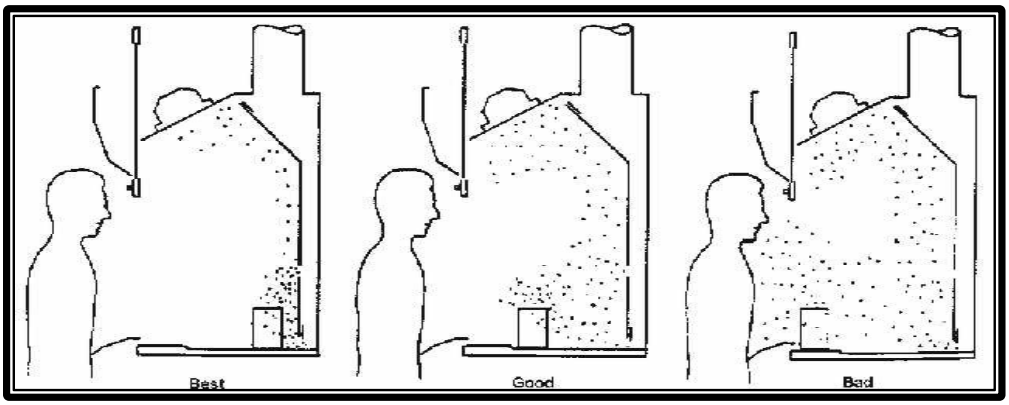
8. Take the measurements at the plane of the sash. Make sure your body is not obstructing the air flow.
9. Document the velocity levels for each area. This is easiest done by drawing the areas as shown above and entering the reading in each box.
10. To determine the air velocity of the hood, calculate the average velocity of the six areas. The average should be in the 80 – 100 fpm range.
11. If any of the six readings are less than 80 fpm or greater than 115 fpm, the adjustable slots should be moved so as to bring all readings into the 80 – 100 fpm range.

NOTE: If the hood does not meet the 80 – 100 fpm criteria (steps 10 <u>and</u> 11), it should not be used until it has been inspected by a qualified person (the vendor/installer) and brought into compliance.

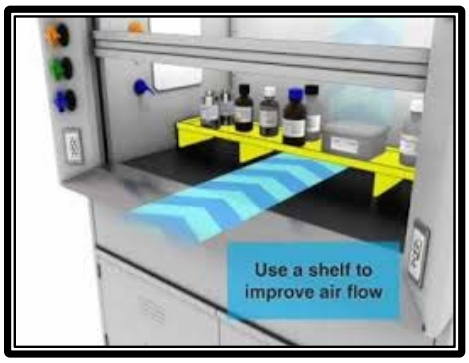
3 - How to use the Hood

Having a well-designed laboratory and proper hood are only part of a safe handling of chemical processes that can result in airborne contaminants. the third part is the proper use of the hood.

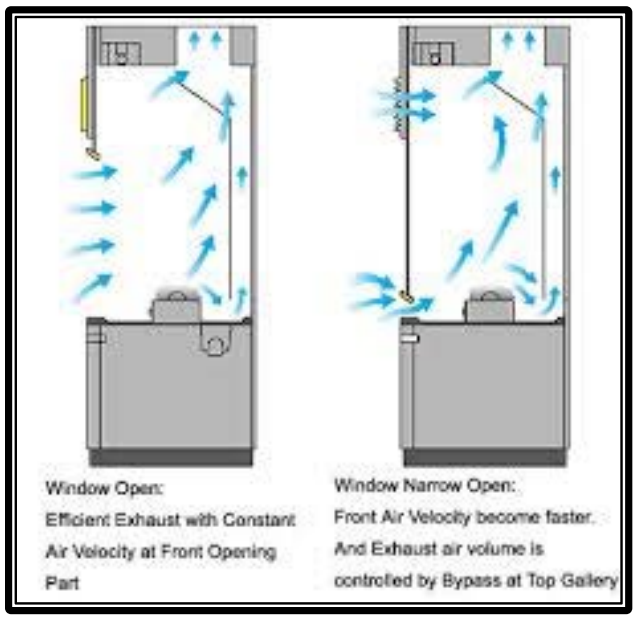
- There must be a uniform airflow over the face of the hood. Since equipment in the hood will affect the distribution of the moving air, the air flow should be checked when there is a significant change in the equipment in the hood.
- Keep all apparatus at least 6 inches (preferably 12 inches) from the front of the hood. A line should be painted on the floor of the hood indicating the minimum distance from the front of the hood that any work should be carried out.



- Do not put head into the hood.
- Do not use the hood as a storage cabinet. Only the equipment and supplies necessary for the work at hand should be in the hood. If an excessive amount of materials are necessary, a temporary shelf can be used to keep the slots open.



- The sash should be closed as far as reasonably possible. This provides protection for the operator in the event that there is an explosion in the hood. This is particularly important when boiling materials or conducting an experiment with reactive chemicals. The partly closed sash also improves air movement in the hood.



- Do not use fume hoods to vent or dispose of hazardous materials through air dilution.

LABORATORY HOODS - WORKSHEET

This worksheet was developed as an aid in assessing the required air velocity for your hood and to provide documentation for the laboratory safety and health program. The hoods should be assessed at least once/year, preferably at the end of the school year so that there is time for any repairs that may be needed before classes resume.

The first page determines the required ventilation rate. This is done through the presentation of two scenarios.

1. Laboratories with perforated ceiling panels. This scenario, leading to a lower required ventilation rate is not recommended in a teaching laboratory. The lower ventilation rate (60 fpm) can work only under ideal conditions and correct practice.
2. Laboratories with ceiling diffusers. This scenario is more likely to be found in school laboratories, and with the higher velocities are more likely to work.

On the first page, the worksheet presents a series of assumptions. If the assumption applies to the hood being reviewed the box beside the assumption should be checked.

It should be noted, that these assumption are “and” conditions with the worst case be the defining factor. As a result the highest rating is the one that applies even if it is the only one in that range. For example, in a laboratory with ceiling diffusers all applicable scores are rated 80 fpm except #8, “Hood located near some traffic”, which has a score of 100 fpm. In this case, the required ventilation rate would be 100 fpm.

The second page of the worksheet is a form for documenting the ventilation rate measurements.

NOTE:

Some schools have “Economy Hoods”. These are hoods that were not designed to meet the specifications outlined above. Specifically:

- The fan does not have the capacity to provide 80 – 100 cfm with the sash open;
- There is no bypass grill;
- There are no adjustable slots.

As a result:

- The hood must be calibrated with the sash down, and a mark placed on the sash frame marking the maximum height that the sash must be lowered to when the hood is used.
- Because there are no adjustable slots, there may be uneven air distribution across the face of the hood. This may result in poor capture characteristics.
- Because of low fan capacity and no bypass grill, fumes may not be adequately scavenged from the hood. This could result in a buildup of contaminants inside the hood.

Recommendation for “Economy Hoods”.

If after completing the worksheet provided below it is confirmed that the “Economy Hood” will not meet the requirements of a good hood, it is recommended that a smoke test be carried out.

This will involve releasing smoke around the opening of the hood while someone is simulating working in the hood. If some of the smoke exits the opening of the hood it should not be used for potentially toxic materials.

LABORATORY HOODS WORKSHEET

Laboratories with perforated ceiling panels

		60 fpm	80 fpm	100 fpm
1	Air velocity from panels <40 fpm			
2	Air velocity from panels <60 fpm			
3	Air velocity from panels >60 fpm			
4	Located away from the hood			
5	Hood located away from doors			
6	Hood located away from traffic			
7	Hood located near some traffic			
8	Work ≥12 inches (30 cm) from the face of the hood			
9	Work ≥ 6 inches (15 cm) from the face of the hood			

Laboratories with ceiling diffusers

1	Air velocity from diffuser <60 fpm			
3	Air velocity from diffuser >60 fpm			
2	No diffusers immediately in front of hood			
3	Diffuser immediately infront of hood			
4	Quadrant facing hood is blocked			
5	Quadrant facing hood is not blocked			
6	Hood located away from doors			
7	Hood located away from traffic			
8	Hood located near some traffic			
9	Work ≥ 6 inches from the face of the hood			
10	Work ≤ 6 inches from the face of the hood			

Required ventilation rate

	60 fpm	80 fpm	100 fpm
Based on highest rating			

Ventilation rate measurements

1 The ventilation rate should be measured according to the method provided earlier.

2 The measurements should be recorded in the table below.

3 If there is not an even air flow across the face of the hood, the slots should be adjusted so the as far as reasonably practicable the air flow is even across the face of the hood.

4 Calculate the average velocity of the six areas. The average should be in the 80 – 100 fpm range

NOTE: 60 fpm is not recommended for a teaching laboratory

The calculated face velocity is [ ] **fpm**

5 **If the hood does not meet the 80 – 100 fpm criteria it should not be used until it has been inspected by a qualified person (the vendor/installer) and brought into compliance.**

Part 6: Cosmetology Laboratory

A **cosmetology** laboratory is an area for learning the application of beauty treatment, including specialties such as hairstyling, skin care, cosmetics, manicures/pedicures, and non-permanent hair removal such as waxing.

The following list highlights some of the health risks cosmetologists could face on the job and potentially in the laboratory:

- **Exposure to hazardous chemicals**
- Risk of infection
- Repetitive motion injuries
- Burns/cuts/scratches
- Noise
- Verbal or physical abuse from clients
- Stress

The emphasis here is on hazardous chemicals. Frequently, these chemicals are the same as found in other laboratories, and the control methods are the same. Before getting into the specifics of a Cosmetology Laboratory the following basic safety housekeeping activities should be carried out as described in Parts 1 – 3 of Rehab the Lab.

1. **Eliminate the Hazard**
   This is essentially an inventory control program. If all unnecessary, obsolete, and unused chemicals/materials are removed from the workplace, all safety programs and administrative activities are reduced and simplified. The main steps are:
   - Get rid of excessive amounts of chemicals;
   - Get rid of unneeded or unused chemicals;
   - Get rid of dangerous chemicals; and
   - Make an inventory of remaining chemicals.

NOTE: For a list of Prohibited and Restricted Ingredients for use in cosmetic products see the Health Canada site.

https://www.canada.ca/en/health-canada/services/consumer-product-safety/cosmetics/cosmetic-ingredient-hotlist-prohibited-restricted-ingredients/hotlist.html

This list is too long, and changes from time-to-time, to be included here. You should be familiar with this site.

At this time the chemical inventory has by now been pared down to chemicals with acceptable hazards, manageable amounts of each chemical, and only needed chemicals. The chemicals are safely stored away from other incompatible materials in appropriate areas. The task now is to ensure that the system is used properly in the future.

At the start of the school year the following should be done.

- The inventory should be checked to determine what is available for the coming year, and what must be purchased to meet the needs of the coming lessons.
- When a chemical is to be purchased, the inventory should be checked to make sure that the school is indeed out of that chemical. The shelves must also be checked to ensure that the inventory is correct.
- When purchasing a new material check to ensure that it is in compliance with the Health Canada Prohibited and Restricted ingredients list.

At this point:

- All chemicals that present an unacceptable risk should have been removed at this time
- The amount of each chemical should be reduced to reasonable amount.
- The school should now have a reduced inventory of only necessary chemicals so that the next steps can be easily achieved

2. Storage/Preparation Room

At this point we have minimized the amount of materials to those we are currently using. This simplifies storage. In a typical chemical teaching laboratory chemicals are stored in a separate secure room that is also used as a preparation area for the instructors.

> Cosmetology laboratories are different from a typical chemical laboratory. The storage area is part of the teaching environment, and must be designed with the students and teaching in mind.

Storage Space

Space requirements are greater in a cosmetology laboratory. There should be room for teachers and students. This is working storage area, not a restricted storage area.

The space at the right is adequate as a storage area, however it is tight as a teaching area where students must learn how to manage such an area themselves.

The original size was probably adequate when designed, before product display stands were available. These organize supplies, but take up space.

Storage should be designed with adequate space to accommodate future changes in the profession.

A typical storage area, effective as storage but small for teaching.

Storage Room Features

Some chemicals such as acetone are purchased in bulk, and should be stored in a flammable cabinet. These come in different sizes. Plan ahead and get a larger size, however where space is limited only the smallest may be appropriate.

A laboratory hood should be considered in a teaching laboratory. It can be used by instructors when preparing materials for the class. It can also be used by students when learning to prepare materials for personal use.

All areas where chemicals are used should have an eyewash fountain. This may sound excessive but most safety data sheets suggest that if you get harmful materials in the eyes they should be flushed “immediately”. Immediately means within 15 seconds. This can only be done if an eye wash station is close by.

3. Ventilation

Good ventilation, in the form of general ventilation and local ventilation, is important for cosmetology laboratories. Occupants are exposed to chemicals that present a risk through inhalation, absorption through the skin, or cause sensitization (such as dermatitis), reproductive effects, or acute or chronic irritation. The most hazardous historical chemicals, formaldehyde and ammonia are no longer used.

While toxic, materials are used, air samples collected in such salons have shown low levels of chemicals in the air, often in the range of below the level of detection and 10% of the acceptable exposure level. Although the exposure levels are low, the thresholds of odour for many of them are even lower so their irritating odours are noted even with low levels in the workplace.

The problem is that although exposure levels to the products used are low, some occupants, particularly nail salon employees, are potentially exposed to dozens of hazardous chemicals including acrylates, solvents, and biocides in the form of dusts or vapors. Exposure to these chemicals on the job have been examined by a small but growing number of studies that have found possible links between nail technicians' work and adverse health outcomes including respiratory, neurological, and musculoskeletal disorders, as well as other health conditions including cancer.

General Ventilation

Since sampling the breathing air in the room is not a good indicator of risk to occupants, the science today suggests that general ventilation be used to protect occupants. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommends that beauty salons maintain 25 cubic feet per minute (cfm) (0.71 cubic meter per minute) of fresh air per person via mechanical ventilation. This guideline would correspond to a measured level of 700 parts per million (ppm) of carbon dioxide in an indoor environment.

The laboratory ventilation system should be adjusted by a competent person to deliver 25 cubic feet per minute (cfm) (0.71 cubic meter per minute) per person. To confirm that the ventilation system is functioning properly under working conditions, the air should be tested for carbon dioxide when students, clients and instructors are in the laboratory. The spot carbon dioxide levels should be ≤ 700 ppm.

4. Best Available Technology

Since workers in salons, particularly nail salons, show symptoms of several occupational illnesses at exposure levels below acceptable exposure limits, simple compliance with exposure limits is not sufficient to protect all workers. Recent simulation studies suggests that worker exposures will exceed exposure limits.

It is recommended that best work practices be used at all times. Work procedures should be developed to reduce exposures. This would include such things as keeping lids on all materials as far as reasonably practicable, use impervious gloves (not low bid), stand upwind of work.

A second tool, is the best equipment. Ventilated nail tables (VNT) and portable nail salon source capture ventilation systems (SCV) that featured local exhaust systems have been shown to reduce chemical and dust exposures by 50 – 60%.

The table is designed with local exhaust ventilation in the center.

Portable side exhaust hoods

These devices should be exhausted outside. If the air is to be recirculated it must be filtered for organic solvents and particulates. A maintenance program for the filters must be implemented.

Part 7: Laboratory Labels

Laboratories and laboratory samples, products, and chemicals require labels under the Manitoba WHMIS system.

The following are some definitions used to identify some of the materials in a laboratory:

- Hazardous products in on-site transport or in reaction systems such as pipes, tanks, tank trucks, ore cars, conveyor belts, reaction vessels, etc.
- Mixtures and substances undergoing analysis, tests or evaluation in a laboratory.
- A laboratory sample is a sample of a controlled product (less than 10 kilograms) intended solely for laboratory analysis, testing or evaluation. A laboratory sample cannot be used for testing other products, for educational and demonstration purposes or for marketing.

There are special rules and label exemptions for each of these items.

NONE OF THE ITEMS ABOVE APPLY TO A SCHOOL LAB

They are for analytical/quality control labs, not school labs.
Do not get them mixed up.

With respect to school laboratory labels.

A laboratory chemical must be obtained from a laboratory supply house for use in a laboratory only. The quantity of laboratory chemical must be less than 10 kilograms.

NOTE: A well-meaning gift from someone clearing out their garage or warehouse may meet none of the above definitions, and thus fall under the full requirements of WHMIS.

There are specific provisions for laboratory chemicals used in a laboratory:

- A GHS supplier label is not always required on chemicals intended for use in laboratory. Small volumes (<100 ml) may have an abbreviated label.
- A workplace label not required if the employer develops an internal system to identify decanted products. This applies to decanted chemicals and mixtures of chemicals.

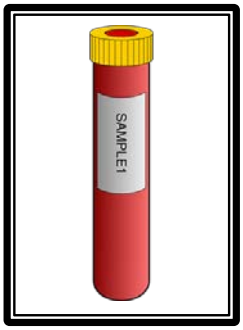
Laboratory chemicals are one of the few situations in which you may use any method of clear identification to label hazardous products. These hazardous products may be identified by any clear means, such as colour codes, or painted, stencilled, or even handwritten identifiers. This exemption is needed where there may be small containers (test tubes, beakers) used that are too small for a full label, or many containers all holding the same chemical.

It is essential that students understand any hazard codes, symbols, or shorthand that are used.

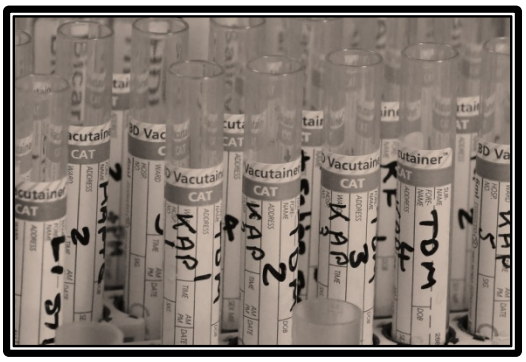
Examples:

- Individual labels

Chemical Name on Label



Colour Labels



Shorthand

- Group labels
  If there are several test tubes in a rack with the same chemical in them, the rack could be labeled instead of the individual tubes.

- Reagent bottles
  Squeeze bottles could be colour coded. For example only water in white bottles, other chemicals such as acids in coloured squeeze bottles.

With respect to school laboratory hazardous wastes.

All hazardous wastes must be properly labeled. This includes the following:

- The label must contain the phrase "**HAZARDOUS WASTES".**
- Hazardous components/risks must be clearly presented.
- Since the material will be turned over to a hazardous waste handler the information should be clear to any person who reads it. Internal codes would be unacceptable.

IMPORTANT: If the contents and hazards are not clearly presented on the label, the failure could have a significant effect on the disposal costs.

Additional Reading

1. Hazardous Waste Management for School Laboratories and Classrooms, EPA 908-F-06-001, February 2006
2. Northwestern University Office for Research Safety, Hazardous Waste Management Program. http://www.research.northwestern.edu/ors/
3. WASTE CHEMICAL DISPOSAL GUIDANCE FOR SCHOOLS, Kansas Department of Health and Environment, Bureau of Waste Management
4. National Institutes of Health. Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards: Updated Version.
5. School Chemistry Laboratory Safety Guide. *October 2006* National Institute for Occupational Safety and Health

ADDENDUM A: Non-Hazardous Chemicals Safe to Throw Out with Your Garbage

123

1,3-diphenylisobenzofuran
2,2-di(4-tert-octylphenyl)-
1-picryl hydrazyl
2-carboxybenzaldehyde
3-quinolinecarboxylic acid

A

Acetylimidazole
adenine hemisulfate salt
adenosine
adenosine 5'-triphosphate,disodium salt
agar
agar, bacteriological grade
agarose
albumin
albumin human
albumin, bovine
alfa-lactose
alspha-D(+) melibiose
alpha-methyl-mannopyranoside
alpha-naphthyl acetate
alumina wool
amberlyst 15
amino-2-naphthol-4-sulfonic acid
aminobutiric acid
ammonium phosphate, monobasic
ampicilline sodium salt
aprotinin
anthracenecarboxylic acid
arginine hydrochloride
aragonite
ascorbic acid
ascorbate oxidase
atipamezole hydrochloride
azelaic acid

B

bacto agar
bacto peptone
bacto tryptone
bacto-levulose
bacto-peptamin
bacto-peptone
barium sulfate
b-cyclodextrin
beef extract
b-nicotinamide adinine dinucleotide
biotin
borax (sodium tetraborate)
boron carbide
bromo phenol blue
brucella agar
buthionine sulfoximine
butylated hydroxytoluene

C

calcite, crystal
calcium acetate
calcium borogluconate
calcium carbonate
calcium d-gluconate
calcium dihydrogenphosphate monohydrate,
calcium lactate
calcium sulfate dehydrate
carbamazepine
carbon powder
casamino acids
catalase
cellobiose
cellulose
cetyl alcohol
chitin
chlortetracycline
cholesterol
choline chloride
chlorophenylalanine
chlorophyllin sodium salt
cinnarizine
collagen
cyanuric acid

D

deoxyribonucleic acid
dexamethasone sodium phosphate
dextran T 500
dextrose
dextrose anhydrous
diammonium phosphate
diastase
dibutyryladenosine AMP
dichlorofluorescein
diglycidyl ether of polypropylene glycol
dihydroxyfumaric acid hydrate
dimethylglyoxime
di-sodim hydrogen phosphate anhydrous
di-sodium hydrogen orthophosphate
dl-octopamine HCL
domperidone
drierite

E

elastase
ethyleneaminotetraacetic acid
ethylenedinitrilo-tetraacetic acid disodium salt dihydrate
europium (III) chloride hexahydrate

F

ferric citrate
ferrozine
ficoll
fluorobenzamide
fructose
fructose 6 phosphate
fucose

G

gadolinium chloride
gelatin
glucose
glucose-1-diphosphate
glucose 1 phosphate
glucose 6 phosphate dehydrogenase
glucose-6-sulfate (potassium salt)
glucuronic acid
glutamine
glycerol 2-phosphate disodium salt hydrate
glycine
glycogen
glycylglycine
gum mastic

H

hektoen enteric agar
hemocyanin
heparin lithium salt
hepes
heptakis (2,6-di-o-methyl)-b-cyclodextrin
hexamethylbenzene
hyaluronic acid
hydrocortisone
hydroxyethylpiperazine-n'-2-ethanesulfonic acid (HEPES)
hydroxypropyl-b-cyclodextrin
hypoxanthine

I

inulin
invertase
isopropyl b-d-thiogalacto-pyranoside

L

L-ascorbic acid
lab-lemco broth
lactose
lanthanum chloride
lauroylsarcosine
leucylglycine
lincocin
lincomycin hydrochloride
lipopolysaccharide
Lithium benzoate
lithium citrate
lithium tetraborate
L-lysine
l-(-)sorbose
lysine monohydrochloride
lysozyme

M

mac-conkey agar
magnesium acetate
magnesium carbonate
magnesium chloride
magnesium hydroxide
magnesium oxide
magnesium sulphate
magnesium sulfate heptahydrate
malt extract
maltose
mannitol
melatonin
methyline blue chloride
methyl-d-glucamine
methyl-d-glucopyranose
minocycline
m-9 minimal salts
molecular sieve
montmorillonite K10
mueller hinton agar
mueller hinton broth
Myoglobin
myo-Inositol

N

nanoanoyl-n-methyl-glucamide
nickel oxide + aluminum oxide
nigrosin
norethindrone
n-propyl gallate

O

Octanediol
Ovalbumin

P

paclitaxel
palmitic acid
p-amino benzoic acid
paraffin
pectin
pectinase (fungal)
pepsin
pepstatin A
pepton from meat pepsin-digested
perylene
phentolamine hydrochloride
placebo drug (sugar pills)
polybrene (= hexadimethrine bromide)
poly-d-lysine hydrobromide
poly (DL-lactide-co-glycolid)
poly caprolactone
poly ethylene vinyl acetate
polygalacturonic acid
poly l lactide
Polymethylmethacrylate powder
polystyrene (recycle plastic # 6)
polyethylene chips
potassium chloride
potassium citrate
potassium di-hyrdogen phosphate
potassium iodide
potato dextrose agar
prednisone
propane-1,2-diol (propylene glycol)
protein a sepharose
propylene glycol
protease
protease E
protein g-agarose
pseudomonas agar base

pseudomonas isolation agar

pumice stone powder

Q

quinidine sulfate salt

R

raffinose
RGP peptide
ribose

S

saccharin
saccharin sodium
saccharose (sucrose)
salicylic acid
sea sand
sephadex
sepharose
silica gel
silicon monoxide
sodium acetate trihydrate
sodium bicarbonate
sodium dihydrogen orthophosphate
sodium hydrogen carbonate
sodium hydrogen orthophosphate (= sodium dihydrogen orthophosphate,)
sodium phosphate
sodium phosphate dibasic dodecahydrate
sodium phosphate monobasic
sodium phosphate monobasic dehydrate
sodium sulfate
sodium thiosulphate
soluble starch
staplococcus medium

starch

starch hydrolysed
stearic acid
sterile water
succinic acid
sucrose
syringic acid

T

tannic acid
tartaric acid
tetramethylmurexide
tetrathionate broth base
thioflavin T
thymidine
thymolphthalein
trehalose
trifluoromethane sulfonic anhydride
triple sugar iron agar
tris
tris (hydroxymethyl) aminomethane hydrochloride,
trisodium citrate
tryptone
tryptophan
tryptose phosphate broth
tungsten disulfide

U

uracil
uridine

V

vanadium
vermiculite
vitabmin B12
Vitamin D31

X

xanthosine
xylazine
xylenecyanol
FF xxt
sodium salt

Y

yeast (and extract of
yeast) ypd (yeast media)

Z

zirconium oxide

ADDENDUM B: Non-Hazardous Chemicals Safe to Dispose Down the Drain

123

2-[4-(2-hydroxyethyl)piperazin-1-yl]ethanesulfonic acid

A

allura red ACalpha
tocopherol acetate
ampicillin sodium
aprotinin
aureomycin

B

bacitracin
benzyl benzoate

C

carbopol
cefotaxime
chloroquine

D

deoxyribonuclease 1
deuterium oxide
dextrose solution
dihydroxyfumaric acid hydrate
di-potassium hydrogen orthophosphate 3-hydrate

E

erada-stain
ethoxyehtoxy ethanol
ethylene glycol

F

fungizone

G

gluconic acid lactone
glycerol
glycerol polyglycidyl ether
griseofulvin

H

hyaluronidase

L

lanolin
liquid paraffin

M

maltose hydrate
mannide mono oleate
methyl green

N

N-nitro-L-arginine

O

oleic acid

P

pegylated interferon
peroxidase
poly(ethylene glycol) diglycidyl ether
poly-lysine
propylene carbonate
protease peptone

S

sodium chloride solution
soybean oil
squalane
streptolysin O

T

tetramethylene sulfone
tocopherol
triacetin
triethylene glycol

V

vasopressin
vitamins

Y

yeast peptone dextrose (ypd) broth

APPENDIX A - Excessive Risk Chemicals - Risk Exceeds Educational Utility

Chemical Name	Hazards
Acetic Anhydride	Explosive potential, corrosive
Acetyl Chloride	Corrosive, dangerous fire risk,reacts violently with water and alcohol
Acrylamide	Toxic by absorption, suspected carcinogen
Acrylonitrile	Flammable, poison
Adipoyl Chloride	Corrosive; absorbs through skin, lachrymator
Aluminum Chloride, anhydrous	Water reactive, corrosive
Ammonia, gas	Corrosive lachrymator
Ammonium Bifluoride	Reacts with water, forms Hydrofluoric Acid
Ammonium Bichromate	May explode on contact with organics, suspected carcinogen
Ammonium Chromate	Oxidizer, poison; may explode when heated
Ammonium Dichromate	Reactive, may cause fire and explosion
Ammonium Perchlorate	Explosive; highly reactive
Ammonium Sulfide	Poison, Corrosive, Reacts with Water & Acids
Aniline	Carcinogen, toxic, absorbs through skin
Aniline Hydrochloride	Poison
Antimony Oxide	Health and contact hazard
Antimony Powder	Flammable as dust, health hazard
Antimony Trichloride	Corrosive; emits hydrogen chloride gas if moistened
Arsenic compounds	Poison, carcinogen
Asbestos, Friable	Inhalation Health Hazard, Carcinogen
Azide Compounds	Explosive in contact with metals, extremely reactive, highly toxic
Barium Chromate	Poison
Benzene	Flammable, carcinogen
Benzoyl Peroxide	Organic peroxide, flammable, oxidizer
Beryllium and its compounds	Poison. Dust is P-listed & highly toxic. Carcinogen
Bromine	Corrosive, oxidizer, volatile liquid
Cadmium compounds	Toxic heavy metal, carcinogen
Calcium Fluoride (Fluorspar)	Teratogen. Emits toxic fumes when heated
Carbon Disulfide	Flammable, toxic, P-Listed Extremely Hazardous
Carbon Tetrachloride	Toxic, carcinogen
Chloral Hydrate	Hypnotic drug. Controlled substance
Chlorine Poison gas.	Corrosive.
Chlorobenzene	Explosive limits 1.8% to 9.6%, toxic inhalation and contact hazard

APPENDIX A - Excessive Risk Chemicals - Risk Exceeds Educational Utility

Chemical Name	Hazards
Chloroform .	Carcinogen. If old forms deadly Phosgene gas
Chlorosulfonic Acid	Toxic a/k/a Sulfuric Chlorohydrin
Chromic Acid	Strong oxidizer. Poison
Collodion	Flammable. Explosive when dry. Nitrocellulose compound.
Cuprous Cyanide	Toxic
Cyanogen Bromide	Poison, strong irritant to skin and eyes
Cyclohexene	Flammable, peroxide former
Dichlorobenzene	Toxic
Dichloroethane	Flammable. Toxic.
Dinitro Phenol	Explosive. "Bomb Squad"
Dinitrophenyl Hydrazine	Severe explosion and fire risk
Dioxane	Flammable, peroxide former
Ether, Anhydrous	Flammable, peroxide former
Ether, Ethyl	Flammable, peroxide former
Ether, Isopropyl	Flammable, peroxide former
Ethyl Ether	Flammable, peroxide former
Ethylene Dichloride	Toxic, contact hazard, dangerous fire risk, explosive in air 6-16%
Ethyl Nitrate	Explosive. "Bomb Squad"
Ethyleneimine	Flammable. Toxic. P -listed
Ferrous Sulfide	Spontaneously ignites with air if wet
Formaldehyde (Formalin)	Toxic, carcinogen, sensitizer
Gunpowder	Explosive
Hydrazine	Flammable Absorbs thru skin Carcinogen. Corrosive
Hydriodic Acid	Corrosive. Toxic
Hydrobromic Acid	Corrosive. Poison
Hydrofluoric Acid	Corrosive, poisonous
Hydrogen	Flammable
Hydrogen Sulfide, gas	Poison. Stench
Immersion Oil (old)	May contain 10-30% PCBs such as Arochlor 1260.
Isopropyl Ether	Flammable, Highest-risk peroxide former
Lithium Aluminum Hydride	Flammable. Reacts with air, water and organics
Lithium Metal	Reacts with water, nitrogen in air
Mercaptoethanol	Flammable. Corrosive. Intense stench
Mercury compounds	Poisonous heavy metal
Mercury, liquid	Toxic heavy metal, carcinogen
Methylene Chloride	Toxic, carcinogen, narcotic
Methyl Ethyl Ketone	Flammable, dangerous fire risk, toxic
Methyl Iodide	May be a narcotic; Carcinogen. Lachrymator.

APPENDIX A - Excessive Risk Chemicals - Risk Exceeds Educational Utility

Chemical Name	Hazards
(Iodomethane)	
Methyl Isocyanate	Flammable, dangerous fire risk, toxic
Methyl Isopropyl Ketone	Toxic
Methyl Methacrylate	Flammable. Vapor causes explosive mix with air
Naphthylamine, a-	Combustible, Toxic. Carcinogen.
Nickel Oxide	Flammable as dust. Toxic, carcinogen
Nicotine	Poison. P-Listed Extremely Hazardous
Nitrilotriacetic Acid	Corrosive
Nitrobenzene	Highly toxic
Nitrocellulose	Flammable. Explosive
Nitrogen Triiodide	Explosive. "Bomb Squad"
Nitroglycerin	Explosive. "Bomb Squad"
Osmium Tetraoxide (Osmic Acid)	Highly toxic. P-Listed Extremely Hazardous.
Pentachlorophenol	Extremely toxic
Perchloric Acid	Powerful oxidizer, reactive
Phosphorus Pentasulfide	Water Reactive. Toxic. Incompatible with Air & Moisture
Phosphorus Pentoxide	Oxidizer, toxic
Phosphorus, Red	Flammable solid
Phosphorus, Yellow or White	Air reactive. Poison.
Picric Acid, Trinitrophenol	Explosive when dry
Potassium Cyanide	Poison. P-Listed Extremely Hazardous
Potassium Perchlorate	Powerful oxidizer. Reactivity hazard
Potassium Sulfide	Flammable. May ignite spontaneously.
Potassium, metal	Water reactive, peroxide former (orange fog/crystals)
Pyridine Flammable.	Toxic. Vapor forms explosive mix with air
Selenium	Toxic.
Silver Oxide	Poison
Silver Cyanide	Extremely toxic
Sodium metal lump	Water reactive, ignites spontaneously in dry hot air, corrosive
Sodium Arsenate	Toxic. Carcinogen.
Sodium Arsenite	Toxic. Carcinogen.
Sodium Azide	Poison, explosive reaction with metals. P-Listed Extremely Hazardous
Sodium Borohydride	Flammable Solid. Water Reactive
Sodium Cyanide	Poison. P-Listed Extremely Hazardous
Sodium Fluoride (Bifluoride)	Highly toxic by ingestion or inhalation; strong skin irritation

APPENDIX A - Excessive Risk Chemicals - Risk Exceeds Educational Utility

Chemical Name	Hazards
Sodium Fluoroacetate	Tox-X Deadly poison!
Sodium Peroxide	Water reactive; may cause fire & explosion
Sodium Sulfide	Fire and explosion risk
Strontium	Flammable. Store under naphtha. Reacts with water.
Testosterone HCl	Controlled substance
Tetrahydrofuran	Flammable, peroxide former
Thioacetamide	Toxic. Carcinogen. Combustible.
Thionyl Chloride	Corrosive.
Thiourea	Carcinogen
Titanium Trichloride	Flammable. Fire risk.
Triethylamine Flammable.	Toxic. Irritant.
Trinitrobenzene	Explosive. "Bomb Squad"
Trinitrophenol	Explosive. "Bomb Squad"
Trinitrotoluene	Explosive. "Bomb Squad"
Uranium/Uranyl	Compounds Radioactive

APPENDIX B - High Risk Chemicals - Only Allow Very Limited Amounts in Storage
Only Appropriate for Advanced-Level High-School Science Classes

Chemical	Hazards
Acetamide	Carcinogen. P-Listed Extremely Hazardous
Ammonium Nitrate	Powerful oxidizer, reactive
Barium Peroxide	Fire and explosion risk with organic materials, oxidizer, toxic,
Butyric Acid	Corrosive; intense stench
Cadmium sulfide	Highly toxic, carcinogen
Calcium Carbide	Flammable. Reaction with water.
Chromium Trioxide	Oxidizer, Poison
Ethidium Bromide	Potent Mutagen
Hexamethylenediamine	Corrosive; absorbs through skin, lachrymator
Hexanediamine, 1-6	Corrosive; absorbs through skin, lachrymator
Hydrogen Peroxide, >29%	Powerful oxidizer, corrosive to skin
Lead compounds	Highly toxic
Lead Nitrate	Toxic heavy metal. Oxidizer
Magnesium, powder	Flammable
Mercury Thermometers	Toxic heavy metal, corrosive
Phenol	Poison
Potassium Chlorate	Powerful oxidizer, reactive
Potassium Chromate	Oxidizer. Toxic
Potassium Dichromate	Powerful oxidizer, carcinogen
Radioactive Materials	Radioactive
Sebacoyl Chloride	Corrosive fumes. Lachrymator
Silver compounds	Toxic
Sodium Chlorate	Powerful Oxidizer
Sodium Chromate	Oxidizer
Sodium Dichromate	Reactive, may cause fire and explosion
Sodium, metal, small chips	Water reactive, corrosive
Strontium Nitrate Oxidizer.	May explode when heated or shocked.
Thermite	Flammable solid
Toluene	Flammable, dangerous fire risk, toxic
Wood's Metal	Poison.
Xylene	Flammable, toxic

APPENDIX C: HIGH RISK CHEMICAL PERMIT

The following form should be customized for each school to make it a working document.

Insert School Name / Logo here

HIGH RISK CHEMICAL PERMIT

This High Risk Chemical Permit is required for the purchase of any chemical on the High Risk Chemical List. The permit must be completed by the teacher wanting to obtain the High Risk Chemical and a designated supervisor *(Insert appropriate title here).*

The completed High Risk Chemical Permit must be posted in the chemical storage area until the chemical has been disposed of.

General Information

Permit #_____

Chemical Name _____

Hazard associated with the chemical _____

This Chemical is not on the Excessive Risk Chemical_____ If so, do not obtain it.

Work site Identification_____ Identification of Teacher _____

Demonstration to be performed_____

Authorized Duration of the Permit DATE:_____ TO _____

THIS HIGH RISK CHEMICAL PERMIT WILL BE AUTHORIZED ONLY IF THE THE FOLLOWING HAS BEEN COMPLETED AND COMPLIED WITH.

Describe in point form all of the hazards associated with this chemical, and how each will be controlled.

Hazard	Control
Hazardous material spill or release	
Fire hazard (flammable/oxidizer)	
Sources of ignition	

Odour/Stench	
Toxicity	
Splash on skin or eyes	
Adequate ventilation	

Describe in detail how the excess chemical will be disposed of.
The excess chemical will be disposed of by: DATE: _____

APPOVALS AND AUTHORIZATIONS:
This permit is valid only so long as work conditions existing at the time of issuance continue. It expires when any change in conditions adversely affect the safety of the work area while work is in progress.

STOP WORK IMMEDIATELY IF AN EMERGENCY ALARM SIGNALS AN EMERGENCY IN OR NEAR YOUR WORK AREA.

I have personally inspected the location where the above work is to be done. I have checked for compliance with safety precautions listed on the permit and authorized the work to be performed.

The following must be signed by the supervisor of the job site and the teachers performing the job/task

Title	Print Name	Signature	Date