LABORATORY

CHEMICAL SAFETY

TRAINING MANUAL

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1.0 INTRODUCTION

This course covers the essentials of working safely with chemicals in a laboratory. The basis for chemical safety is what is termed the “Workplace Hazardous Materials Information System” or WHMIS.

WHMIS is a Canada-wide system to provide information on hazardous materials used in the workplace. It was developed by the collaborative efforts of government, industry and labour and is supported by both federal and provincial legislation.

Exposure to hazardous materials can cause or contribute to a variety of health effects such as irritation, burns, sensitization, heart aliments, kidney and lung damage and cancer. Some materials may also contribute to fires, explosions and other accidents if improperly stored or handled. It is estimated that about 25% of Canadian workers are exposed to chemical hazards on the job.

WHMIS is an information system with three key elements.

1. Labels

Labels must be placed on all containers of hazardous materials to alert employers and workers to the dangers of the product and basic safety precautions.

2. Material Safety Data Sheets

Material Safety Data Sheets must be prepared for all hazardous products. These data sheets provide more detailed information about the product than can be put on a label.

3. Worker Education

Worker education programs provide instruction on the hazards of chemicals in the workplace and training in understanding and using the WHMIS information.

The ultimate goal of WHMIS is to create a safer workplace by providing workers with the knowledge and tools to enable them to understand the hazards and to work safely.

2. REGULATORY REQUIREMENTS

2.1 Federal Legislation

2.1.1 WHMIS

WHMIS is implemented through a combination of federal and provincial legislation.

The federal *Hazardous Products Act* requires suppliers of hazardous materials, called "controlled products" to provide appropriate labels and Material Safety Data Sheets as a condition of sale and importation.

The *Controlled Products Regulation*, issued under the *Hazardous Products Act* specify the form and content of supplier labels, the types and arrangement of information on material safety data sheets, conditions of exemption from WHMIS requirements and the criteria which define a controlled product.

The *Ingredient Disclosure List* contains the names of chemicals which must be identified on material safety data sheets if they are present either as a pure substance or as an ingredient in a mixture. If substances on the *Ingredient Disclosure List* are present in amounts greater than an exemption limit (0.1% or 1%, depending on the chemical), the WHMIS requirements apply.

WHMIS recognizes the right of manufacturers to keep confidential certain information on materials that they produce. The *Hazardous Materials Information Review Act* establishes a commission to rule on claims and appeals to exemptions form disclosure of confidential business information. The *Hazardous Materials Information Review Regulations* provide criteria for determining the validity of a claim for an exemption. The type of information that qualifies to be considered exempt from disclosure is very limited and WHMIS attempts to strike a balance between a manufacturer's right to maintain confidential information and the worker's right to know about the hazards to which the worker may be exposed,

In summary, the federal legislation applies to manufacturers and importers of controlled products and requires them to:

(a) Identify and classify controlled products
(b) Affix supplier labels to all controlled products
(b) Provide Material Safety Data Sheets

2.1.2 Consumer Chemicals and Containers Regulations

These regulations, issued under the Hazardous Products Control Act, apply to hazardous chemicals which are sold directly to consumers in retail stores. They provide for specific labeling which differs from the WHMIS labels. Since hazardous

consumer products may be purchased and brought into the workplace, one must also be aware of the consumer product labels. They apply specifically to:

- Toxic materials
- Corrosive materials
- Flammable materials
- Quick skin-bonding adhesives

2.1.3 Transportation of Dangerous Goods

All dangerous goods transported in Canada are regulated by the Transportation of Dangerous Goods regulations issued by Transport Canada under the Transportation of Dangerous Goods Act.

These regulations provide requirements for the packaging and labeling of shipments of hazardous materials. The labels for shipping are somewhat different from those used in the workplace.

2.2 Provincial Legislation

Local workplaces fall under provincial jurisdiction and are governed by provincial Occupational Health and Safety legislation. All provinces have adopted WHMIS legislation based on a model regulation produced by the tripartite committee which developed WHMIS.

In Ontario the *Occupational Health and Safety Act* is the governing legislation. The Act sets out the duties of employers and workers, gives workers the right to refuse unsafe work, the right to be informed about workplace hazards, and the right to participate on a joint (worker-employer) health and safety committee, The Act also sets out penalties for non-compliance. The Act provides for fines for individuals of up to $25,000 and/or imprisonment for up to 12 months. For corporations the fine can be up to $500,000.

The Act requires employers to:

(1) ensure hazardous materials in the workplace are properly labeled,
(2) obtain and make available material safety data sheets for all hazardous materials in the workplace,
(3) provide instruction and training to workers, and
(4) Assess and label any hazardous products produced in the workplace.

The regulations which follow pertain to Ontario and include both WHMIS and other pertinent regulations pertaining to chemicals. Other provinces have a similar WHMIS regulation but have other regulations which differ from those in Ontario.

Workers are required to:

(1) Participate in training programs,
(2) Report to the employer any workplace hazards and any instances of non-compliance with the Act and regulations,
(3) Use or wear any protective equipment or clothing required by the employer.

2.2.1 WHMIS Regulation

Local workplaces fall under provincial jurisdiction and are governed by provincial Occupational Health and Safety legislation. All provinces have adopted WHMIS legislation based on a model regulation produced by the tripartite committee which developed WHMIS.

The three basic components of WHMIS are:

- Labels
- Material Safety Data Sheets
- Worker Education

Labels must be placed on all containers of hazardous materials to employers and workers to the dangers of the product and the basic safety precautions.

Material Safety Data Sheets must be prepared for all hazardous products. These data sheets provide more detailed information about the product than can be put on the label.

Worker education programs provide instruction on the hazards of chemicals in the workplace and training in understanding and using the WHMIS information.

Suppliers of chemicals have the following duties:

1. To identify and classify controlled products
2. To prepare supplier labels
3. To prepare Material Safety Data Sheets

Employers have the following duties:

1. To obtain Material Safety Data Sheets and make them available to workers
2. To prepare workplace labels where needed
3. To train workers

4. To assess and label products produced in the workplace

2.2.2 Exemptions from WHMIS

The following types of products are completely exempt from the WHMIS legislation.

- Wood or wood products
- Tobacco or tobacco products
- Manufactured articles
- Hazardous materials in transit
- Hazardous wastes

Certain other products, which fall under other laws, are exempt from the labeling and MSDS requirements, but they are not exempt from the training requirements. These are:

- Explosives as defined in the *Explosives Act*
- Cosmetics, drugs, devices, or food as defined in the *Food and Drug Act*
- Pesticides as defined in the *Pest Control Products Act*
- Radioactive Materials regulated by the *Nuclear Safety and Control Act*, and
- Products packaged as consumer products and in quantities normally used by the consuming public.

The labels required on these products by their respective governing legislation are accepted as WHMIS labels in the workplace. MSDSs are not required for these products; however the **worker education requirements of WHMIS do apply.**

2.3 Designated Substance Regulations

Ontario has specific regulations for eleven chemical substances which have been “designated” as being particularly hazardous. These are termed the “Designated Substances Regulations” and they comprise the following chemicals:

- Acrylonitrile
- Arsenic
- Asbestos
- Benzene
- Coke oven emissions
- Ethylene oxide
- Isocyanates
- Lead
- Mercury
- Silica

- Vinyl chloride

If any of these substances are used in a workplace the employer is required to prepare a written assessment of the exposure or likelihood of exposure to a worker from the chemical. If the assessment shows that a worker is likely to inhale, absorb or come into contact with the material and that the health of the worker may be affected, then the employer must prepare a written control program which includes measures and procedures to control the exposure of workers to that chemical.

The regulations also include maximum permissible exposure levels for these chemicals.

2.4 Regulation on Control of Exposure to Hazardous Biological or Chemical Agents.

The regulation on Control of Exposure to Biological or Chemical Agents provides tables of exposure limits for a large number of chemicals. It also requires employers to:

- Take all measures reasonably necessary in the circumstances to protect workers from exposure to a hazardous biological or chemical agent because of the storage, handling, processing or use of the agent in the workplace; and

  The measures to be used include the provision and use of engineering controls, work practices, hygiene facilities and practices, and persona protective equipment.

3. CHEMICAL HAZARDS

3.1 How Chemicals Enter the Body

In order for a chemical to be hazardous to a person's health it must either enter or come into contact with the body and have some deleterious biological effect on the body. The four major routes of entry are:

- **Inhalation** (the respiratory system)
- **Absorption** through intact skin or eyes
- **Ingestion** (the digestive system)
- **Injection** through a penetration of the skin

Inhalation is the most common way for workplace chemicals to enter the body. Any fume, dust, smoke, mist or vapour that is airborne can be inhaled. Inhaled chemicals can pass through the lungs into the blood stream and affect other body organs or they can directly affect the lungs themselves. Some particles can be swallowed and end up I the digestive system. An average person breathes in about 6 litres of air per minute together with any contaminants that the air contains. Some acids, caustics or organic chemicals when inhaled in sizeable amounts can cause burn damage to the mouth, nose, trachea, bronchi and lungs.	**Fume** Solid particles suspended in air generated by condensation from the gaseous state generally after volatilization from molten metals. The particle size is generally less than 1 µm in diameter. (e.g. welding fumes). **Dust** Solid particles generated by grinding or crushing of material such as rock, wood, ore, metal or grain. The particle size is generally 0.1 to 25 µm in diameter. Dust particles will tend to settle out on surfaces under the force of gravity. **Smoke** Carbon or soot particles less than 0.1 µm in size generated from the incomplete combustion of carbonaceous material such as coal, oil or wood. Smoke generally contains droplets as well as dry particles. **Mist** Mists are suspended droplets generated by condensation of liquids from the vapour back to the liquid state or by breaking a liquid into a dispersed state by splashing, foaming or atomizing. **Vapour** The gaseous form of a substance that is normally a solid or a liquid at room temperature and pressure.

Some chemicals, when they come into contact with the skin, can directly affect the skin (e.g. corrosive materials such as acids or bases or cause allergic reactions or dermaitis); others may be absorbed directly through the skin and enter the blood stream e.g. some aliphatic and aromatic hydrocarbons and pesticides). Other sites of absorption are the eyes or other mucous membranes. Such chemicals are indicated on the Material Safety Data Sheet by the "skin notation".

Once swallowed, chemicals can enter the digestive system and then carried to other body organs. The most common way of ingesting chemicals is through vial contaminated hands or food or drink.

Chemicals can also enter the body through cuts or wounds in the skin, or through a cut or puncture from a sharp object such as broken glass or a needle. This is a common route of entry when dealing with biohazardous materials such as blood.

Regardless of the way in which the chemical enters the body, once it enters the blood stream it can be distributed anywhere in the body and can effect organs which are far away from the initial site of entry.

3.2 Toxicity vs Hazard

It is important to distinguish between the toxicity of a chemical and the hazard which it poses to the body.

Toxicity

Toxicity is an inherent property of the chemical and is its ability to cause harm when it reaches a certain concentration in the body. The higher the toxicity, the smaller the amount of material is necessary to produce a harmful effect.

Toxicity is generally measured through experiments on animals and is quantified as the LD_{50}, or the amount of material required to cause death in 50% of the animals (generally expressed in mg of material per kg of body weight). The smaller thel LD_{50} the more toxic is the material.

The following table gives the LD_{50} values of some common materials which can help put the LD_{50} values in context.

Hazard

The hazard of a chemical is its potential to cause harmful effects in the circumstances under which is being used. The hazard posed by a chemical depends both on its toxicity and the manner in which it is used or handled.

One can safely work with a very toxic material by taking appropriate precautions. Likewise, a low toxicity material can be quite hazardous if used improperly with few precautions.

Examples of Chemical Toxicity

Material	LD_{50} ($mg.kg^{-1}$)	Subject/Route
Sucrose (cane sugar)	29,700	Rat, oral
Sodium bicarbonate (baking soda)	4220	Rat, oral
Sodium Chloride (table salt)	3000	Rat, oral
Ethanol	2080	Rat, oral
Caffeine	192	Rat, oral
Sodium Cyanide	6.4	Rat, oral
Sarin (nerve agent)	24	Human, percutaneous (skin contact)
VX (nerve agent)	0.14	Human, percutaneous (skin contact)

3.3 Acute vs Chronic Exposure

Exposures to chemicals can be either acute or chronic. An acute exposure is delivered in single event. A chronic exposure is one which is protracted over a long period of time which can be days, weeks, months or years.

An acute exposure is usually caused by exposure to a high concentration of a substance that causes immediate harmful effects. A spill of acid on the skin causing a burn would constitute an acute effect. Such effects normally are immediately obvious and action can be taken to remediate them.

Chronic effects generally result from a low concentration of a substance over a long period of time. There are no immediately observable effects from the exposure and a person may not even know that he/she is being exposed. The effects only become manifest after many years. Common examples are smoking and exposure to asbestos.

Effects from some chemicals exhibit a **latency period**. That is there may be an extended period of time (years) between the exposure and the onset of disease. The latency period depends on the chemical and the disease but can manifest itself in

both chronic and acute exposures. The most common example of this is exposure to asbestos for which the onset of cancer can occur 20-30 years after exposure.

Chemicals which exhibit this latency period tend to be those which cause damage to the DNA in the body's cells. Damaged DNA can cause mutations leading to death of cells or abnormal growth. These chemicals are classified as mutagens, carcinogens and teratogens and, where applicable, these terms will be found on the Material Safety Data Sheet.

Mutagen

A mutagen is a chemical or physical agent that changes the DNA of an organism and thus increases the frequency of mutations above the natural background level. As many mutations cause cancer, mutagens are typically also carcinogens.

Carcinogen

A carcinogen is any substance or physical agent directly involved in the promotion of cancer or in the facilitation of its propagation.

Teratogen

A teratogen is a substance or physical agent capable of causing malformations in the developing fetus. The most commonly known teratogen is the drug thalidomide.

4. HAZARD CLASSIFICATION SYSTEM

The WHMIS system groups hazardous materials into six major classes or categories (one class is subdivided into three subclasses) based on the type of hazard that they represent. These materials are also called controlled products. The exact criteria relating to each classification are given in the *Controlled Products Regulation*.

Each category (and sub-category) has its own hazard symbol and it is important to recognize these.

Responsibilities for Classification

- The responsibility for classification of controlled products imported into or sold in Canada rests with the supplier.
- The employer has the responsibility for classification of products produced in the workplace
- Where the employer imports a product directly into the workplace from a source outside Canada for use in the workplace, the employer is considered the “supplier” and has the responsibility for classification.

4.1 Class A – Compressed Gases

A compressed gas is a material which is a gas at normal room temperature (20 C) and pressure, but is packaged as a pressurized gas, dissolved gas, or gas liquefied by compression of refrigeration.

The hazard from these materials, aside from their chemical nature, arises from sudden loss of integrity of the container. A compressed gas cylinder, when ruptured, can become a projectile with the potential to cause significant damage.

Compressed gases which are flammable, toxic or have other hazardous properties will be identified with both the compressed gas and other appropriate hazard symbol.

Typical precautions to be taken with compressed gases are:

- Ensure container is always secured
- Store in appropriate designated areas
- Do no allow to drop or fall
- Use the proper regulator
- Ensure cylinder is capped when in storage

4.2 Class B – Flammable and Combustible Material

This class contains all chemicals which can pose a fire hazard and includes gases, liquids, solids, aerosols and reactive flammable materials.

Flammable Gases

Gases such as hydrogen and butane which can form ignitable mixtures in air are classified as flammable gases. Cylinders of these gases will be identified with both the compressed gas and flammable material symbols.

Flammable Liquids

Any liquid with a flash point below 37.8 C is considered flammable. Such liquids can without any external heating evolve vapours at concentrations which can easily be ignited. A spark or other ignition source can easily ignite flammable liquids at or below room temperature.

Examples of flammable liquids are gasoline, acetone, ethanol, methanol, and toluene.

Combustible Liquids

Combustible liquids have flash points above 37.8 C. Combustible liquids are more difficult to ignite than flammable liquids since they usually require heating to give off sufficient vapours to present a fire risk.

Diesel fuel and kerosene are examples of combustible liquids.

Flammable Solids

Flammable solids are those that ignite through friction such as white phosphorus or that can be readily ignited and burn vigorously such as magnesium and a number of finely divided metals.

Flammable Aerosols

Flammable aerosols include aerosol products containing flammable ingredients or products that use a flammable propellant such as propane, butane and dimethyl ether. All pressurized products that pass a specific flame projection or flash back test are included as flammable aerosols.

Reactive Flammable Materials

This group includes a few particularly dangerous materials that are spontaneously combustible under normal conditions of use or chemicals which, when in contact with water, become flammable or give off a flammable gas. Examples are aluminum alkyls, metallic sodium and lithium aluminum hydride. Many of these may be common in the laboratory.

Typical precautions to be exercised with flammable and combustible materials are:

- Use only in well ventilated areas
- Store in designated flammable storage area or flammable storage cabinets
- Avoid excessive heat
- Avoid sparks or other sources of ignition

Note also that the Fire Code prohibits the storage and use of certain flammable liquids in basements. There are also quantity limits on for flammable liquids in laboratories.

4.3 Class C – Oxidizing Material

An oxidizing material may or may not itself burn, but will release oxygen or another oxidizing substance and thereby causes or contributes to the combustion of another material.

The presence of oxidizers will increase the risk that a fire will break out, and will cause any fire to burn more intensely. Some strong oxidizers can start fires with combustibles without the need for a flame and some can react with flammable or combustible materials with explosive results.

Ozone, chlorine and nitrogen dioxide are oxidizing materials. These will support a fire and are highly reactive. Another commonly used group of oxidizers are organic peroxides. Some of these are unstable enough to spontaneously ignite or explode.

Typical precautions to use with oxidizers are:

- Store in areas away from combustibles
- Store in proper containers which will not rust or oxidize
- Wear body, hand, face and eye protection

4.4 Class D1 – Materials Causing Immediate and Serious Toxic Effects

Materials in this class are generally those highly toxic chemicals that cause death within a short period following exposure. Small amounts can be fatal if inhaled, ingested or absorbed through the skin. Examples are arsenic and cyanide.

Typical precautions are:

- Avoid breathing dust or vapours
- Avoid contact with skin or eyes
- Use personal protective equipment or work in properly designated areas
- Store only in designated areas

4.5 Class D2 – Materials Causing Other Toxic Effects

This class contains chemicals where the effect generally arises from long-term chronic exposure. The types of toxic effects from this class are:

- Skin and eye irritation
- Chronic toxicity
- Sensitization – causing skin or respiratory allergies
- Mutagenicity - causing genetic damage
- Carcinogenicity – causing cancer
- Teratogenicity – causing birth deformities
- Embryotoxicity – causing fetal death
- Reproductive toxicity

A wide variety of chemicals can fall in this class and it is important to consult the Material Safety Data Sheet to determine the nature of the effect.

4.6 Class D3 – Biohazardous Infectious Material

Biohazardous infectious materials include any organisms and the toxins produced by these organisms that have been shown to cause disease or are believed to cause disease in either humans or animals.

Blood and body fluids fall into this category since they can potentially contain hepatitis A, B or C viruses or HIV.

Precautions to be taken when working with biohazardous infectious materials are:

- Only open containers in an appropriate containment area
- Special training required to work with biohazardous materials
- Avoid all direct contact
- Avoid creating or breathing aerosols
- Disinfect or sterilize area after work
- Store only in designated areas
- Use “universal precautions”

“Universal Precautions” are generally accepted standards for dealing with potentially infected materials. They cover personal protection, handling techniques and waste disposal.

Biohazardous infectious material is covered under the University Biosafety Program and the standards and procedures are detailed in the Biosafety Manual.

4.7 Class E – Corrosive Material

Corrosive materials can attack (corrode) metals or cause permanent damage to human tissues such as the skin and eyes. Burning, scarring and blindness may result from skin or eye contact.

Included in this class are many of the common acids such as sulphuric, hydrochloric and nitric. It also includes alkalis or bases such as sodium hydroxide (caustic soda).

Typical precautions to be taken include:

- Wear body, face and eye protection
- Use adequate ventilation

- Avoid all body contact

4.8 Class F – Dangerously Reactive Material

Dangerously reactive materials may undergo vigorous polymerization, decomposition or condensation. They may react violently under conditions of shock or an increase in pressure or temperature.

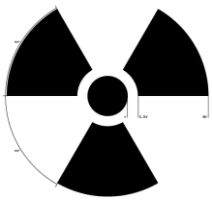
The chemical reactions can sometimes lead to a fire or explosion. They may also react vigorously with water to release a toxic gas.

Examples of chemicals in this category are sodium cyanide, sodium and magnesium metal, picric acid, and azides.

Specific precautions for these substances will vary but in general one should:

- Avoid vibration, shocks and sudden temperature changes
- Read the MSDS for specific packaging and storage requirements.

4.9 Radioactive Materials

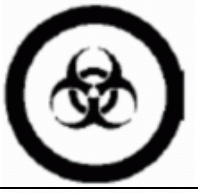


Although exempt from WHMIS and not part of the WHMIS classification and labeling system, radioactive materials may be present at the University.

The standard symbol for radiation is the “trefoil”

All uses of radioactive materials are regulated by the Canadian Nuclear Safety Commission and fall under the University’s Radiation Safety Program. Consult the Radiation Safety Manual for more information.

SUMMARY OF WHMIS HAZARD CLASSES

CLASS	DESCRIPTION	SYMBOL
A	Compressed Gas	
B	Flammable and Combustible	
C	Oxidizing Material	
D1	Poisonous and Infectious Material- Immediate and Serious Toxic Effects	
D2	Poisonous and Infectious Material- Other Toxic Effects	
D3	Biohazardous Infectious Material	
E	Corrosive Material	
F	Dangerously Reactive Material	

5. LABELS

Labeling of controlled products is a basic requirement of WHMIS. Any hazardous material, whether it be in transit, storage, or use must be labeled. The specific labeling requirements depend on a number of factors but there are basically two types of labels: These are:

- Supplier labels
- Workplace labels

There is a special subset of workplace labels applicable to laboratories and these are discussed later in this section.

5.1 Supplier Labels

Every supplier of a controlled product is required to affix a supplier label, the form and contents of which are prescribed by the WHMIS regulation. There are seven required pieces of information on a supplier label.

1) Name of the Product (chemical name, common name, generic name or trade name)
2) Name of the Supplier
3) Reference to the MSDS
4) Hazard Symbol(s)
5) Risk Phrases
6) Precautionary Measures
7) First Aid Measures

In addition to the content requirements there are two design and language requirements

1) The supplier label must be in English and French
2) A prescribed hatchmark border must surround the label in a colour that contrasts with the background. Typically the border is in either black or red.

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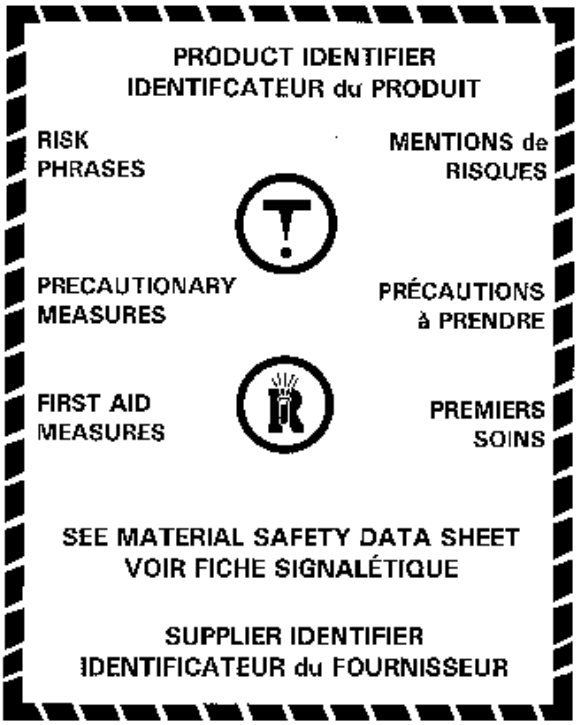
This label is typical of the type which would be affixed to products from industrial suppliers.



If a supplier label becomes illegible or is removed, the employer must replace the label with either a new supplier label or a workplace label.

Products sent from Laboratory Supply Houses to the University for use in a laboratory have less stringent labeling requirements provided they are intended solely for use in a laboratory and are packaged in a quantity of less than 10 kg. In this case the label must only contain:

1) a product identifier,
2) reference to a MSDS,
3) risk phrases, precautionary measures and first aid measures applicable to the product.

5.2 Workplace Labels

As long as a controlled product is in its original supplier-labeled container no additional labeling is required in the workplace. However, a workplace label is required under the following circumstances.

1) where the product is transferred from the original supplier-labeled container into another container,
2) where the supplier label has become illegible or has been removed
3) where a controlled product is produced in the workplace

The information required on a workplace label is less than that required on a supplier label and there are three categories of information required.

1) a product identifier
2) Safe handling instructions
3) A statement making reference to the MSDS

There are no specific design requirements for a workplace label, however a typical workplace label would look like this:

Hydrochloric Acid

Corrosive – handle with care

Causes severe burns

Avoid contact with eyes and skin

Use with local exhaust ventilation

See the MSDS before using product

Exceptions to the Workplace Label

1. Under the following limited circumstances, no supplier or workplace label is required on a portable container:

   - The portable container is filled directly from a container with a supplier or workplace label; and
   - The controlled product is under the control of and used exclusively by the worker who filled the portable container, and
   - The controlled product is used only during the shift in which the portable container was filled, and
   - The contents of the portable container are clearly identified, or
   - If all of the controlled product in the portable container is required for immediate use.

   In this case all that is required is a product identifier (e.g. the name of the chemical)

2. Alternate means of identification (other than a workplace label) such as colour coding, labels, placards may be used when the controlled product is contained in or transferred to:

- A pipe or piping system,
- A process vessel or reaction vessel
- A tank car, tank truck conveyor belt or similar conveyance.

3. Hazardous wastes do not require WHMIS labels, however employers must identify hazardous waste through a combination of some identification and worker education.

4. There are special provisions for labeling of controlled products in laboratories. These are described in the following section.

5.3 Laboratory Labels

WHMIS provides exemptions from the standard WHMIS labels for products used in laboratories. These exemptions relate to repackaged or decanted products and laboratory samples.

5.3.1 Controlled Products Received from a Laboratory Supply House

No supplier label is required on a controlled product received from a laboratory supply house if:

- It is intended solely for use in a laboratory, and
- It is packaged in a container in a quantity of less than 10 kg

In this case, the supplier must provide a label containing the following information:

- A product identifier
- A statement referring to the MSDS if available
- Risk phrases, precautionary measures and first aid measures applicable to the product.

5.3.2 Laboratory Samples from an External Source

A laboratory sample is defined as a sample of a controlled product that is intended solely to be **tested** in a laboratory. It does not include a controlled product that is to be used for testing other products, materials or substances or is to be used for educational or demonstration purposes.

For laboratory samples, no supplier label is required if:

- The sample contains less than 10 kg of the controlled product,

In this case, the supplier must provide a label containing the following information:

- A product identifier
- The chemical identity or generic chemical identity of any controlled products in the sample
- A supplier identifier
- The statement "*Hazardous Laboratory Sample, for hazard information or in an emergency call…(insert emergency telephone number)"*
- An emergency telephone number of the supplier.

If the laboratory sample contains more than 10 kg it is not considered a laboratory sample and requires a supplier label.

5.3.2. Laboratory Samples Produced In-House

A laboratory sample that is produced within a laboratory, is not removed from the laboratory and is intended solely for evaluation, analysis or testing for research and development does not require a supplier label.

In this case the sample:

- Must be clearly identified through a combination of identification visible to workers at the workplace and worker education that allows the workers to readily obtain information to ensure the safe use, storage and handling of the sample.

The identification of the sample can be by name, alphanumeric code, colour code or any other system provided the laboratory workers have been trained to understand the code and in the safe handling of the material.

The labeling required on laboratory samples depends on the source of the sample, i.e. whether it is from an external source or is produced in the laboratory and is not removed from the laboratory. The basic thing to remember is that every sample containing a controlled product must be labeled by some means or another.

5.3.3 Repackaged or Decanted Products

A supplier or workplace label is not required for a controlled product that is produced in the laboratory or that is transferred from the container in which it was received if the following apply:

- The material was received from a laboratory supply hours or is a laboratory sample.

- It is intended solely for use, analysis, testing or evaluation in a laboratory,
- It is clearly identified through a combination of identification visible to workers and worker education.

In this case there need only be a label on the container identifying the product. The worker education must be such as to enable the worker to readily identify and obtain risk phrases, precautionary measures, and first aid measures for the product.

The labeling requirements for laboratories are somewhat complex and they are summarized in the following table.

SUMMARY OF LABELLING REQUIREMENTS FOR LABORATORIES

	External Source			Internal Source (5)	
	Lab Supply House (1) (<10 kg)	**Lab Sample (< 10 kg) (2)**	**Lab Sample (>10kg) (2,4)**	**Repackaged (decanted) (6,7)**	**Laboratory Sample (2)**
Product Name or Identifier	Required	Required	Required	Required **(8)**	Required **(8)**
Supplier Identifier		Required	Required		
MSDS Reference	Required		Required	Equivalent information available **(9)**	Equivalent information available **(9)**
Hazard Symbol			Required		
Risk Phrase	Required		Required		
Precautionary Measures	Required		Required		
First Aid Measures	Required		Required		
Safe Handling Information				Worker training **(9)**	Worker training **(10)**
Listing of Controlled Ingredients		Required	Required		
Hazardous Statement		Required **(3)**			
Hatched Border			Required		
Emergency Phone Number		Required			

NOTES

1. Hazardous products originating from a laboratory supply house and intended solely for use in a laboratory and in a quantity of less than 10 kg.

2. A “laboratory sample” is a sample intended solely for analysis, testing or evaluation in a laboratory.

3. Required Hazard Statement – “Hazardous Laboratory Sample, for hazard information or in an emergency call (insert emergency phone number of the supplier)”

4. Samples larger than 10 kg are not considered laboratory samples and must be labeled with a proper WHMIS supplier label.

5. “Internal Source” refers to hazardous materials produced or repackaged in a laboratory that will only be used in that laboratory.

6. Produced in the workplace or is in a container other than that received from a laboratory supply house.

7. Intended solely for use, analysis or testing in a laboratory.

8. Identifiers such as codes are acceptable under WHMIS where a workplace label is not practical. When an identifier is used, there must be a worker education program which provides the information listed under “worker training” (9 and 10 below).

9. The education program must enable the worker to obtain from the sample identifier, either the information required on an MSDS, or a) the product identifier, b) risk phrases, c) precautionary measures and d) first aid measures.

10. The education program must enable the worker to obtain from the sample identifier, either the information required on an MSDS, or such other information as is necessary to ensure the safe use, storage and handling of the controlled product.

6. CONSUMER LABELS

Consumer products, which are available to the public in retail stores, are exempt from the labeling and MSDS requirements of WHMIS. However, they can be purchased and brought into the workplace and, if they pose a hazard, they are not exempt from the training requirements of WHMIS.

Consumer products have their own labeling system which is defined in the *Consumer Chemicals and Containers Regulation* under the federal *Hazardous Products Act.* Since these products can be brought into and used in the workplace, it is important to understand these labels and the circumstances in which WHMIS workplace labeling will apply.

Consumer products are divided into five categories based on the type of hazard.

- Toxic
- Corrosive
- Flammable
- Quick skin-bonding adhesives
- Pressurized Containers

Each of these categories, with the exception of quick skin-bonding adhesives, has a hazard symbol which is different from the WHMIS symbols. Several of the categories are further subdivided into subcategories and these are differentiated by the wording on the container.

The following information must be displayed on the container:

- A hazard symbol
- A signal word “Extreme Danger”, “Danger” or “Caution” as appropriate
- A primary hazard statement
- A specific hazard statement
- Negative instructions
- Positive instructions
- A first aid statement

Depending on the size of the container, some of these may be omitted; however the hazard symbol and the signal word must be displayed.

CONSUMER LABELS

CATEGORY	EXAMPLES OF RISK PHRASES	SYMBOL
TOXIC PRODUCTS	• Very Toxic • Toxic (Danger) • Harmful (Caution) • Poison • Do not swallow • Do not get in eyes or on skin or on clothing • Keep out of reach of children	
CORROSIVE PRODUCTS	• Very Corrosive (Extreme Danger) • Corrosive (Danger) • Irritant (Caution)\ • Causes severe burns • Dangerous fumes formed when mixed with other products • Handle with Care • Keep out of reach of children	
FLAMMABLE PRODUCTS	• Very Flammable (Extreme Danger) • Flammable (Danger) • Spontaneously Combustible (Caution) • Combustible (Flammable symbol not used) • Contents may catch fire • Do not smoke • Use only in well ventilated area	
PRESSURIZED CONTAINER	• Caution • Contents under pressure • Container may explode if heated • Do not puncture • Do not burn • Store away from heat	
QUICK SKIN-BONDING ADHESIVES	• Caution • Bonds skin instantly • Do not get in eyes or mouth or on skin • Keep out of reach of children	**NO SYMBOL**

7. MATERIAL SAFETY DATA SHEETS

The Material Safety Data Sheet is an important source of information on the hazards of specific chemicals. It is one of the three basic elements of the WHMIS system.

Suppliers are required, under the Hazardous Products Act, to provide a Material Safety Data Sheet with each controlled product they sell, however the regulations do not require an MSDS to be sent with every shipment of the product. The MSDS must be reviewed and updated every three years. The information on the MSDS is prescribed in the Controlled Products Regulation under the Hazardous Products Act and there are nine categories of information required.

- Product identification and use
- Hazardous ingredients
- Physical data
- Fire and explosion data
- Reactivity data
- Toxicological properties
- Preventative measures
- First aid measures
- Preparation information and date

The employer is responsible for ensuring that MSDS's are available to all employees at any time. The MSDS may be provided by electronic means, however there must be provision for providing a hard copy on request.

AT UOIT/Durham College Material Safety Data Sheets are available on the web from the Canadian Centre for Occupational Health and Safety (CCOHS). The database is accessed through the UOIT Health and Safety Website at

http://ccinfoweb.ccohs.ca.uproxy.library.dc-uoit.ca/asp/

Access requires your Banner ID and password.

Remember that it is against the law to use a controlled product in the workplace unless the WHMIS requirements for labeling, Material Safety Data Sheets and worker training have been met. You should not use a controlled product unless you have read the MSDS.

Departments and individual laboratories should maintain hard copies of the MSDS for all chemicals that they use.

Examples of the various sections of an MSDS are shown below. The format of the

MSDS and the order of the sections may vary from one supplier to another, but the information required on the MSDS is specified by the WHMIS legislation.

For definitions of the terms used in the MSDS, see the glossary of terms in Section 9.

SECTION 1 – PRODUCT INFORMATION	
Product Name: Acetone	**Product ID Number:** 1090
Other Names: Dimethyl ketone, 2-propanone	**Product Use:** Solvent
Manufacturer's Name: GE Betz Canada	**Supplier's Name:** Same
Address: 2010 Winston Park Drive Suite 400 Oakville, Ontario L6H 5R7	**Address:** Same
Emergency Telephone Number: 1-800-829-5000	**Emergency Telephone Number:** Same

SECTION 2 – HAZARDOUS INGREDIENTS				
Hazardous Ingredients	**%**	**CAS Number**	**LD_{50} (species and route)**	**LC_{50} (species and route)**
Acetone	100	67-64-1	Oral-Rat: 5,800 mg/kg Dermal-Rabbit: 20,000 mg/kg	Inhalation-Rat: 50.1 g/m^3/8 hr

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SECTION 3 – PHYSICAL DATA		
Physical State: Liquid	**Boiling Point:** 56.5 C	**Freezing Point**: -94.7 C
Odour and Appearance: Clear, Colourless Liquid Sweet, pleasant odour	**Odour Threshold:** 100-150 ppm	**Evaporation Rate:** ND (not determined)
Vapour Pressure: 181.7 mmHg at 20 C	**Vapour density: (air=1)** 2	**Specific Gravity:** 1.0 at 20C
pH: NA (not applicable)	**Coefficient of water/oil distribution:** ND (not determined)	

SECTION 4 – FIRE AND EXPLOSION DATA	
Flammability: Highly flammable and can be a severe fire hazard. The vapour easily forms explosive mixtures with air at room temperature.	
Extinguishing Media: dry chemical, carbon dioxide or foam	
Hazardous Combustion Products: Carbon monoxide	
Flashpoint: -17.8 C (closed cup)	**Autoignition Temperature:** 578 C
Upper Flammable Limit: 12.8% by volume	**Lower Flammable Limit:** 2.6% by volume
Explosion Data: Sensitivity to Mechanical Impact: Low	
Explosion Data: Sensitivity to Static Discharge: ND (not determined)	

SECTION 5 – REACTIVITY DATA
Conditions under which unstable: Stable under normal conditions
Incompatibility with other substances: May react with strong oxidizers such as peroxides and nitrates; halogenated hydrocarbon/alkali mixtures.
Hazardous polymerization: Will not occur
Conditions of reactivity: Strong oxidizers
Hazardous decomposition products: Carbon monoxide

SECTION 6 – TOXICOLOGICAL PROPERTIES
Route of Entry: Skin contact, Eye contact, Inhalation, Ingestion
Effects of acute exposure: May cause slight irritation to the skin. Severe irritant to the eyes. Primary route of exposure is inhalation of vapour; produces irritation of the upper respiratory tract. Prolonged exposure may cause headaches or dizziness. Ingestion may result in gastrointestinal irritation with possible nausea, vomiting, headache, dizziness, unconsciousness and injury to the kidneys and liver. Small amounts aspirated during vomiting may cause lung injury, possible death.
Effects of chronic exposure: No known serious long-term effects. Long-term contact with the liquid removes natural oils from the skin.
Irritancy: Liquid is mildly irritating on skin contact. Severe irritant to eyes.
Sensitization: None known
Carcinogenicity: No evidence of cardinogenicity
Teratogenicity: No evidence of teratogenicity
Reproductive Toxicity: No evidence of reproductive toxicity.
Mutagenicity: No evidence of mutagenicity
Toxicologically synergistic products: unknown

SECTION 7 – PREVENTIVE MEASURES
Engineering Controls to be used: Adequate ventilation to maintain air concentrations below exposure limits. General dilution ventilation may be adequate when acetone is used in small amounts at room temperature. Explosion-proof local exhaust ventilation is normally needed for large scale use or at elevated temperatures.
Respiratory Protection: If local ventilation is inadequate, wear an air-purifying respirator equipped with organic vapour cartridges. In confined spaces or emergency situations wear self-contained breathing apparatus.
Protective Clothing: Avoid skin contact. Wear neoprene, butyl or styrene-butadiene rubber gloves.
Eye Protection: Splash-proof chemical goggles
Other: An eyewash should be located near an area where acetone is routinely handled.

SECTION 8 – FIRST AID MEASURES
Skin Contact: Wash thoroughly with soap and water: Remove contaminated clothing. Get medical attention if irritation develops or persists.
Eye Contact: Remove contact lenses. Hold eyelids apart. Immediately flush eyes with plenty of low-pressure water for at least 15 minutes. Get immediate medical attention.
Inhalation: Remove to fresh air. If breathing is difficult, give oxygen. If breathing has stopped give artificial respiration. Get immediate medical attention.
Ingestion: Do not feed anything by mouth to an unconscious or convulsive victim. Do not induce vomiting. Immediately contact physician. Dilute contents of stomach by 30-4 glasses of milk or water.
Notes to Physicians: Aspiration into the lungs will result in chemical pneumonia and may be fatal.

SECTION 9 – STORAGE AND HANDLING
Storage requirements: Store closed containers in a cold, well-ventilated, flammable liquids storage cabinet or room. Use approved solvent containers. Keep away from heat, flames or sparks. No smoking in storage area.
Handling Procedures and equipment: Prevent skin and eye contact. Avoid breathing vapours. Use in well ventilated areas. Ventilation fans must be explosion-proof. Keep away from sources of heat, sparks or flames. Containers should be grounded and bonded during liquid transfer.
Special shipping information: Transportation of Dangerous Goods Act applies.

SECTION 10 – SPILL/LEAK DISPOSAL PROCEDURES
Spill Cleanup: Ventilate area. Use specified protective equipment. Contain and absorb on absorbent material. Place in waste disposal container. Remove ignition sources. Flush area with water. Spread sand/grit.
Waste Disposal: Dispose of as flammable organic, non-halogenated solvent waste.

SECTION 11 – PREPARATION INFORMATION
Prepared by:
Telephone:
Date:

8. CONTROL OF HAZARDS

There are four basic means of controlling hazards.

Engineering Controls

Engineering controls are part of the design of the workplace. They are intended to work independently of any action by the worker. They include physical barriers placed between the worker and the hazard and ventilation which either removes the hazard as it is generated (local ventilation) or which reduces the air concentration of a hazard to acceptable levels (general exhaust ventilation).

Since engineering controls work independently of the worker, they are the generally preferred and the most effective type of control. It is important, however, to ensure that the engineering controls are effective and maintained. A preventive maintenance program is essential to ensure that the engineering controls are working.

Administrative Controls

Administrative controls include policies and procedures which are not under the control of the worker. These would include purchasing controls on hazardous materials and requirements for approvals to work with specific chemicals. They also include such things as mandated work/rest periods and job rotation to reduce exposures.

Work Practices and Procedures

Work practices and procedures include specific steps for the safe handling of chemicals. Workers must be trained to follow these procedures. They are less effective than engineering and administrative controls, since they are subject to human error by the worker.

Personal Protective Equipment

Personal protective equipment includes things such as safety glasses and goggles, protective clothing and respirators. They are controls applied at the worker and, although necessary in some circumstances (i.e. safety goggles when working with hazardous liquids which can be splashed into the eyes), they should be considered a last line of defense and used only when the other types of controls are not feasible or as a backup to these controls. It is not desirable to use personal protective equipment as a primary control.

In most cases one will use a combination of all of these types of controls. It is desirable to use more than one control as human and system errors will occur and the

more controls or “barriers” one puts in place, the less likely is an overexposure to happen to a worker.

These four types of controls can be put in place in three major areas:

- At the source
- Along the path to the worker
- At the worker

Control at the Source

The best place to control the hazard is at the source of the hazard. The basic principles used are:

Elimination: If possible eliminate the chemical. If it is not necessary for the work then eliminate it.

Substitution: Substitute a hazardous product for one less hazardous.

Isolation: Use engineering controls to isolate the substance from the worker. Examples would be working with the chemical in a fume hood or a glove box (local exhaust ventilation).

Control along the Path to the Worker

After control at the source, the next best place to control is along the path to the worker. Methods used are:

Ventilation: General dilution ventilation in rooms whereby fresh air is continually brought in and room air is exhausted may be sufficient to maintain airborne concentrations of contaminants to acceptable levels.

Housekeeping: Housekeeping means keeping the working area neat, tidy and clean. It involves cleaning up chemical spills immediately, proper packaging and storage of chemicals and wastes.

Control at the Worker:

This should be the last line of defense and used only when other controls are not feasible or in conjunction with other controls to provide another barrier.

Personal Protective Equipment (PPE):

PPE includes laboratory coats, gloves, goggles, face shields and respirators.

Basic protective equipment for use in laboratories include:

- Lab coats
- Protective eyewear (goggles which seal around the eye)
- Gloves (where appropriate)

The Material Safety Data Sheet will include the preventive measures to be used which working with a specific chemical.

9. GLOSSARY OF TERMS

Acute Exposure – a short-term exposure usually occurring at a high concentration.

Acute Health Effect – an effect that develops either immediately or a sort time after exposure.

Autoignition Temperature – the minimum temperature required to initiate or cause self-sustained combustion in the absence of a spark or flame. The closer the autoignition temperature is to room temperature, the greater the risk of fire.

Biohazardous Infections Material – a material that contains organisms and the toxins produced by these organisms that have been shown to cause disease or are believed to cause disease in either humans or animals.

Boiling Point – the temperature at which a liquid changes from a liquid to a gas, at normal atmospheric pressure.

Carcinogen – agents that may induce cancer in humans.

CAS Registry Number – a number assigned to a material by the Chemical Abstracts Service (CAS) to provide a single, unique identifier.

Chemical Formula – sometimes called the molecular formula, indicates the elements that make up a chemical compound.

Chemical Name – the proper scientific name for a pure chemical.

Chronic Exposure – a long-term exposure usually occurring at a low concentration.

Chronic Health Effect – an effect that appears a long time (years) after exposure.

Coefficient of Oil/Water Distribution – the ratio of the solubility of the chemical in an oil to its solubility in water. It also indicates how readily a chemical can be absorbed into or stored in the body.

Combustible Liquid – a liquid which has a flash point above 37.8 C. The *Ontario Fire Code* defines two classes of combustible liquids according to their flash points.

> **Class II Combustible Liquids** – flash point >37.8 C and < 60 C
> **Class IIIA Combustible Liquids** – flash point >60 C and <93.3 C

In general, because they have lower flash points, combustible liquids are less dangerous than flammable liquids, provided they are not heated.

Compressed Gas – a material which is a gas at normal room temperature (20 C) and pressure but is packaged as a pressurized gas, dissolved gas, or gas liquefied by compression or refrigeration.

Condensation – the process of reducing from one form to another denser form such as steam to water.

Controlled Product – defined under the *Controlled Products Regulation* as a material, product or substance which is imported or sold in Canada and meets the criteria for one or more of the following classes:

Class A – Compressed Gas
Class B – Flammable and Combustible Material
Class C – Oxidizing Material
Class D – Poisonous and Infectious Material
Class E – Corrosive Material
Class F – Dangerously Reactive Material

Corrosive Material – a material that can attack (corrode) metals or cause permanent damage to human tissues such as the skin and eyes on contact.

Cryogenics – materials which exist at extremely low temperatures such as liquid nitrogen.

Dangerously Reactive Materials – materials that may undergo vigorous condensation, decomposition or polymerization. They may react violently under conditions of shock or increase in pressure or temperature. They may also react vigorously with water or water vapour to release a toxic gas.

Decomposition – the breakdown of a substance often due to heat, decay, or other effect, with the release of other compounds such as vapours or gases that may be flammable or toxic.

Density – the weight of a material in a given volume. It is usually given in grams per milliliter (g/ml) or grams per cubic centimetre (g/cm^3)

Dilution Ventilation – dilution of contaminated air with uncontaminated air in a general area, room or building for the purposes of health hazard or nuisance control, and/or for heating and cooling.

Dose – amount of the agent that has entered the body through the various routes of entry. It is usually expressed in grams (or milligrams) per kg of body weight.

Evaporation Rate - the rate at which a liquid changes to vapour at normal room temperature. The higher the evaporation rate, the more quickly the air concentration can increase to dangerous levels.

Explosive (Flammable) Limits – the lower explosive (flammable) limit (LEL) is the lowest concentration of vapour in air which will burn or explode upon contact with a source of ignition.
The upper explosive (flammable) limit (UEL) is the highest concentration of vapour in air which will burn or explode upon contact with a source of ignition. Below the LEL there is insufficient fuel to sustain combustion, above the UEL there is insufficient oxygen.

Explosive (flammable) Range – the range between the LEL and the UEL.

Exposure Limits – established concentrations which, if not exceeded, will not generally cause adverse health effects to the worker exposed. Exposure limits differ in name and meaning depending on the origin.

The Ontario regulation *Control of Exposure to Biological or Chemical Agents* (R.R.O.1990, Regulation 833) specifies three types of limits

- **Time-Weighted Exposure Value (TWAEV) –** the average airborne concentration of a biological or chemical agent to which a worker may be exposed in a work day or a work week.

- **Short Term Exposure Value (STEV)** – the maximum airborne concentration of a biological or chemical agent to which a worker may e exposed in any 15 minute period.

- **Ceiling Exposure Value (CEV)** – the maximum airborne concentration of a biological or chemical agent to which a worker may be exposed at any time.

  Threshold limit values (TLVs) are exposure guidelines developed by the American Conference of Governmental Industrial Hygienists (ACGIH). These guidelines have been adopted by many governments (including many Canadian provinces) as their legal limits. The ACGIH limits are expressed as:

- **Threshold Limit Value – Time Weighted Average (TLV-TWA)** – the time-weighted average concentration for a normal 8 hour work day and 40 hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

- **Threshold Limit Value – Short Term Exposure Limit (TLV-STEL)** – a 15 minute time- weighted average exposure which should not be exceeded at any time during a work day even if the 8 hour TWA is within the TLV. Exposures at the STEL should not be repeated more than 4 times per day and there should be at least 60 minutes between successive exposures at the STEL.

- **Threshold Limit Value – Ceiling (TLV-C)** – the concentration that should not be exceeded during any part of the working exposure.

- **Skin** – the notation "skin" following the name of an agent in the regulation indicates that direct or airborne contact with the agent may result in significant absorption of the agent through the skin, mucous membranes or eyes. In this case preventive action should be taken to prevent contact with skin, mucous membranes or eyes.

  Note that the definitions of the Ontario provincial limits are almost identical to those of the ACGIH and in most cases the values are also identical. The name for the limit differs because the word "TLV" is proprietary to the ACGIH.

  Other exposure limits include the Permissible Exposure Limits (PEL) which are legal exposure limits in the United States.

Flammable Substance – one that will readily catch fire and continue to burn in air if exposed to a source of ignition.

Flammable Liquid – a liquid that gives off vapour which can readily catch fire and continue to burn. Flammable liquids have flash points below 37.8 C. The *Ontario Fire Code* defines three classes of flammable liquids depending on their flash point and boiling point.

Class 1A Flammable Liquids – Flash point <22.8 C, Boiling point <37.8 C
Class 1B Flammable Liquids – Flash point <22.8 C, Boiling point >37.8 C
Class 1C Flammable Liquids – Flash point >22.8 C and <37.8 C.

Because of their low flash points, Class 1 flammable liquids may not be stored, handled or used in basements.

Flashback – this occurs when a trail of flammable vapour is ignited by a distant source of ignition and the flame travels back along the trail of vapour to its source.

Flash Point – the lowest temperature of a liquid at which it gives off enough vapour to form an ignitable mixture of vapour and air immediately above the liquid surface. The lower the flash point, the greater the risk of fire.

Freezing Point – the temperature at which a liquid becomes a solid at normal atmospheric pressure.

Hazard – the potential for harmful effects

Hazardous Combustion Products – chemicals which may form when a material burns. These chemicals may be flammable, toxic or have other hazards.

Hazardous Decomposition Products – materials formed when a material desomposes (breaks down) because it is unstable or reacts with materials such as water or oxygen in air.

Hazardous Ingredient – under the *Hazardous Products Act*, a chemical must be listed in the Hazardous Ingredients section of an MSDS if:

- It meets the criteria for a controlled product,
- It is on the ingredient disclosure list,
- There is no toxicological information available, or
- The supplier has reason to believe it might be hazardous.

Hazardous Polymerization – polymerization is a process of forming a polymer by combining large numbers of chemical units or monomers into long chains (polyethylene from ethylene, or polystyrene from styrene). Uncontrolled polymerization can be extremely hazardous as some polymerization processes can release considerable heat or can be so rapid as to be explosive.

Ingestion – taking a material into the body by mouth (swallowing).

Inhalation – taking a material into the body by breathing it in.

Irritant – a material that causes irritation, inflammation or aggravation of whatever tissue with which the material comes into contact.

LC_{50} – the concentration of a material which causes death in 50% of a group of test animals. LC stands for lethal concentration. It is usually defined in terms of air concentration.

LD_{50} - the weight of material which caused the death of 50% of a group of test animals. It is usually expressed as the weight of material per weight of test animal. LD stands for lethal dose.

LEL (lower Explosive Limit) - see “Explosive (flammable) Limits”

Local Exhaust Ventilation – ventilation which captures pollutants at the source, as opposed to dilution ventilation which dilutes the material in the air of a room. A fume hood or Biosafety cabinet are examples of local exhaust ventilation.

Material Causing Immediate and Serious Toxic Effects – classified under “Poisonous and Infectious Material” as toxic or very toxic based on information such as the LD_{50} or LC_{50}.

Material Causing Other Toxic Effects – classified under “Poisonous and Infectious Material” as a material causing toxic effects such as skin or respiratory sensitization, carcinogenicity, mutagenicity, etc.

Melting Point - the temperature at which a solid material becomes a liquid at normal pressure.

Mutagen – an agent that affects the genes or cells of the exposed people in such a way that it may cause cancer in the exposed individual or an undesirable mutation to occur in some later generation.

NA Number – see “UN Number”

Odour Threshold – the airborne concentration, usually in parts per million, at which an odour becomes noticeable.

Oxidizing Material – a material that gives up oxygen easily or can readily oxidize other materials.

Parts per Million (ppm) - a unit of concentration. If a gas is present in air at a concentration of 1 ppm, there is one part of the gas per million parts of air.

Permissible Exposure Limit (PEL) – legal limits in the United States, set by the Occupational Safety and Health Administration (OHSA).

pH – a measure of the acidity or alkalinity (basicity) of a material when dissolved in water. Pure water is neutral with a pH of 7. Acids have pH values <7 and bases have pH values >7.

Polymer – a natural or man-made material formed by combining units, called monomers, into long chains.

Polymerization – the process of forming a polymer by combining large units of chemical units or monomers into long chains.

Product Identification Number (PIN): - a number, specified in the *Transportation of Dangerous Goods Regulation* that identifies the chemical. This number is used by fire fighters and other emergency response personnel for identification of material during transportation.

Sensitization – the development, over time, of an allergic reaction to a chemical.

Solubility – the ability of a material to dissolve in water or another liquid.

Solvent – a material which is capable of dissolving another chemical.

Specific Gravity – the density of a liquid compared to the density of water.

Stability – the ability of a material to remain unchanged in the presence of heat, moisture or air.

Teratogen – agents or compounds that can cause defects in a foetus.

TLV – see “Exposure Limits”

Toxicity – the ability of a substance to cause harmful effects.

Trade Name – the name under which a product is commercially known.

TWA – see “Exposure Limits”

UEL (Upper Explosive Limit) = see “Explosive(flammable) Limits”

UN Number – a four digit number assigned to a potentially hazardous material or class of materials. UN (United Nations) numbers are internationally recognized and are used by fire fighters and other emergency response personnel for identification or materials during transportation emergencies. NA (North American) numbers are assigned by Transport Canada and the US Department of Transport to materials they consider hazardous and to which a UN number has not been assigned.

Vapour – a gaseous form of a material which is normally solid or liquid at room temperature and pressure.

Vapour Density – the density of a vapour compared to the density of air. If the vapour density is greater than one, the material can accumulate at ground level.

Vapour Pressure - the pressure of a vapour in equilibrium with its liquid or solid form. Vapour pressure is a measure of the tendency of a material to form a vapour. The higher the vapour pressure, the higher the potential vapour concentration.

Ventilation – the movement of air.

Volatility – the ability of a material to evaporate.