A Guideline on

Chemical Handling and Storage

August 2002

A Guideline on Chemical Handling and Storage

TABLE OF CONTENTS PAGE

Acknowledgements

Cover photo – provided by Terra Universal Inc.

Table on page 12 – provided by the American Chemical Society; extracted from *Chemical Safety Manual For Small Businesses, 2nd Edition.*

I. INTRODUCTION

This guideline is intended to be a training tool and a resource for workers and employers to safely store and handle chemicals in the workplace. The goal of this guideline is to reduce the incidence and risk of fire, workplace incidents, and hazardous short-term and long-term exposures when working with chemicals.

This guideline provides a general overview, and is not intended to be comprehensive in every aspect of chemical handling and storage. Furthermore, training in the Workplace Hazardous Materials Information System (WHMIS) is essential in any work environment dealing with hazardous materials.

It is recommended that your workplace create a chemical safety plan, which outlines proper procedures for handling chemicals in your workplace. Fire safety and emergency planning specific to your workplace should also be included. This document may be used to help you with the creation of your safety plan, however other information, particularly on safe practices for specific chemical handling operations, will be required. Documents outlining safe handling practices may be obtained from various sources, including your chemical supplier, the Canadian Standards Association, the National Fire Protection Association, and other publications from Workplace Safety and Health.

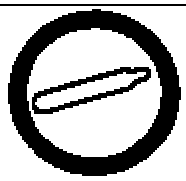
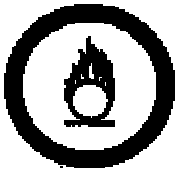
II. HAZARDOUS MATERIAL IDENTIFICATION SYSTEMS

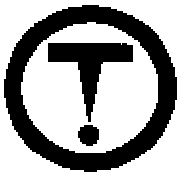
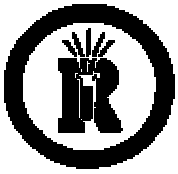
This section will introduce the WHMIS system as a means of identifying hazardous products. Other systems used in North America will be briefly discussed as well.

Workplace Hazardous Materials Information System (WHMIS)

Manitoba implemented the WHMIS system by passing the WHMIS regulation (MR52/88) in 1988. In the WHMIS system, hazardous chemicals are termed "controlled products." This system is used throughout Canada, and identifies the hazards associated with controlled products used in workplaces. The regulation requires all applicable products to be labelled according to their hazards. Material Safety Data Sheets (MSDS) for each product must be made easily accessible and include the following topic headings: product information, reactivity data, preparation information, toxicological properties, hazardous ingredients, preventative measures, physical data, first aid measures, and fire or explosion hazards. Workplace and supplier labels must refer to the MSDS. All employers are required to educate workers on: the content, purpose and significance of information on supplier labels, workplace labels, and MSDSs; procedures for the safe use, storage, handling and disposal of controlled products; and procedures to be followed in case of an emergency involving a controlled product.

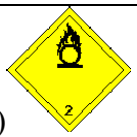
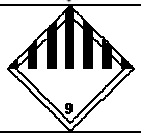
Controlled products are divided into 6 classes, some with subclasses. A particularly hazardous chemical may have a number of these symbols based on the hazards that it possesses:

Class A - Compressed Gases		Pose an explosive danger because these gases are contained under pressure; may cause container to explode if heated in a fire or subjected to impact forces.
Class B – Flammable and Combustible Material		Material that will burn (a potential fire hazard) or may burst into flame spontaneously, in air, or release a flammable gas on contact with water vapour; may cause a fire when exposed to heat, sparks, flames or as a result of friction.
Class C – Oxidizing Material		Pose a fire and/or explosion risk in the presence of flammable or combustible material; may react violently or cause an explosion when contacting combustible materials.
Class D – Poisonous and Infectious Material:		
D - Division 1		Materials causing immediate and serious toxic effects - may be a potentially fatal poisonous substance; may be fatal or cause permanent damage if inhaled or swallowed, or upon entering the body through skin contact.

D - Division 2		Materials causing other toxic effects – a poisonous substance that may not be immediately dangerous to health; may cause permanent damage as a result of repeated exposures over time; may be a sensitizer (produce chemical allergies); may cause cancer, birth defects or sterility.
D - Division 3		Biohazardous Infectious Material – may cause a serious disease resulting in illness or death (not covered in this guideline).
Class E		Corrosive Material – Causes eye and skin tissue damage upon contact; causes severe tissue damage with prolonged contact; may be harmful if inhaled.
Class F – Dangerously Reactive Material		Is very unstable; may react with water to release toxic gas; may explode as a result of shock, friction or increase in temperature; may explode if heated in a closed container; undergoes vigorous polymerization or decomposition.

Transportation of Dangerous Goods (TDG)

All provinces and territories have adopted Transportation of Dangerous Goods Regulations, which establish the safety requirements for the transportation of dangerous goods. TDG is similar to, but not exactly like WHMIS as far as division of dangerous goods into classes. TDG uses 9 classes:

CLASS	LABEL	COLOUR
Class 1 – Explosives – there are various subclasses		Orange
Class 2 – Gases – a)Non-flammable non-poisonous non-corrosive gas, b)Poison gas, c)Flammable gas, d)Oxidizing gas	a)  b)  c)  d) 	a)Green, b)White, c)Red, d)Yellow
Class 3 – Flammable liquids		Red
Class 4 – a)Flammable Solids, b)spontaneously combustibles, c)Substances that, on contact with water, emit flammable gases	a)  b)  c) 	a)Red/White, b)Red/White, c)Blue
Class 5 – a)Oxidizing substances, b)Organic peroxides	a)  b) 	Yellow
Class 6 – Poisonous (toxic) and infectious substances – a)Poisonous, b)Infectious	a)  b) 	White
Class 7 – Radioactive Materials - there are 3 categories		Yellow/White
Class 8 – Corrosives		Black/White
Class 9 – Miscellaneous products and substances		Black/White

National Fire Protection Association (NFPA) System

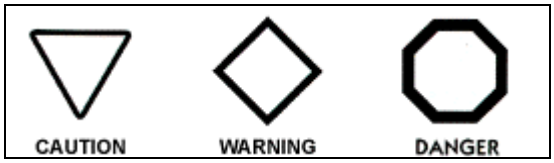
The NFPA's hazard coding system was developed in the United States, and is used all over North America. This system consists of a symbol with 4 quadrants. Numbers 0 to 4 are placed in each quadrant indicating the seriousness of each hazard (0 being none or little, 4 being severe). The left quadrant (usually in blue) indicates the relative health hazard. The top quadrant (usually in red) indicates the flammability. The right quadrant (usually in yellow) indicates the relative reactivity. The bottom quadrant (in white) indicates any special characteristics of the substance. Symbols used in the bottom quadrant are: C - may be carcinogenic upon chronic exposure, Cor - corrosive, Exp - risk of explosion, Oxy - oxidizing agent, SC - suspected carcinogen, T - toxic, ~~W~~ - water reactive, and Pol - polymerizes under normal conditions. Below is an example of an NFPA symbol:

NFPA symbols are for additional information only. This system by itself, is not acceptable to meet WHMIS requirements.

Household Product Symbols

Products intended for consumer purchase do not have WHMIS symbols. These products have a simple pictorial system to identify hazards.

All symbols are outlined by a triangle, diamond, or octagon. The more sides the symbol has, the greater the hazard:



Hazardous products can fall into any of 4 classes:


Corrosive


Explosive (contents under pressure)


Flammable


Toxic

An example of a complete warning symbol:


Symbol for extremely toxic material

III. IMPORTANT INFORMATION FOR STORAGE AND HANDLING

This section discusses important general advice for storing and handling a hazardous chemical. Important information about chemical reactivity is also discussed. The majority of this information is based on good industry and laboratory practice. Some of this information, however, is based on legal requirements, such as those outlined in the Manitoba Fire Code, the Manitoba Building Code, WHMIS regulations, and others. Detailed storage and handling methods for each chemical group will be discussed in the next section.

General Storage

The MSDS – always read the chemical's Material Safety Data Sheet and note any warnings regarding incompatibilities and special storage conditions *before* attempting to store or use any chemical. MSDSs must be easily accessible.

Small Quantities – The Manitoba Fire Code specifies small quantity exemptions for hazardous goods (Table 3.2.7.1). This means that quantities smaller than those specified in the Fire Code are exempt from additional rules outlined in section 3.2.7 of the Code. Proper segregation and other precautions, as outlined in this guideline, are still highly recommended when storing *any* quantity of hazardous material.

The Store Room – Storage rooms where hazardous materials are kept must have the following specifications:

- Separated from the remainder of the building by a fire separation having a fire-resistance rating of at least 1 hour; A fire separation of at least 2 hours is required if any oxidizing, flammable, or dangerously reactive materials are stored;
- Storage areas containing flammable, oxidizing, toxic and corrosive substances must be located on the exterior wall of the building;
- Equipped with self-closing fire doors;
- The floor of the room must be adequately lower than the surrounding floor, or the opening of the room should be equipped with an adequately high sill or ramp; Floors should be made of impermeable material, to prevent the absorption of chemicals;
- Equipped with an emergency drainage system (not leading into the sewer) that directs hazardous materials and fire protection water to a safe location; Where toxic or environmentally harmful substances are stored, dyking must be present to prevent runoff of fire-fighting water – with adequate retention volumes; Retention volumes will depend on the type and amounts of chemicals stored;
- In the presence of flammable or combustible materials, all electrical wiring, connections and equipment must be properly grounded and in compliance with CSA C22.1, "Canadian Electrical Code, Part 1," for the applicable locations;
- Areas where flammable, oxidizing, or dangerously reactive materials are stored must be equipped with explosion proof lights;

Outdoor Storage – Be aware that the Manitoba Fire Code has distinct regulations for the outdoor storage of dangerous goods regarding maximum amounts and methods of storing (section 3.3.4). For example, incompatible chemicals that require separate fire compartments when stored indoors, may be separated by a horizontal distance of 3 m in lieu of separate fire compartments, when stored

outdoors. Segregation based on compatibility, and other precautions for indoor storage still apply to outdoor storage.

Outdoor storage may be appropriate for some hazardous materials, and not for others. For example, highly flammable liquids, gas cylinders, and liquid chlorine may require outdoor storage. Necessary precautions for protection from the effects of atmospheric conditions, such as roofs, should be taken. Always check the MSDS to ensure atmospheric temperatures are safe for the materials stored. As with indoor storage, unauthorised access must be prevented.

Hazardous Chemical Control Measures

Substitution – Consider substituting the chemical you are using for a less hazardous alternative when possible. For example, replacing benzene with toluene. This can be the most effective way of reducing chemical hazards.

Store Minimum Quantities – Never stock up more than a year's supply of chemicals. Amounts of chemicals that can be used up in 3 months are recommended. Do not purchase larger quantities than needed - it will increase the potential hazard, take up valuable space, and could result in a costly disposal problem.

Store Chemicals in the Storage area – Store as little chemical in the work area as possible, usually only a one day supply. Chemicals should be put back into the storeroom at the end of the workday. Assign responsibility for the chemicals, and have them "signed-out" to assure their proper return. Storage areas must be separate from processing/handling areas.

Access – Unauthorized access to the storage areas must be prevented. Security systems may be appropriate.

Proper Shelving – Shelving should be more than strong enough to support the weight of the chemicals, and firmly secured to the wall or ceiling. Shelving should be made of the appropriate chemically resistant materials. Shelves should be shallow and have a raised-lip to prevent containers from falling off, or, preferably, have glass or metal doors. Shelves should not be made of unfinished wood. Metal or high-density plastic is recommended. Secondary containment, able to hold the total amount of stored chemical in the event of a spill, should be present. Peninsula and island shelves are not recommended. Ensure that shelves are adequately spaced to allow for easy access to, and movement within the storage area.

Proper Placement – Containers of chemicals should not be crowded. Accessing one container should not require the movement of other containers. Containers of chemicals should not be stacked on top of one another. Store chemicals below eye level, but avoid storing chemicals on the floor, even temporarily (except for gas cylinders). In addition, to avoid serious physical and chemical hazards in the event of a spill, the following general rules should be used: solid materials placed on higher shelves than liquids, and heavier containers placed on lower shelves than lighter containers.

Labelling – All chemicals must be properly labelled, with information on its contents, all appropriate supplier hazard information associated with the chemical including WHMIS symbols (if required), the date received, and an expiration date, if applicable. Some chemicals, such as organic peroxides, require the labelling of the date they were opened. Labels should be waterproof, easily legible and written in manner that is waterproof. Periodically check to ensure that labels are not falling off. A lost label could result in a costly disposal problem.

Access to Information – Have a posted floor plan or accessible database of where different chemical groups are listed, and ensure that any chemical can be found easily. Material Safety Data Sheets (MSDSs) for every chemical stored and used must be easily accessible. Floor plans should be made available to the local fire department upon request. Signs indicating the type of chemicals in a storage area (e.g. "Water Reactives") should be present – placards conforming to the classification system are useful.

Neatness – Ensure that there is no clutter in the storage area. The chemical storage area should not double as a general storage area. Machines, tools, manufactured goods should not be kept in the storage room. Aisles and exits must be clear and unobstructed at all times.

Inventory – A good, working inventory control will help minimize the risk of many hazards. This includes:

- inspecting all incoming hazardous materials and ensuring that they are properly labelled and the containers are not damaged or leaking - do not accept shipment of damaged or mislabelled chemicals;
- assigning an expiration date to all chemicals and removing and properly disposing of expired chemicals (a computer database is extremely helpful in red-flagging expired chemicals);
- immediately putting away chemicals to their appropriate storage area;
- regularly (at least twice a year) inspecting the entire storage area for signs of leakage, decomposition, misplaced or expired chemicals, or other unsafe storage conditions. When inspecting chemicals, be on the lookout for discoloration, turbidity, caking, moisture in dry solids, particles or larger solids in liquids, signs of pressure build-up such as distortion of the container, and expired chemicals. When inspecting shelving and cabinets, be on the lookout for spilled materials, signs of corrosion, cracks, spotted surfaces, and rust.

Chemical Reactivity

It is important to understand the conditions and variables that govern how reactive or toxic a chemical may be. The following are *general* rules (some exceptions do exist):

Stability – Stability refers to whether a chemical will react or change its chemical structure under normal light, pressure, and temperature conditions. Some chemicals, themselves, may not be hazardous, but may undergo changes that create hazardous products. Chemicals may undergo *decomposition* (a molecule breaking down into simpler molecules) or *polymerization* (molecules joining to form long chains called polymers). The MSDS will note the possible decomposition and polymerization products for your chemicals (if the products are hazardous), and will note storage conditions necessary to ensure your chemical's stability.

Temperature – Materials generally become more reactive, and decompose at faster rates, the higher the temperature. Also, some chemicals may release flammable or toxic gas at high temperatures. For this reason, some chemicals may need to be kept under temperature control. Some chemicals

require the use of explosion-proof refrigerators or other means to regulate the temperature, and keep the chemical stable. Be aware that the temperature range a chemical may need may be quite small. For example, some peroxides may require cooling, but cannot be allowed to get cold enough to freeze, as the solid form of the chemical may be more reactive.

Concentration - The higher a chemical's concentration, the "stronger" the chemical's properties. At higher concentrations, acids and bases are more corrosive, toxins are more harmful, peroxides are more reactive, and so on. To safely store or handle some chemicals, *dilution* may be necessary. See *General Handling Advice* for information on diluting chemicals.

Organic and Inorganic – Throughout this document, the terms *organic* and *inorganic* are used to describe materials. This is because some chemicals may react vigorously in the presence of organic materials. Simply, *organic* compounds are those which contain carbon atoms in the molecule. This can be verified by looking at the chemical formula on the MSDS - the symbol for carbon "C" will be present. For example, acetic acid, with the formula CH_3COOH, is organic. All chemicals without carbon in the molecule are termed *inorganic*. Organic materials are not limited to a bottled chemical form. Wood, paper, plastics, grease, and biological material (living or dead) are examples of common organic material.

Catalysts and Inhibitors – A chemical reaction may occur much faster in the presence of a *catalyst* - another chemical that increases a reaction rate while not being consumed in the reaction. Hydrogen peroxide, for example, may be stable in a plastic bottle for months, but in the presence of a manganese salt, the peroxide vigorously decomposes. Catalysts should be used and stored wisely, so as to prevent their accidental contact with the reactive chemical. Similarly, a chemical reaction may be made much slower in the presence of an *inhibitor*. Inhibitors may be necessary to keep chemicals stable in storage. When in use, ensure that adequate levels of inhibitors are maintained.

Oxidizers and Reducers – An oxidation-reduction reaction is one that involves a transfer of electrons between compounds – oxidizing agents (oxidizers) gaining electrons and reducing agents (reducers) losing electrons. Strong oxidizers are given their own class under WHMIS and TDG due to their strong ability to support a fire (in a fire, a flammable acts as a reducer). Because of these classifications, strong oxidizers are easily identified. In addition to flammables, oxidizers must also be separated from strong reducers due to the potential explosive reaction between the two. Reducers, however, are more difficult to identify, as there is no separate WHMIS or TDG classification for them. The MSDS may state that the material is a strong reducing agent, or may state, "keep away from oxidizers."

General Handling

Be Knowledgeable – Everyone working with or around chemicals must know the following:

- The location of, and how to use the emergency equipment present;
- The safety rules and procedures for the work being done, including the potential hazards required for the materials being used;
- The types of personal protective equipment required and their location;
- Not to handle a material until they have read and understood its MSDS.

Follow Instructions – Follow procedures carefully. Changing quantities or types of chemicals may be dangerous. Also, be aware of the actions of your fellow workers. Their mistakes or unsafe practices can seriously harm themselves and others, and therefore must be pointed out or, if necessary, reported.

Mixing Chemicals – NEVER MIX CHEMICALS UNLESS YOU ARE ABSOLUTELY SURE OF THE OUTCOME. Mixing chemicals haphazardly can result in fires, explosions, or the release of toxic vapours. For example, mixing toilet bowl cleaner with an acid-based drain cleaner may produce extremely harmful chlorine gas. When *knowledgeably* mixing chemicals, add them slowly, do not just dump them in. Add a small amount first, wait a few moments (some reactions take time), and observe what happens. Only continue to add if no undesired or harmful reactions take place. **Beware of the release of large amounts of heat, toxic vapours, fumes, and splashing.** When possible, chemical processes should be performed under a fume hood or other well-ventilated area (See part VIII on *Ventilation)*.

If the chemical mixture begins to react violently, releasing unexpected or uncontrollable amounts of heat or toxic vapours, STOP adding chemicals to the mixture immediately. Remove any heat sources present and shut off electrical devices. Alert others nearby, and move away from the reaction. Only return when the vigorous reaction has subsided, and a technically qualified person has deemed the location to be safe, with no risk of fire or hazardous exposure. Personal protective equipment will likely be necessary.

Dispensing – When dispensing from one container to another, do so one transfer at a time. Ensure that all new containers are adequately labelled and closed tightly. Containers should be made of compatible materials and have appropriate caps (e.g. some materials require vent caps to be used).

Diluting Chemicals – Chemicals may be diluted with a solvent (usually water) to reduce the strength of a certain property, or to minimize the reactivity of a compound. When diluting, add the chemical slowly to the solvent, stirring slowly. After diluting, always write the new concentration on the label. Concentrations are written in many different forms (moles per litre (M), grams per millilitre (g/mL), parts per million (ppm), percent (parts per hundred), among others). The new concentration can be calculated from the old concentration with the following formula:

New Concentration = (Original Concentration × Original Volume) ÷ New Total Volume

Also, if diluting with a solvent *other than water*, write the type of solvent used on the label.

Transporting Chemicals – When transporting flammable, corrosive, or toxic materials, use impact-resistant transport containers. Transportation of hazardous materials outside of your workplace must comply with the *Transportation of Dangerous Goods Act,* and its regulations. Fork-lift trucks and similar vehicles may only be driven by trained individuals. Attention should be given to ensure fork-lift trucks do not provide a source of ignition for flammable substances.

Unattended Reactions and Operations – Unattended and overnight reactions and operations should be avoided. Reactions should be checked regularly. If operations must be run overnight, fail-safe provisions are required to ensure there are no fires or explosions. Leave an easily visible note with a phone number you can be reached at.

Unknown Chemicals – Treat all unknown chemicals as extremely hazardous until their identity can be verified. Never sniff or taste a chemical to try to identify it. Consult those in the work area to try to identify the substance. **If the product cannot be identified safely it must be disposed of as hazardous waste.**

Work Area – Work sites should be clean and orderly. Floors and other surfaces should be dry and slip-resistant. Spilled material must be cleaned up immediately. Wastes must not be allowed to accumulate – they must be stored safely and be removed form the work site promptly.

Working Alone – Avoid working alone with hazardous chemicals. If working alone cannot be avoided, employers are required to create a plan to ensure the safety of the employee (refer to Manitoba Regulation "Working Alone" MR 105/88R). This can include arranging for someone from another working area or a security guard to crosscheck periodically and advising them of the hours you will be there. Do not perform a specific chemical procedure alone if recommended practice forbids it.

Cleaning Equipment – In many cases, equipment that has been in contact with a chemical must be cleaned when no longer in use. Beware of chemical incompatibilities with water or the cleaning agents used. After cleaning, water or other solvents used in washing may need to be treated as hazardous waste.

Excess – Do not return excess chemical back in its original container. Impurities entering the container can cause an undesired reaction.

Pipetting or Starting a Siphon – Pipetting or staring a siphon, for any material, must never be performed "by mouth." Use aspirator bulbs or other appropriate equipment. In a workplace dealing with chemicals, nothing should ever be put in, or near the mouth.

Opening Lids – Treat stuck lids or stoppers with caution. The friction caused when vigorously opening a container may cause sensitive chemicals to explode. Also, excessive force may damage the seal, resulting in leaks and spills later.

Washing – Wash hands thoroughly after working with chemicals, and before eating.

Eating, Drinking, Smoking – Eating, drinking, smoking, or applying cosmetics is prohibited anywhere hazardous chemicals are used or stored. Signs must clearly label and distinguish work areas from eating and smoking areas.

IV. SAFE STORAGE AND HANDLING OF CHEMICALS BY GROUP

The improper storage of chemicals is a major cause of accidents in laboratories and other workplaces. Fires, poisonings and other accidents can be avoided with a proper scheme for grouping and organizing chemicals, as well as a good knowledge of the nature of the chemicals you are storing. Chemical storage practices such as organizing by alphabetical order or storing all chemicals in the work area, while practical, have proven to be dangerous. If a fire or spill occurs it is important to be sure that the chemicals stored together will not combine to make the hazard worse. Chemical *compatibility* must be considered.

The best way to segregate chemicals is to divide them into easily identifiable storage groups. The following group structure is suggested for storing, groups 1-8 will be explained in detail:

1. Compressed Gases
2. Water Reactives
3. Other Dangerous Reactives
4. Oxidizers
5. Flammables
6. Corrosives
7. Toxins
8. General Chemicals
9. Special Hazardous Materials: Radioactives* and Explosives*

*Will not be explained in detail, however, references to other information sources are given.

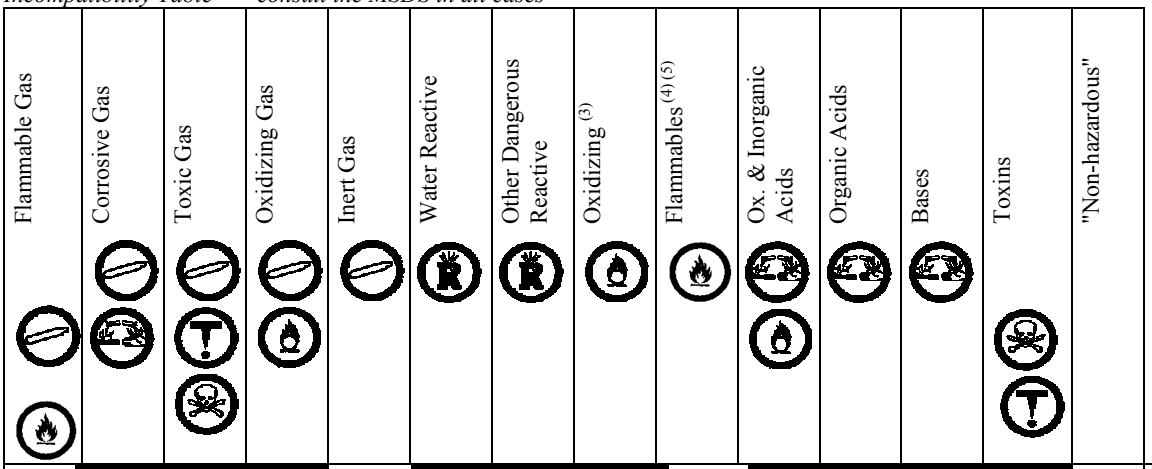
Notes:

- The above grouping scheme does not conform exactly to either the WHMIS or the TDG classification systems. This scheme uses information from WHMIS, TDG, and other systems to establish a group structure that will account for the majority of chemical incompatibilities, while keeping the groups simple and easily identifiable. Depending on the chemicals you are storing, you may require a more (or less) complex segregation scheme.
- Some chemicals may fall under 2 or more storage groups. In that case, segregate according to the group that represents the most severe hazard. Unless otherwise noted, choose the lower group number first; 1 (compressed gases), then 2 (water reactives), and so on. Regardless of storage group, **none of the chemical's hazards should be ignored**. If possible, create additional segregation areas within a group.
- See the *Incompatibility Table* for a summary of chemical storage compatibilities.
- **This chemical segregation guide is not all-encompassing! It does not account for every possible chemical reaction. EACH CHEMICAL'S MATERIAL SAFETY DATA SHEET (MSDS), *MUST* BE REFERRED TO, TO FIND OTHER IMPORTANT INCOMPATIBILITIES!**

When quantities of chemicals are *below* exemption amounts (Table 3.2.7.1. of the Manitoba Fire Code), and facilities do not provide an adequate number of fire compartments, secondary containers may be used in place of separate fire compartments. Secondary containers, such as deep trays able to contain the entire amount of chemical should a spill occur, are extremely valuable in separating incompatible materials within storage groups. This document makes note of the most important separations, as does each chemical's material safety data sheet (MSDS). In all cases, storage arrangements must not violate section 3.2.7 of the Manitoba Fire Code. The *Incompatibility Table* is consistent with this section.

Incompatibility Table

Incompatibility Table [1] - consult the MSDS in all cases



	x	x	x		x	x	x		x	x	x	x		Flammable Gas
					x	x		x						Corrosive Gas
						x		x						Toxic Gas
					x	x		x	x	x	x		C	Oxidizing Gas
														Inert Gas
						x	x	x	x	x	x	x		Water Reactive
							x	x	x	x	x	x		Other Dangerously Reactive
								x	x	x	x		C	Oxidizing [3]
									x					Flammables [4] [5]
										x	x		C	Oxidizing & Inorganic Acids
											x			Organic Acids
														Bases
														Toxins
														General, "Non-hazardous"

x Highly incompatible - Store in separate fire compartments [2] with a fire-resistance rating of 2 hours

Incompatible - separate by at least 1 meter horizontal distance

Separate storage may not be required - **consult MSDS**

C Keep away from organic material (1 meter horizontal distance)

NOTE:

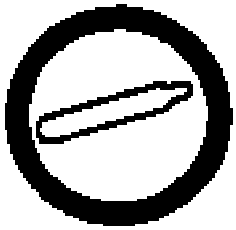
[1] This table is partially adapted from Table 3.2.7.6 of the Manitoba Fire Code (1998).
[2] Separate fire compartments may be separate rooms or separate cabinets (e.g. flammable liquid cabinets), provided walls or cabinets have the necessary fire rating.
[3] Organic Peroxides must be kept in separate fire compartments from toxics, corrosive gases, and toxic gases.
[4] Flammables in the solid form may be stored at a 1 meter horizontal distance from toxic gas and corrosive gas.
[5] Spontaneously Combustible (pyrophoric) substances must be stored separately from all other flammables, a minimum 1 metre horizontal distance.

The following is a list of specific individual chemical incompatibilities, extracted, with permission, from the American Chemical Society's *Chemical Safety Manual for Small Businesses.* This incompatibility information is for general information only and is not considered to be complete. Consult each chemical's MSDS, or Bretherick's *Handbook of Reactive Chemical Hazards* for more thorough information.

Chemical	Incompatible With
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric and sulfuric acid mixtures
Alkali and alkaline earth metals (such as powdered aluminum or magnesium, calcium, lithium, sodium, potassium)	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury (e.g. in manometers), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids
Bromine	*See chlorine*
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid and chromium	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	All other chemicals
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, combustible materials
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Acids
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen: flammable liquids, solids or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids
Potassium perchlorate (*see also chlorates*)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerine, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, such as sodium, lithium)
Tellurides	Reducing agents

1. Compressed Gases

Compressed gases are gases that are condensed and stored under pressure in special cylinders. Because of the unique hazards that come with storing compressed gases, this group will be divided up into subgroups which account for other hazards the gases may have. Compressed gases can be identified by the following symbols:



WHMIS symbol for compressed gas

TDG label for compressed gas.

Note: The cylinder symbol is not always present. The "2" at the bottom denotes a compressed gas. A variety of symbols may be present depending on the secondary hazard.

Household symbol for material stored under pressure (aerosol cans).

For storage considerations, compressed gases should be divided into **2 subgroups**:

A) Flammable Gases

Flammable gases are gases that can cause fire if ignited or raised to high temperatures. Flammable Gases have both of these WHMIS symbols:

AND

B) Non-flammable Gases

Non-flammable gases can contain any other of the WHMIS classifications. Other classifications include: Oxidizing, Toxic, and Corrosive gases. Inert (non-reactive) gases also fall in this category.

Also, see sections on oxidizing, flammable, corrosive, and toxic materials for specific information on their respective hazards.

Examples

Flammable Gas:	hydrogen, acetylene
Oxidizing Gas:	oxygen, chlorine
Toxic Gas:	carbon monoxide, hydrogen sulphide, chlorine
Corrosive Gas:	nitrogen dioxide, chlorine
Inert Gas:	helium, carbon dioxide, nitrogen

Storage Concerns

- Because of their highly pressurized state, compressed gas cylinders should be stored separately from nearly all liquid and solid hazardous materials (some exceptions exist, e.g. Toxic gas may be stored with toxic solids and liquids– see the *Incompatibility Table*).
- **Flammable gases** must be separated from all hazardous **Non-flammable** gases (oxidizing, corrosive and toxic gases). Separating **flammable** gas from **oxidizing** gas is the highest priority, and therefore must be stored as far apart as possible.
- Compressed gas cylinders must be stored in a cool, dry, well-ventilated area, away from heat and ignition sources including sparks, flames, hot pipes and direct sunlight. Cylinders must not be exposed to temperatures greater than 52° C.
- Storage rooms that contain flammable, toxic, corrosive, or oxidizing gases must be separated from the remainder of a building by a gas-tight fire separation.
- Natural ventilation to the outside should be present, in conjunction with a suitable mechanical ventilation system (See part VIII on *Ventilation*).
- All compressed gas cylinders, including empty ones, must be stored in an upright position and secured to a wall or other solid structure with chains or straps, preferably individually.
- When not in use, the valve cap, on the top of the cylinder, must be securely in place to protect the valve.
- Empty compressed gas cylinders should be labelled as such and stored separately from full cylinders. Empty cylinders should have their valves kept *closed*.
- Ensure that cylinders and valves are not leaking. Leaking cylinders should be moved outdoors, and the supplier should be contacted. Depending on the contents of the cylinder, an emergency response team may need to be contacted.

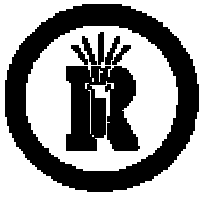
Handling Concerns

- Only trained employees may handle compressed gas cylinders.
- Never drop a cylinder, or allow them to fall over or strike each other.
- When transporting cylinders, use a special hand cart or trolley which can secure the cylinders so they do not fall off. Never drag or roll cylinders on their side. You may roll a cylinder on its bottom edge, but only for short distances (less than 2 meters).
- Always open valves *slowly* and never open a valve that appears to be broken or tampered with.
- Use the appropriate regulator for each gas cylinder. Do not use adapters or any home-made modifications. Regulators should be removed from empty cylinders promptly.
- When burning a flammable gas, do not extinguish the flame until the gas has been shut off.
- Do not rely on the colour of a gas cylinder for identification, as different companies use different colour coding systems. Always read the label.
- Use corrosive, oxidizing, toxic, reactive, and flammable gas in a fume hood or some other effective ventilation system.
- It is important to know that ALL compressed gases, including inert gases, pose a significant hazard. The cylinders are under extremely high pressures, and therefore are potentially explosive. Also, the release of any gas into the air, especially in confined areas, can dilute the oxygen content in the air down to dangerous levels. Extreme caution must always be taken when working with any compressed gas.
- Do not allow a cylinder to be completely emptied (i.e. “bleeding” a cylinder). To ensure contaminants do not enter the cylinder, leave a pressure of approximately 10 psi remaining.

- When compressed gas is used for cleaning (blowing away dust and dirt) great caution should be taken (compressed gas may only be used for cleaning if no alternative is available). A chip guard or other guarding means at the nozzle must be used to prevent particles from blowing back at the face or body. The air stream must not be directed at any part of the body, or used on work clothes. Always use the lowest possible pressure for the task (never above 30 psi) - a pressure-reducing device may be necessary. Adequate protective equipment must always be worn.
- Do not use grease or oil on valves or regulators.

2. Water Reactives

Water reactives are materials that, when they come into contact with water, become spontaneously flammable, or release flammable or toxic gas. Water reactives are a special class of hazardous material because they require unique storing conditions, so as to prevent their contact with water during fire-fighting operations. They can be identified by the phrase "incompatible with water," "reacts vigorously with water," or "dangerous when wet," located on the chemical's MSDS. These chemicals may also have the following symbols:



WHMIS symbol for Dangerously Reactive Material

TDG label for "Dangerous when wet" material (BLUE IN COLOUR)

NOTE: SPECIFIC DETAILED TRAINING IS REQUIRED FOR ANY WORKER STORING OR USING THESE CHEMICALS. Discuss this issue with your chemical supplier.

Examples Sodium metal, lithium aluminum hydride, calcium oxides

Storage Concerns

- The utmost care must be taken to ensure that these chemicals do not come in contact with water. These chemicals are often stored in petroleum to prevent contact with water. Only use the supplier-recommended waterproof containers. Transferring to an incompatible container may be dangerous.
- Store water-reactive chemicals away from nearly all other chemical groups, including **oxidizers, flammables, corrosives,** and **any materials containing water.** See the *Incompatibility Table*. Water reactives must be stored safely away from all plumbing pipes and fixtures.
- Water reactives must be stored in a cool, dry, well-ventilated area that is NOT EQUIPPED WITH A WATER SPRINKLER SYSTEM (another *compatible* fire suppression system must be used). This storage facility must be fire-resistant and water-proof. The area must be free of heat and ignition sources including sparks, flames, hot pipes and direct sunlight.
- Fire extinguishers suitable for water-reactives must be on hand.
- Some water-reactives may require an oxygen-free environment. An inert gas atmosphere may be needed. Consult the chemical's MSDS.
- Examine storage containers frequently for signs of chemical reactions and for damage to containers.
- Store as little amount of this material as possible.
- Warning signs must be posted and must be clearly visible, advising fire fighters of the presence of water reactive chemicals.

Handling Concerns

- These chemicals must not be allowed to come into contact with water. Chemical solutions, sinks and hoses, the air, and moisture from skin are examples of sources of water that must be kept out of contact with these chemicals.
- Do not return excess amounts of chemical to the original container. Even very small amounts of water introduced into the container can cause an explosion.
- All equipment that comes in contact with this material must be clean, free of impurities, and dry.
- Work with the smallest quantities possible.

3. Other Dangerous Reactives

This group is for unstable materials that react vigorously when they come into contact with air, or are under conditions of shock, temperature or pressure increases, or when certain inhibitors are absent. They can be identified by the following symbol:

WHMIS symbol for Dangerously Reactive Material

NOTE: SPECIFIC DETAILED TRAINING IS REQUIRED FOR ANY WORKER STORING OR USING THESE CHEMICALS. Discuss this issue with your chemical supplier.

Examples picric acid, boron, aluminum chloride

Storage Concerns

- Store in a cool, dry, well-ventilated area, away from heat and ignition sources including sparks, flames, hot pipes and direct sunlight.
- These chemicals are incompatible with most other groups (see the *Incompatibility Table*), and should be stored separately.
- Chemicals within this group may react with each other. Each chemical's MSDS must be read and understood before attempting to store these chemicals.
- Chemicals should only be stored in the supplier-recommended containers. Transferring to an incompatible container may be dangerous.
- Some chemicals may require very specific temperature conditions. Refrigerators may be necessary. Do not use ordinary household refrigerators, use only approved explosion-proof refrigerators for storage. Label the refrigerator with its contents, and never store food in the same refrigerator.
- Some chemicals require inhibitors to prevent a vigorous reaction from occurring when in storage. Recommended levels of inhibitors must be maintained and checked regularly.
- Examine storage containers frequently for signs of chemical reactions and for damage to the container.
- Store as little amount of this material as possible.

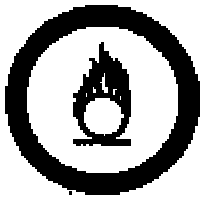
Handling Concerns

- The material may react vigorously when in contact with air, light, or another chemical. The specific precautions on each chemical's MSDS must be followed closely to avoid unwanted reactions. Always know the properties of the material prior to working with it.
- Containers of shock-sensitive chemicals must be handled carefully to avoid shock or friction. Never drop, drag, or slide these containers. Do not use "chipping" as a method to break up solid materials.
- Do not allow these chemicals to contact ignition sources such as a flame, a spark from an electrical device or socket, a spark from friction such as grinding metal, or even static electricity.
- Do not return excess amounts of chemical to the original container. Even very small amounts of impurities introduced into the container can cause an explosion.
- All equipment that comes in contact with this material must be clean and free of impurities.

- Work with the smallest quantities possible.

4. Oxidizers

Oxidizers are substances that yield oxygen or another oxidizing substance, contributing to the combustion of another substance. This grouping also includes organic peroxides. Oxidizers are a hazard due to their high potential to cause fires and explosions. They can be identified by the following symbols:



WHMIS symbol for oxidizing material.

TDG label for oxidizing material.
A "5.2" indicates an organic peroxide.

Examples sodium hypochlorite, compressed oxygen, hydrogen peroxide

Storage Concerns

- Store in a cool, dry, well-ventilated area, away from heat and ignition sources including sparks, flames, hot pipes and direct sunlight.
- The *primary* concern when storing oxidizers is to separate them from fuel, namely **flammables,** they must be stored as far apart as possible. All combustible materials must be stored separately from oxidizers. Oxidizers must be stored away from most other chemicals as well, including **most compressed gases, water reactives, other dangerous reactives, corrosives, strong reducing agents** and **organic substances.** See the *Incompatibility Table* for details.
- Read Part III (Chemical Reactivity) for an explanation of oxidizers and reducers.
- Also, keep in mind that some oxidizing substances may react vigorously with each other. Check the chemical's MSDS for more information.
- Some oxidizers may require very specific temperature conditions. Refrigerators may be necessary. Do not use ordinary household refrigerators, use only approved explosion-proof refrigerators for storage. Label the refrigerator with its contents, and never store food in the same refrigerator.
- Oxidizers should be placed on trays and stored in cabinets made of non-combustible materials.
- When possible, and chemically compatible, consider storing oxidizers as dilute solutions in water instead of dry forms. This can reduce the release of dusts and reduce the reactivity of the substance. Always follow the supplier's instructions when diluting.
- To prevent build-up of pressure inside a container caused by the substance decomposing and giving off gas, special vent caps are often needed. If required, use vent caps and ensure they are working properly.
- Some strong acids are also oxidizers, and therefore should be treated similarly (i.e. separate from fuel sources), however details on storing oxidizing acids can be found in the storage section of *Corrosives*.
- ***Peroxides****:*
    - Peroxides are compounds with two oxygen atoms joined together (-O-O-). They are a special class of oxidizer which needs special consideration due to their high instability and reactivity. Many peroxides are additionally classified as "dangerous reactives". Contact with combustible or flammable material may result in spontaneous combustion. Extreme caution must be taken when storing or handling these chemicals.

- **Organic peroxides** are particularly unstable. They continuously decompose, potentially generating enough heat and flammable gas to explode. They are sensitive to heat, light, friction and impact. Furthermore, they are themselves extremely flammable. Organic peroxides must be kept away from reducing agents and other strong oxidizers.
- **Inorganic peroxides** are generally stable by themselves, however they may form unstable organic peroxides and hydroperoxides on contact with organic material. Inorganic peroxides may also be extremely water reactive.
- **Peroxide formers** are materials that react with oxygen or oxidizers to form peroxide compounds. Frequent monitoring is required to ensure that peroxide accumulations are at safe levels.
- Specific detailed training is required for any worker storing or using peroxides compounds. Discuss this issue with your chemical supplier.

Handling Concerns

- Do not return excess amounts of the chemical to the original container. Even very small amounts of impurities introduced into the container can cause an explosion.
- Do not allow these chemicals to contact ignition sources such as a flame, a spark from an electrical device or socket, a spark from friction such as grinding metal, or even static electricity.
- Do not allow oxidizing material to come into contact with organic material.
- Many oxidizers are shock sensitive. Do not use "chipping" as a method of breaking up solid oxidizers.
- An eyewash station and safety shower must be present in areas where these chemicals are used.

5. Flammables

Flammables include substances that will catch fire at normal working temperatures (a flash point below 38°C, as defined by WHMIS). Combustibles are substances that will catch fire at temperatures above normal (a flash point above 38°C and below 93°C). For the purposes of storage and handling, we will refer to both as *flammables*. Flammables can be recognized by the symbols:

WHMIS symbol for flammable material

Household symbol for flammable material

TDG label for flammable liquid (RED IN COLOUR)

TDG label for flammable solid (RED AND WHITE IN COLOUR)

TDG label for spontaneously combustible material (RED AND WHITE IN COLOUR)

Examples acetone, benzene, gasoline

Storage Concerns

- The *primary* concern when storing flammables is to separate them from **oxidizers.** They must be stored in a separate fire compartment, as far apart as possible. Flammables must also be stored separately from **corrosives, water reactives, other dangerous reactives, toxins,** and most **compressed gases** – See the *Incompatibility Table* for details.
- Pyrophoric (spontaneously combustible) materials fall under this group, however pyrophoric material must be stored separately from all other flammables.
- If possible, separate organic and inorganic flammables.
- Store in a cool, dry, well-ventilated area, away from heat and ignition sources including sparks, flames, hot pipes and direct sunlight.
- Pyrophoric (spontaneously combustible) materials must be kept in tightly closed containers under an atmosphere of inert gas or under an inert liquid. See the chemical's MSDS and contact your chemical supplier for instructions.
- Storage of flammables must comply with Part 4 of the Manitoba Fire Code. These requirements include, but are not limited to, specific storage room specifications, maximum quantities, ventilation, spill control measures, and fire suppression systems.

- Flammable materials should be stored in the supplier's containers or other appropriate containers, such as metal safety cans (glass containers are not recommended), in an approved flammable liquid cabinet. Always keep the doors of a flammable liquid cabinet closed.
- No more than 3 flammable liquid cabinets may be stored in any one fire compartment. No more than 500 L of flammables may be stored in each cabinet, of which no more than 250 L are Class 1 flammables (flammables with a flash point of below 38°C – see MSDS). Consult Manitoba Fire Code section 4.2.10. for more details.
- Maximum quantities of flammable substances stored in industrial occupancies are covered under section 4.2.7.5. of the Manitoba Fire Code. Maximum quantities for other occupancies can be found throughout Part 4.
- Flammable liquid drums, tanks, cabinets and other containers must meet their applicable CSA standards.
- Electrically bond and ground large containers of flammables to prevent sparks.
- Some flammables may require very specific temperature conditions. Refrigerators may be necessary. Do not use ordinary household refrigerators - use only approved explosion-proof refrigerators for storage. Label the refrigerator of its contents, and never store food in the same refrigerator.
- The flammables storage room must be easily accessible to fire departments, preferably on the exterior walls of a building. Other fire code regulations such as fire extinguisher, sprinkler and electrical equipment requirements must be met.
- "No Smoking" and "No Ignition Sources" signs must be clearly visible anywhere flammables are used or stored.
- Ensure that all containers are tightly closed.
- Do not store paper, cardboard, or similar combustible materials in the flammable material storage area.

Handling Concerns

- Flammable chemicals must be used away from sources of ignition, such as flames, sparks from an electrical device or socket, sparks from friction by grinding metal, or static electricity.
- Handling of flammables must comply with Part 4 of the Manitoba Fire Code. This includes, but is not limited to, methods of controlling static charge, transfer techniques, and ventilation.
- Portable lighting devices designed to eliminate ignition sources are available. Use electrical devices approved by a recognized safety agency such as the Canadian Standards Association (CSA).
- If a flammable substance must be heated, do not heat it with a burner or electrical device directly – use a steam bath, heating mantle, water bath, oil bath or hot air bath.
- Adequate ventilation must be provided when using flammable liquids. Flammable vapours can only ignite if they are within the *flammability range*. The flammability range refers to the maximum and minimum concentrations of a flammable vapour in the air that can be ignited. These maximum and minimum concentrations are called the upper explosive limit (UEL) and the lower explosive limit (LEL), respectively. These values can be found on the chemical's MSDS. To ensure that a fire does not result, concentrations of flammable vapours in the air must be kept below 10% of the LEL. See part VIII on *Ventilation*.
- Electrical grounding/bonding procedures are necessary to prevent static electricity. The use of approved portable fuel transfer tanks are a good way of reducing hazards when transferring flammable liquids. For more information refer to *WorkSafe Bulletin #178.*
- Never use gasoline or other flammable solvents as a cleaning agent.

- Remove all flammable materials and notify all other occupants in the area before lighting a flame.
- Equipment that is oil or gas fired must be equipped with flame failure safety controls to prevent the flow of flammable materials should the burner or pilot light go out.

6. Corrosives

Corrosives are materials that, on contact, chemically destroy body tissue, metals, and other materials. All corrosives can be identified by the following symbols:

WHMIS symbol for corrosive material

TDG label for corrosive material

Household symbol for corrosive material

Corrosives are often characterized by their pH. The pH scale ranges from 0 to 14, and is an indicator of the strength of a corrosive. A pH of 7 is neutral, below 7 is acidic, and above 7 is basic. The further a pH is from 7, the more corrosive the chemical. Corrosives can be divided into 3 incompatible groups:

A) **Oxidizing and Inorganic Acids** – acids can be identified by their low pH (*less than* 2), located on the chemical's MSDS. Oxidizing acids can be identified by having both WHMIS symbols:

AND

Inorganic acids are acids that do not contain carbon (see the chemical formula on the MSDS). They are also referred to as "mineral acids."

B) **Organic Acids** – organic acids are acids (pH below 2) that have carbon containing compounds (see the chemical formula on the MSDS).

C) **Bases** – bases can be identified by their high pH (*above* 11.5). They are also known as "caustic" or "alkali".

Examples

Oxidizing/inorganic acid:	nitric acid, sulfuric acid
Organic acid:	acetic acid, formic acid
Bases:	sodium hydroxide, ammonia

Storage Concerns

- Store oxidizing/inorganic acids, organic acids, and bases all separately. Acids must be stored in a dedicated acid cabinet. Nitric acid must be stored separately from other acids, unless the acid cabinet provides a separate compartment for nitric acid.
- Store corrosives away from **flammables, water reactives, other dangerous reactives, oxidizers,** and **organic material** (see the *Incompatibility Table* for details).
- Organic acids may be stored with organic flammables.
- Be aware that precautions that apply to oxidizers also fully apply to oxidizing acids such as nitric acid and perchloric acid.
- Corrosives must be kept in a cool, dry, well-ventilated area, away from sources of heat and ignition.
- Store corrosives at their recommended temperature. Acetic acid will freeze at temperatures just below room temperature (16°C), potentially breaking the container.
- Corrosives should be stored on trays (secondary containers) made of corrosion-resistant materials, and should be large enough to contain the volume of the liquids in the containers in case the bottle breaks or spills.
- Inspect storage bottles for signs of damage caused by corrosion, and replace bottles as needed.
- Label the concentration of all stored acid and base solutions.

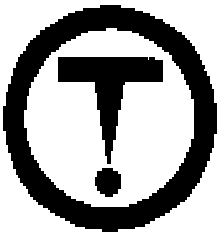
Handling Concerns

- Great care must be taken to ensure that these chemicals do not come into contact with the skin or eyes. Appropriate protective equipment should be worn.
- Use a fume hood or other effective ventilation system when handling corrosives, even if the corrosive is not volatile. Hazardous gases, such as flammable hydrogen gas, may be released.
- Perchloric acid is especially hazardous and requires its own dedicated water wash-down fume hood constructed of non-combustible material. Exhaust systems should be frequently inspected for accumulations of perchloric acid and perchlorate. Perchloric acid reacts explosively with organic material and peroxides.
- When diluting acids with water, DO NOT add water to the acid! This will result in a vigorous reaction releasing large amounts of heat. Always add ACID TO WATER, slowly down the sides of the container, with frequent stirring. Allow the mixture to cool before capping the container.
- An eyewash station and safety shower must be present in areas where these chemicals are used.
- Do not allow incompatible materials, such as organic materials to come onto contact with corrosive materials.
- Open containers of corrosive materials *slowly*.
- Hydrofluoric acid is an *extremely* hazardous corrosive and can penetrate the skin, causing serious permanent damage. Working with this chemical should be avoided, and extreme caution must be used when it is being handled.

7. Toxins

Toxins, also referred to as "poisons," are substances that can cause death or serious health effects if even small amounts are ingested, inhaled, or absorbed through the skin. Many chemicals that fit into the previous sections are also classified as toxins. For storage compatibility purposes, this group is reserved for chemicals that are toxic and fit none of the previous groups.
Toxins can be identified by the following symbols:

WHMIS symbol for chemicals which can cause acute (immediately harmful) effects



WHMIS symbol for chemicals causing other toxic effects, such as skin irritation and long term effects such as cancer and mutagenicity.

Household symbol for poisonous material

TDG label for poisonous substances

Examples cyanides, lead, DDT

Storage Concerns

- Toxins must be stored separately from **flammables**, **oxidizers**, **water reactives**, and **other dangerous reactives** (see the *Incompatibility Table* for details).
- Toxins must be kept in a cool, dry, well-ventilated area, away from sources of heat and ignition.
- Unbreakable secondary containers are recommended for chemicals which are highly toxic, volatile, or carcinogenic (cancer-causing). Excellent ventilation must be provided.
- Ventilation in areas with toxic chemicals must be designed so that exhausted air cannot be circulated to general building ventilation systems. Suitable air cleaners may be necessary.
- Separating organic (carbon-containing) toxins from inorganic toxins is recommended – see the chemical formula on the chemical's MSDS.
- Warning signs must be posted to alert to the presence of carcinogenic chemicals, if present.

Handling Concerns

- Avoid direct skin contact, inhalation, or ingestion of even tiny amounts of these chemicals. Engineering controls must be in place to prevent direct contact. Appropriate protective equipment is usually also required.
- Make a conscious effort to avoid touching your face, eyes or mouth. Smoking, scratching, and nail-biting are common practices that can expose workers to toxic chemicals .

- Toxic chemicals, especially volatile liquid toxins, may only be handled in an area with special ventilation equipment, such as a fume hood (See part VIII on *Ventilation*).
- Be on the lookout for signs of exposure to toxic chemicals. These can include, but are not limited to, dizziness, headache, blurred vision, nausea, or skin and eye irritation. Note: Not all toxins are accompanied by immediate warning signs of exposure, i.e. cancer-causing chemicals. The MSDS provides information on the health effects of acute and chronic exposure.
- Practice good personal hygiene. Wash hands and arms thoroughly after working with these chemicals. For some toxic substances, workers may be required to shower before returning home.
- An emergency shower and eyewash station must be nearby wherever these chemicals are used.
- Areas designated for eating must be kept separate from work areas.

8. General Chemicals (Non-Hazardous)

This section is for chemicals that do not pose any *major* physical or chemical hazards. These chemicals will have no WHMIS symbols on their labels. It should be noted that "non-hazardous" is a relative term. Any material, if carelessly handled, can cause injury or death.

Examples sodium chloride, silica gel, iron oxide

Storage Concerns

- Always check the MSDS before attempting to store a chemical. Even "non-hazardous" chemicals can have incompatibilities or special storage instructions and warnings.
- If possible, separate organic (carbon-containing) chemicals from inorganic chemicals.
- Organic chemicals are incompatible with **oxidizers,** and **oxidizing acids.**
- Alphabetic storage arrangements of these chemicals may be acceptable.

Handling Concerns

- Be aware of specific handling precautions on the chemical's MSDS.

9. Special Hazardous Materials: Radioactives and Explosives

This section is for materials that will not be covered in detail in this guideline due to the extreme nature of their hazards, and the specific legislation that govern their storage, handling, transportation, and disposal.

Radioactives

Radioactive materials are unstable elements that emit excess energy in the form of ionizing radiation.

General, widely used symbol for radioactive material

TDG label for radioactive material

Although not covered under WHMIS, radioactive materials have the following symbols:

The handling and storage of radioactive materials is regulated under ***The Nuclear Safety and Control Act. The Canadian Nuclear Safety Commission (CNSC)*** should be contacted with regard to obtaining regulatory guides.

Canadian Nuclear Safety Commission:
Phone: 1-800-668-5284 Web Site: www.cnsc-ccsn.gc.ca E-mail: info@cnsc-ccsn.gc.ca

Explosives

Explosive materials are those that are capable of self-sustained chemical reactions, rapidly burning or decomposing, and producing destructive amounts of gas, heat and pressure changes. Explosives are not specifically covered under WHMIS, however they can be recognized by the following symbols:

General, widely used symbol for explosive material

TDG label for explosive material

The handling and storage of explosive materials is regulated under *The Explosives Act*. The *Explosives Regulatory Division (ERD)* of *Natural Resources Canada* should be contacted with regard to obtaining regulatory guides.

Explosives Regulatory Division:
Phone (Western Regional Office): (403)-292-4766 Web Site: www.nrcan.gc.ca/mms/explosif

V. SPILLS

Note: For a chemical spill on the body see part X on *First Aid*.

The procedure for cleanup of a chemical spill largely depends on the type of chemical spilled and the hazards associated with it. It is recommended that your workplace create a spill response plan so that you are prepared for a spill of any chemical you are using or storing. Preplanning a spill cleanup procedure, and training all personnel is essential in quickly and effectively minimizing exposure of the chemical to personnel and property. Chemical spills should be dealt with quickly, but not in haste. Cleanup steps for each type of chemical should be carefully planned ahead of time. Adequate materials and equipment for handling the spill must be on hand. Spills of large magnitude or of extreme hazards should be handled by a spill response team – address this issue when creating your spill response plan.

SPILL RESPONSE - The following is a general procedure to follow immediately when a chemical spill occurs. Follow any step only if it is safe to do so:

CHEMICAL SPILLS SHOULD ONLY BE HANDLED BY *TRAINED* INDIVIDUALS WITH THE KNOWLEDGE OF THE SPILLED CHEMICAL'S HAZARDS AND THE PRECAUTIONS NEEDED TO BE TAKEN.

- First, decide if you or other personnel can safely handle the spill. If not, emergency assistance is necessary.

- **For spills of large magnitude or extremely hazardous materials, where emergency assistance is necessary:**
  - Close all windows and doors and evacuate the area. If appropriate, sound the fire alarm.
  - From a safe location, contact the fire department and your large-scale spill response team and inform them of the location and the substances spilled.
  - Contact Manitoba Conservation's emergency spill line at 944-4888.
  - Do not re-enter the room until the fire department or other authorities have determined that it is safe.

- **For small spills that can be *safely* handled:**

  - **CHECK THE CHEMICAL'S MSDS** for specific spill procedures.
  - Non emergency response information can be obtained by contacting:
    Manitoba Conservation: Phone: 945-7100.
  - Immediately notify all personnel in the area of the spill. Place hazard signs around the area, if possible.
  - Adequate protective equipment must be worn. Gloves, boots, goggles, face shields, a full body protective suit, and a respirator may be necessary.
  - If the spill is of a flammable material, remove all sources of ignition.
  - Ensure that ventilation in the room is isolated from the rest of the building, and increase local ventilation rates to capture or direct the flow of vapours. Also, open windows and doors to the to the outside, provided that this does not contaminate other areas.

- Remove other materials, equipment, or containers that are in the path of the spill.
- Close off access to the sewer.
- **Absorption** - contain the spread of the spill by using appropriate *compatible* material to absorb or block the flow of the spill. For example, sawdust should not be used to absorb oxidizing material, as oxidizers react vigorously with organic material.
- Pre-packaged spill kits are available which absorb the spill, but are specific to certain types of chemicals. Be sure to use the right kit for the spill. When using the kit, apply the material from the outside of the spill and work towards the centre. Do not step in the spill.
- **Dilution** - the addition of an inert, compatible substance (sometimes water) to the spill. Dilution reduces the reactivity of the spilled material, however is only appropriate in some instances.
- **Neutralization** - another chemical is applied to the spill and reacts with the spilled material to inactivate it. For example, adding bases to acids, or reducers to oxidizers. *Mixing chemicals should only be attempted if you are absolutely certain what will result.* When applying a neutralizing chemical, apply from the outside in, working towards the centre. A colour change may occur. Add cautiously, in small amounts. Be aware that the release of large amounts of heat as well as toxic or flammable vapours may occur.
- When using either an absorbing or neutralizing kit, avoid using metal tools for cleanup as they may spark, possibly igniting the spill.
- **Vacuuming** - a specially made or modified vacuum may be necessary (HEPA filter vacuum). This is the preferred method of cleanup for toxic solids, such as lead, to avoid generating airborne dusts that may be inhaled. Be aware that an electric vacuum may act as an ignition source for flammable materials.
- All spilled material must be disposed of as hazardous waste.

- **If the spill occurs outdoors:**

  Contain the spill in the same manner as above. Prevent the chemical from contaminating the ground water and sewer system. Do not leave the spill site unattended. Contact Manitoba Conservation's emergency spill line at 944-4888.

VI. DISPOSAL

The disposal of chemicals is another aspect of hazardous material management where chemical compatibility is of high importance. Careless disposal practices, such as pouring all chemicals down the drain, or all into a large drum to be later buried in a landfill, may be harmful to humans and environmentally unsound.

Containers of waste must be adequately labelled as to their contents. For information on the proper disposal of hazardous materials contact:

Manitoba Conservation: Phone: 945-7100

VII. APPROPRIATE ATTIRE AND PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment is the last line of defence from exposure to harmful chemicals. The type of protective equipment needed depends on the type of chemical being used, the quantities and concentrations being handled, and the nature of the work being done. Each chemical's MSDS will outline the protective equipment required for that chemical. It is important to note that personal protective equipment must never be used in lieu of proper engineering controls designed for safety – personal protective equipment must be used as a backup *in conjunction with* engineered safety measures. Also, **ONLY PERSONS TRAINED TO USE PERSONAL PROTECTIVE EQUIPMENT MAY SELECT AND USE THE EQUIPMENT. THOSE THAT ARE NOT TRAINED MAY NOT PERFORM TASKS REQUIRING THE USE OF PERSONAL PROTECTIVE EQUIPMENT.**

Some chemicals' MSDSs do not specify the proper material needed for the chemical being handled. Your protective equipment supply company or your chemical supplier should be able to assist you in equipment selection. Additionally, you may consult the National Institute for Occupational Safety and Health's (NIOSH) publication, *Recommendations for Chemical Protective Clothing: A Companion to the NIOSH Pocket Guide to Chemical Hazards* for information.

The following is an outline of the general types of equipment that may be needed:

Regular Attire – Even when using other protective equipment, the clothing must always cover the body fully. This includes long-sleeved tops that fully cover the midsection, pants that cover the legs completely, including ankles. Dresses, skirts, and very loose-fitting shirts and pants should not be worn. Shoes must completely cover the feet and long hair must be tied back. Remove jewellery and watches from hands and wrists.

Gloves – Gloves are necessary when there is any danger of hand contact with a hazardous material, particularly poisonous and corrosive chemicals. It should be noted that there is not one glove suitable for all chemicals, nor is any one glove complete protection from any one chemical. In some cases, multiple layers of gloves may be required. Be aware that some glove material may cause allergic reactions in some people (e.g. latex) – substitute when necessary.

All gloves have a set chemical breakthrough time for each chemical, which may range from a few hours to just a few minutes. Ensure that gloves are changed often enough to prevent chemical breakthrough. Contact your protective equipment supplier for help in choosing the most appropriate gloves, and for advice on the frequency of your glove changing. A plan or schedule should be in place to ensure workers are changing gloves often enough.

Gloves should fit well and be suitable for performing the required tasks. Gloves must be long enough so that there is no gap of exposed skin between the glove and sleeve. Check gloves for holes and other defects before each use. After use, rinse the gloves thoroughly with water before removing.

Eye and Face Protection – The extreme vulnerability of the eyes means that protective eyewear is *required* any time hazardous chemicals are being used. Regular prescription glasses and contact lenses do not qualify as protective eye-wear. In fact, contact lenses are not recommended, as they

may concentrate gases and vapours under the eye, or trap foreign materials, causing greater eye damage. Safety goggles may be worn overtop of prescription glasses. Protective eyewear must meet the requirements of the Canadian Standards Association's "Industrial Eye and Face Protectors" (CSA Standard Z94.3). Eye-cup goggles, monoframe goggles, or face shields may be needed (face shields alone are not adequate protection from chemical splashes in the eye, and therefore must be used in conjunction with goggles). In some cases a hood may be required. Eyewear must fit properly and be clean and scratch-free. Also, all work areas where toxic, corrosive, or oxidizing materials are used must be equipped with an eyewash station.

Respirators – Ventilation methods that carry contaminated air away from the individual are preferred over respirators as a primary means of controlling exposure to hazardous materials (see part VIII on *Ventilation*). When ventilation methods are inadequate, a respirator must be used. The type of respirator chosen will depend on the chemical contaminant that the individual is being exposed to. Respirators must be chosen and used in accordance with the Canadian Standards Association's "Selection, Use, and Care of Respirators" (CSA Standard Z94.4-93). Excellent fit of the respirator is extremely important – contaminated air must not be allowed to leak into the mask. Fit testing must be performed when initially choosing a respirator, and a user seal check must be performed before each use. Respirators must be cleaned and inspected regularly, and stored in an uncontaminated area.

Other Equipment– In some cases, especially when very large amounts of chemicals are being used, full body protective suits are needed. Other equipment such as aprons, boots, and hair coverings may be needed. All equipment must be made of compatible materials.

VIII. VENTILATION

In many cases, ventilation is the best way of keeping airborne contaminants down to safe levels. Two types of exhaust ventilation systems exist: general and local. **General dilution** works by supplying outside air to be mixed in with the contaminated air, thereby diluting the contaminant to safe levels. **Local exhaust systems** work by capturing the contaminant at its point of generation and exhausting it outdoors (e.g. a fume hood). This method is far more effective at removing airborne contaminants from the source, and should always be used unless it is impractical for the work area. A combination of both systems may be necessary for your work area.

Measures of Air Contamination

The primary goal of the ventilation system is to bring concentrations of airborne contaminants down to safe, acceptable levels, called Occupational Exposure Limits (OEL). In the United States, these are known as Permissible Exposure Limits (PEL), published by the Occupational Safety and Health Administration (OSHA). Manitoba references the Threshold Limit Values (TLVs®) issued by the American Conference of Governmental Industrial Hygienists (ACGIH). These represent the airborne concentrations of a contaminant to which a worker may be exposed day after day without experiencing adverse health effects. Five types of TLVs are often used:

1) Time Weighted Averages (TWA) – the average airborne concentration that a worker may be exposed to over an 8-hour workday and 40-hour week without experiencing adverse effects.
2) Short Term Exposure Limits (STEL) – a 15 minute time-weighted average exposure which should not be exceeded (even if the 8-hour average exposure is within the TWA). A worker should not be exposed to levels above the TWA up to the STEL for more than 15 minutes at a time, and no more than 4 times a day.
3) Ceiling Limit (C) – a maximum concentration which should never be exceeded.

For substances that do not have a listed STEL, the following estimation is used:

4) 3 Times Excursion – worker exposure levels may exceed 3 times the TWA for no more than a total of 30 minutes per day.
5) 5 Times Excursion– worker exposure levels may never exceed 5 times the TWA.

These values are normally found on a chemical's MSDS. It is recommended that, where a worker may be exposed, contaminant concentrations should be kept below these values at all times. To accomplish this, an *action level* of 50 percent of the OEL should be utilised.

Signs of Contamination

Various monitoring techniques can be used to find actual contaminant concentrations. These must be used whenever there is reason to believe contaminant levels may be too high. Our own senses, however, may be the first to detect exposure to a chemical. The appearance of vapours, moist surfaces, reactions in the body such as skin and eye irritation, nausea, dizziness and headaches, and odours can all be signs of contaminated air, and must be treated very seriously and investigated immediately. Note that not all chemicals will give obvious signs of their presence (e.g. carbon monoxide). Suitable detectors must be used.

The Ventilation System

All ventilation systems should be engineer-designed. The following points should be noted when choosing a new ventilation system, or when determining if current ventilation systems are adequate:

- Local exhaust systems are preferred over general dilution. They allow less contaminant to be released into the work area. General dilution should only be used when local exhaust systems are not practical. Also, operational costs for general dilution are usually much higher.
- Ventilation systems should be evaluated regularly to ensure their effectiveness.

General dilution

- Exhaust intakes should be placed near the point of contamination if possible.
- Air supply and exhaust systems should be placed so that airflow moves from the supply, past the worker, through the zone of contamination, and into the exhaust. This orientation will reduce the amount of chemicals that can enter the worker's breathing zone.
- Outlets discharging exhaust should be far away from any outside air intakes or windows. Exhaust should be discharged high above the roof-line. The recirculation of contaminated air must be prevented.
- The amounts of chemical being released and its toxicity should be considered when establishing an adequate air-flow rate for ventilation.

Local exhaust systems

- A contaminant's point of entry into a local exhaust system is known as a *hood.* Two types of hoods exist: enclosing and exterior. Enclosing hood systems completely or partially enclose the process or source of contamination. Exterior hoods are located adjacent to the source of contamination and do not enclose it. Enclosing hoods are more effective at removing contaminant, and should be used whenever feasible. Enclose a process releasing hazardous chemicals as much as possible.
- The hood should be oriented so that contaminated air is removed close to the point of release. Do not place the hood near the floor assuming the contaminant is "heavier than air."
- Contaminated air should be drawn away from the individual, rather than past the individual's breathing area.
- Ventilation air-flow should be sufficiently high as to effectively remove the contaminant. This will depend on many factors, including the speed at which the contaminant is released, the physical properties of the chemical, and the motion of the surrounding air. Commonly used air-flows, like those used in chemical laboratories, are 80-120 fpm (feet per minute). For prevention of fire, the Manitoba Fire Code requires an exhaust rate of at least 18 cubic metres per hour per square metre of room area, with a minimum of 250 cubic meters per hour. Prevention of toxic exposure may require higher air-flow rates. Your ventilation rate must be sufficiently high to reduce the exposure down to the action level (50 percent of the OEL) for that chemical.
- Ventilation systems must be constructed of compatible materials. Some chemicals, such as perchloric acid, require a special dedicated fume hood.
- Strong air currents (cross currents) can disrupt the movement of air into the hood, and should therefore be eliminated or minimized. Common sources of cross currents include free-standing fans, open windows and doors, and poorly placed supply air ducts.
- The recirculation of contaminated air must be prevented.
- Ensure the ventilation system is working properly before each use.

IX. FIRE SAFETY

Emergency Planning

All workplaces must comply with all applicable sections of the Manitoba Fire Code including having a fire safety plan (section 2.8). This type of plan can be used as the basis for developing all emergency plans. The following points must be part of a fire safety emergency plan:

- All personnel must be trained on the proper procedures for when a fire occurs, including how to contact the fire department, and how to use fire extinguishers.
- An evacuation plan, to be followed when the alarm sounds, should be created, instructed to all personnel, and clearly posted on all floors.
- The location, type, and operation of all fire emergency systems should be outlined in a document with diagrams.
- Supervisory staff should be designated and trained for special fire safety duties.
- Special arrangements for the assisted evacuation of physically challenged persons should be made.
- Fire drills should be performed as often as outlined in the Fire Code (section 2.8.3) – a minimum of once every 12 months for most buildings.
- Sprinklers, fire extinguishers, and other fire suppression tools should be present, *and should be compatible with the chemicals used and stored in the workplace* (i.e. water sprinkler systems should not be present in areas where water reactive chemicals are used and stored). Ensure good working order of all fire suppression tools.
- Automatic sprinklers, fire extinguishers, and outdoor fire hydrants should be regularly inspected by local authorities.
- An emergency safety shower should be easily accessible (reachable within 10 seconds), and can be used to extinguish personnel who have caught fire.
- Ensure that the local fire department is well acquainted with the workplace, and the hazards present.
- The fire safety plan should be reviewed annually.

Chemical Storage and Fire Safety

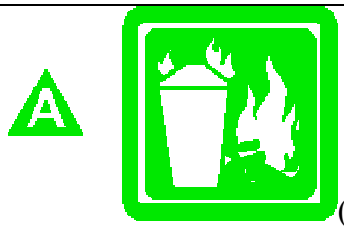
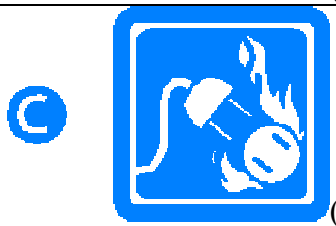
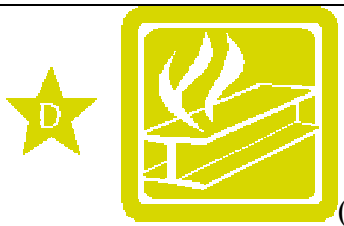
- The fire safety plan must include an outline of the names, groups, and locations of all chemicals stored in the building. This information must be easily accessible, and be readily available to the fire department, should they need it for fire fighting measures.
- Chemicals must be stored in compliance with the Manitoba Fire Code in all aspects, including, amounts of chemicals stored, heights of storage racks, size of storage areas, storage methods used, sprinkler systems (and other fire protection systems), and posted signs.

Fire Extinguishers

- See section 6.2 of the Manitoba Fire Code.
- Fire extinguishers should be easily accessible (it is recommended that extinguishers be reachable within 10 seconds) and located in or adjacent to corridors that provide access to exits.

Choosing a fire extinguisher:

- The appropriate type of fire extinguisher should be available for the chemicals that are being used and stored. Different types of extinguishers may work on more than one type of fire. There are 4 classes of fire:

Fire Class	Symbols	Fire Type	Extinguisher type
Class A	 (Green)	Combustible material such as wood, cloth, paper, and some plastics.	Pressurized water, foam, or multipurpose (ABC-rated) dry chemical.
Class B	 (Red)	Flammable or combustible liquids, fat or grease.	Foam, carbon dioxide, ordinary (BC-rated) dry chemical, multipurpose (ABC-rated) dry chemical, or halon.
Class C	 (Blue)	Energized electrical equipment.	Carbon dioxide, ordinary (BC-rated) dry chemical, multi-purpose (ABC-rated) dry chemical, or halon
Class D	 (yellow)	Combustible metal (sodium, potassium).	Specially designated (for specific material(s)) dry powder extinguishing agents.

- Fight the fire only if you are trained to do so and are familiar with fire fighting techniques, equipment, and procedures.
- Always account for chemical compatibility when extinguishing any fire. **Some information about fire fighting can be found on the chemical's MSDS.** Choosing the wrong extinguisher can make the fire worse. Address this issue when preplanning an emergency action plan.

- Do not use a fire extinguisher not suited for the specific type of fire (e.g. do not use an ordinary (BC-rated) dry chemical extinguisher on a class A fire.

X. FIRST AID

Hazardous materials can chemically harm us by entering our body in one of 4 ways: through ingestion, inhalation, contact with the skin or the eyes, or injection. The means of entry into the body will determine the most appropriate action to take when an accident occurs. Adequate planning and training is essential to be prepared for a chemical exposure. The following points are general requirements for your workplace to be prepared for incidents requiring first aid:

- Refer to the Manitoba Regulation on First Aid (MR140/98) for detailed information on workplace requirements.
- First aid kits should be available and appropriate for the work area. Kits should be immediately replenished as needed.
- Emergency phone numbers should be posted. This includes ambulance, local medical facilities, and the poison control centre.
- Ensure that eye wash stations and safety showers are nearby (reachable within 10 seconds), and are not blocked by any obstruction. Flush eye wash stations on a regular basis to ensure that they are working, and to clear the lines of stale water and debris. The use of eyewash bottles is not a suitable first aid measure – permanent plumbed eye wash stations should be present. Read *Work Safe Bulletin # 104* for more information.
- Sufficient staff should be trained in basic first aid and cardiopulmonary resuscitation (CPR).

FIRST AID PROCEDURES **- The following is a *general* first aid procedure, and may not be applicable, or appropriate for all situations. This information is for reference only, to aid you in making a more complete first aid plan for your workplace.**

- **ALWAYS READ THE CHEMICAL'S MSDS** for specific first aid measures.

- **REMAIN CALM.**

- If necessary, have someone contact emergency personnel. They should provide the following information: the location of the victim, the type of chemical involved, and the nature and extent of contact with that chemical. Stay with the victim until the ambulance arrives. Give paramedics all necessary information.

- Before proceeding with first aid, ensure the area is safe (i.e., no risk of fire, explosion, or further harmful chemical exposure to the victim or others – wear protective clothing if necessary).

- Administer the proper first aid. If necessary AND you are properly trained, perform AR (artificial respiration) or CPR. These methods should only be performed by trained individuals.

- For **Ingestion –** Call 911 or a poison control centre immediately, and have the chemical's MSDS on hand. DO NOT haphazardly administer another chemical in an attempt to neutralize the first one. You may be instructed to dilute the chemical with water or induce vomiting.

- For **Inhalation –** Move the victim to fresh air immediately. Do not risk your own safety by staying in an area with contaminated air – respirators may be necessary (only those trained in the

use of respirators may use them). Monitor the victim's breathing. If the victim is breathing, loosen clothing around the airway. If breathing stops, or is ineffective, perform artificial respiration if properly trained.

- For **Eye Contact –** Flush the area with lukewarm water for *at least* 15 minutes using an eyewash station (if an eyewash station is not available, have the victim lay on their backs and pour water over their eyes). If the chemical is a penetrating corrosive (see the MSDS), up to 60 minutes of flushing may be needed. Help the victim hold the eyelids open and away from the eyes (try not to squint). Roll the eyes around to flush out all areas. DO NOT attempt to neutralize by adding another chemical. *If the casualty is wearing contact lenses*: St. John Ambulance Canada recommends that you should not waste time trying to remove the contact lenses. Flush the eyes for at least 15 minutes.

- For **Skin Contact –** (if the chemical is a dry solid, quickly brush off as much of the chemical as possible *before* flushing). Immediately flush the area with water for *at least* 15 minutes using the emergency shower, eyewash station, or sink. While flushing, remove contaminated clothing, jewellery, shoes, and equipment. DO NOT be modest. Watches, rings, belts, and other constrictive accessories must also be removed before the affected areas swell up. Unless the eyes are affected, do not remove the safety goggles until all chemical has been washed from the face and hair. DO NOT attempt to neutralize by adding another chemical. DO NOT add lotions or ointments to the area. Protect the burned areas.

- Transport the victim to a medical facility as soon as possible. Have someone knowledgeable about the chemical and the incident accompany the victim. Bring the chemical's MSDS.

- All (major or minor) chemical exposures should be followed up by trained medical professionals as soon as possible. A minor exposure to a small amount of a toxin can cause major life threatening situations. **The decisions on the severity of an exposure should only be made by a medical professional.**

XI. CONTACT INFORMATION

WORKPLACE SAFETY AND HEALTH DIVISION
200 – 401 York Avenue, Winnipeg, MB. R3C 0P8
TOLL FREE: 1-800-282-8069 (In MB. Only)
INTERNET: http://www.gov.mb.ca/labour/safety

Client Services	Workplace Safety and Health (Wpg.)	(204) 945-6848
	Workplace Safety and Health (Brandon)	(204) 726-6361
	Mines Inspection (Flin Flon)	(204) 687-1618
24-Hour Emergency Line	Workplace Safety and Health	(204) 945-0581
Fax	Workplace Safety and Health (Wpg.)	(204) 945-4556
	Workplace Safety and Health (Brandon)	(204) 726-6749
	Mines Inspection (Flin Flon)	(204) 687-1623

XII. REFERENCES AND ADDITIONAL READING

American Chemical Society (ACS). *Chemical Safety Manual for Small Businesses*, *2nd Edition*, Washington, DC, 1992.

American Conference of Governmental Industrial Hygienists (ACGIH). *TLVs and BEIs: Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,* Cincinnati, 2002.

American Conference of Governmental Industrial Hygienists (ACGIH*). Industrial Ventilation: A Manual of Recommended Practice, 22nd Edition*, Cincinnati, 1995.

Bretherick, L. *Handbook of Reactive Chemical Hazards, 4th Edition,* Butterworths, London, 1990.

Green, M.E., Turk, A. *Safety in Working With Chemicals*, Macmillan, New York, 1978.

Manitoba Environment and Workplace Safety and Health. *WHMIS Core Material: A Resource Manual for the Application and Implementation of WHMIS,* 1988.

National Research Council of Canada. *Manitoba Fire Code 5th Ed*., Ottawa, 1998.

National Research Council of Canada. *National Fire Code of Canada 7th Ed*., Ottawa*,* 1995.

National Fire Protection Association (NFPA). National Fire Codes, 1998.

National Institute for Occupational Safety and Health (NIOSH). *NIOSH Pocket Guide to Chemical Hazards, June 1997 Edition,* 1997.

National Institute for Occupational Safety and Health (NIOSH). *Recommendations for Chemical Protective Clothing: A Companion to the* ***NIOSH Pocket Guide to Chemical Hazards,*** 1997.

Occupational Safety & Health Administration. *Chemical Hazards: OSHA's Hazard Communication Standard,* TCP Training Systems, Illinois, 1986.

Pipitone, D. (Ed.). *Safe Storage of Laboratory Chemicals,* John Wiley and Sons Inc., New York, 1984.

St. John Ambulance. *First on the Scene: The Complete Guide to First Aid and CPR,2nd Edition,* St. John Ambulance, Ottawa, 1996.

United Nations Environmental Programme. *Storage of Hazardous Materials: A Technical Guide for Safe Warehousing of Hazardous Materials*, Paris, 1990.

Western Australia Legislation*. Explosives and Dangerous Goods (Dangerous Goods Handling and Storage) Regulations – Part ,4 Division 3*, 1992.

Young, J.A. *Improving Safety in the Chemical Laboratory: A Practical Guide,* John Wiley and Sons Inc., New York, 1987.

Internet

Manitoba Labour, Workplace Safety and Health Branch; www.gov.mb.ca/labour/safety
Canadian Centre for Occupational Health and Safety (CCOHS); www.ccohs.ca
Canadian Standards Association (CSA); www.csa.ca
National Institute for Occupational Safety and Health (NIOSH; US); www.cdc.gov/niosh/homepage.html
Occupational Safety and Health Administration (OSHA; US); www.osha.gov