



Safe Work Groups for Rural Manitoba

**STARTING AN
OCCUPATIONAL HYGIENE
PROGRAM**

O H G
Consulting

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What is Occupational Hygiene?

Industrial hygiene is the science of anticipating, recognizing, evaluating, and controlling workplace conditions that may cause workers' injury or illness. Industrial hygienists use environmental monitoring and analytical methods to detect the extent of worker exposure and employ engineering, work practice controls, and other methods to control potential health hazards.

There has been an awareness of industrial hygiene since antiquity. The environment and its relation to worker health was recognized as early as the fourth century BC when Hippocrates noted lead toxicity in the mining industry. In the first century AD, Pliny the Elder, a Roman scholar, perceived health risks to those working with zinc and sulfur. He devised a face mask made from an animal bladder to protect workers from exposure to dust and lead fumes. In the second century AD, the Greek physician, Galen, accurately described the pathology of lead poisoning and also recognized the hazardous exposures of copper miners to acid mists.

In the Middle Ages, guilds worked at assisting sick workers and their families. In 1556 the German scholar, Agricola, advanced the science of industrial hygiene even further when, in his book *De Re Metallica*, he described the diseases of miners and prescribed preventive measures. The book included suggestions for mine ventilation and worker protection, discussed mining accidents, and described diseases associated with mining occupations such as silicosis.

Industrial hygiene gained further respectability in 1700 when Bernardo Ramazzini, known as the "father of industrial medicine," published in Italy the first comprehensive book on industrial medicine, *De Morbis Artificum Diatriba (The Diseases of Workmen)*. The book contained accurate descriptions of the occupational diseases of most of the workers of his time. Ramazzini greatly affected the future of industrial hygiene because he asserted that occupational diseases should be studied in the work environment rather than in hospital wards.

Industrial hygiene received another major boost in 1743 when Ulrich Ellenborg published a pamphlet on occupational diseases and injuries among gold miners. Ellenborg also wrote about the toxicity of carbon monoxide, mercury, lead, and nitric acid.

In England in the 18th century, Percival Pott, as a result of his findings on the insidious effects of soot on chimney sweepers, was a major force in getting the

British Parliament to pass the *Chimney-Sweepers Act of 1788*. The passage of the English Factory Acts beginning in 1833 marked the first effective legislative acts in the field of industrial safety. The Acts, however, were intended to provide compensation for accidents rather than to control their causes. Later, various other European nations developed workers' compensation acts, which stimulated the adoption of increased factory safety precautions and the establishment of medical services within industrial plants.

What Are Some Examples of Job Hazards?

Air Contaminants

These are commonly classified as either particulate or gas and vapor contaminants. The most common particulate contaminants include dusts, fumes, mists, aerosols, and fibers. Dusts are solid particles that are formed or generated from solid organic or inorganic materials by reducing their size through mechanical processes such as crushing, grinding, drilling, abrading or blasting.

Fumes are formed when material from a volatilized solid condenses in cool air. In most cases, the solid particles resulting from the condensation react with air to form an oxide.

The term mist is applied to a finely divided liquid suspended in the atmosphere. Mists are generated by liquids condensing from a vapor back to a liquid or by breaking up a liquid into a dispersed state such as by splashing, foaming or atomizing. Aerosols are also a form of a mist characterized by highly respirable, minute liquid particles.

Gases are formless fluids that expand to occupy the space or enclosure in which they are confined. Examples are welding gases such as acetylene, nitrogen, helium, and argon; and carbon monoxide generated from the operation of internal combustion engines or by its use as a reducing gas in a heat treating operation. Another example is hydrogen sulfide which is formed wherever there is decomposition of materials containing sulfur under reducing conditions.

Liquids change into vapors and mix with the surrounding atmosphere through evaporation. Vapors are the volatile form of substances that are normally in a solid or liquid state at room temperature and pressure. Vapors are the gaseous form of substances which are normally in the solid or liquid state at room temperature and pressure. They are formed by evaporation from a liquid or solid and can be found where parts cleaning and painting takes place and where solvents are used.

Chemical Hazards

Harmful chemical compounds in the form of solids, liquids, gases, mists, dusts, fumes, and vapors exert toxic effects by inhalation (breathing), absorption (through direct contact with the skin), or ingestion (eating or drinking). Airborne chemical hazards exist as concentrations of mists, vapors, gases, fumes, or solids. Some are toxic through inhalation and some of them irritate the skin on contact; some can be toxic by absorption through the skin or through ingestion, and some are corrosive to living tissue.

The degree of worker risk from exposure to any given substance depends on the nature and potency of the toxic effects and the magnitude and duration of exposure.

Information on the risk to workers from chemical hazards can be obtained from the Material Safety Data Sheet (MSDS) that OSHA'S *Hazard Communication Standard* requires be supplied by the manufacturer or importer to the purchaser of all hazardous materials. The MSDS is a summary of the important health, safety, and toxicological information on the chemical or the mixture's ingredients. Other provisions of the *Hazard Communication Standard* require that all containers of hazardous substances in the workplace have appropriate warning and identification labels.

Biological Hazards

These include bacteria, viruses, fungi, and other living organisms that can cause acute and chronic infections by entering the body either directly or through breaks in the skin. Occupations that deal with plants or animals or their products or with food and food processing may expose workers to biological hazards. Laboratory and medical personnel also can be exposed to biological hazards. Any occupations that result in contact with bodily fluids pose a risk to workers from biological hazards.

In occupations where animals are involved, biological hazards are dealt with by preventing and controlling diseases in the animal population as well as proper care and handling of infected animals. Also, effective personal hygiene, particularly proper attention to minor cuts and scratches, especially those on the hands and forearms, helps keep worker risks to a minimum.

In occupations where there is potential exposure to biological hazards, workers should practice proper personal hygiene, particularly hand washing. Hospitals should provide proper ventilation, proper personal protective equipment such as gloves and respirators, adequate infectious waste disposal systems, and appropriate controls including isolation in instances of particularly contagious diseases such as tuberculosis.

Physical Hazards

These include excessive levels of ionizing and nonionizing electromagnetic radiation, noise, vibration, illumination, and temperature.

In occupations where there is exposure to ionizing radiation, time, distance, and shielding are important tools in ensuring worker safety. Danger from radiation increases with the amount of time one is exposed to it; hence, the shorter the time of exposure the smaller the radiation danger.

Distance also is a valuable tool in controlling exposure to both ionizing and non-ionizing radiation. Radiation levels from some sources can be estimated by comparing the squares of the distances between the worker and the source. For example, at a reference point of 10 feet from a source, the radiation is 1/100 of the intensity at 1 foot from the source.

Shielding also is a way to protect against radiation. The greater the protective mass between a radioactive source and the worker, the lower the radiation exposure.

Nonionizing radiation also is dealt with by shielding workers from the source. Sometimes limiting exposure times to nonionizing radiation or increasing the distance is not effective. Laser radiation, for example, cannot be controlled effectively by imposing time limits. An exposure can be hazardous that is faster than the blinking of an eye. Increasing the distance from a laser source may require miles before the energy level reaches a point where the exposure would not be harmful.

Noise, another significant physical hazard, can be controlled by various measures. Noise can be reduced by installing equipment and systems that have been engineered, designed, and built to operate quietly; by enclosing or shielding noisy equipment; by making certain that equipment is in good repair and properly maintained with all worn or unbalanced parts replaced; by mounting noisy equipment on special mounts to reduce vibration; and by installing silencers, mufflers, or baffles.

Substituting quiet work methods for noisy ones is another significant way to reduce noise, for example, welding parts rather than riveting them. Also, treating floors, ceilings, and walls with acoustical material can reduce reflected or reverberant noise. In addition, erecting sound barriers at adjacent work stations around noisy operations will reduce worker exposure to noise generated at adjacent work stations.

It is also possible to reduce noise exposure by increasing the distance between the source and the receiver, by isolating workers in acoustical booths, limiting workers' exposure time to noise, and by providing hearing protection. OSHA

requires that workers in noisy surroundings be periodically tested as a precaution against hearing loss.

Another physical hazard, radiant heat exposure in factories such as steel mills, can be controlled by installing reflective shields and by providing protective clothing.

Ergonomic Hazards

The science of ergonomics studies and evaluates a full range of tasks including, but not limited to, lifting, holding, pushing, walking, and reaching. Many ergonomic problems result from technological changes such as increased assembly line speeds, adding specialized tasks, and increased repetition; some problems arise from poorly designed job tasks. Any of those conditions can cause ergonomic hazards such as excessive vibration and noise, eye strain, repetitive motion, and heavy lifting problems. Improperly designed tools or work areas also can be ergonomic hazards. Repetitive motions or repeated shocks over prolonged periods of time as in jobs involving sorting, assembling, and data entry can often cause irritation and inflammation of the tendon sheath of the hands and arms, a condition known as carpal tunnel syndrome.

Ergonomic hazards are avoided primarily by the effective design of a job or jobsite and better designed tools or equipment that meet workers' needs in terms of physical environment and job tasks. Through thorough worksite analyses, employers can set up procedures to correct or control ergonomic hazards by using the appropriate engineering controls (e.g., designing or re-designing work stations, lighting, tools, and equipment); teaching correct work practices (e.g., proper lifting methods); employing proper administrative controls (e.g., shifting workers among several different tasks, reducing production demand, and increasing rest breaks); and, if necessary, providing and mandating personal protective equipment. Evaluating working conditions from an ergonomics standpoint involves looking at the total physiological and psychological demands of the job on the worker.

Overall, industrial hygienists point out that the benefits of a well-designed, ergonomic work environment can include increased efficiency, fewer accidents, lower operating costs, and more effective use of personnel.

In sum, industrial hygiene encompasses a broad spectrum of the working environment. Early in its history OSHA recognized industrial hygiene as an integral part of a healthful work setting. OSHA places a high priority on using industrial hygiene concepts in its health standards and as a tool for effective enforcement of job safety and health regulations. By recognizing and applying the principles of industrial hygiene to the work environment, America's workplaces will become more healthful and safer.

THE WALK-THROUGH SURVEY

A worksite analysis is an essential first step that helps an industrial hygienist and management determine what jobs and work stations are the sources of potential problems. During the worksite analysis, the industrial hygienist measures and identifies exposures, problem tasks, and risks. The most effective worksite analyses include all jobs, operations, and work activities. The industrial hygienist inspects, researches, or analyzes how the particular chemicals or physical hazards at that worksite affect worker health. If a situation hazardous to health is discovered, the industrial hygienist recommends the appropriate corrective actions.

The objective of a walk-through survey is to determine what are the hazards, what controls exist, and potential risks and to develop action plans to assess potentially unacceptable risks.

To do this, participants must have a basic knowledge of workplace hazards and the risks they present. This includes legislated definitions of hazards, risks and their control which may not always follow good practice. Without this information, the participants will not be able to recognize a hazard or risk if they see one. Examples of areas where background information is needed are:

- Control methods
- Safety hazards
- Chemical hazards
- Biohazards
- Legislation
- MSDSs

PLANNING/PREPARATION

The following data sources may be of use in planning and carrying out a walk-through survey.

What processes and equipment are used?

- manufacturers specs
- trade information

What special precautions are recommended?

- special installation instructions
- safety recommendations

Diagram process flow chart

What modifications have been made?

- temperature changes

- chemical substitutes
- speed changes

What materials are used?

- manufacturers specs
- MSDSs
- Labels

What waste materials are produced?

What legislation applies

Frequency and timing of survey, what are work cycles?

- shift - end of shift may be worse
- days - many work processes are not continuous
- Season
 - buildings are closed in winter
 - heat problems in summer
 - seasonal pollution
- process changes, repairs, new equipment
- complaints, illnesses

THE SURVEY

All areas to be visited

First impressions are important

No equipment used, just senses

- odours
- haze/mist/fog
- liquid or dust on floor or ledges
- lighting
- heat
- noise

Staff comments are important

- talk to staff in the area
- necessary to find intermittent problems

Are special precautions followed

- recommended ventilation
- personal protection
- safety equipment/ procedures followed
- storage precautions
- housekeeping

- waste disposal

Final report

- who writes it
- what is in it
- where does it go
- ensure follow up

MSDSs

A Material Safety Data Sheet is a technical document which states:

- The potential health effects of exposure to the product and how to protect workers;
- Hazard evaluations related to use, storage and handling of the product; and
- Emergency procedures.

The MSDS supplements the information provided on WHMIS labels.

The MSDS is a good starting point in the development of the worksite program for the safe use of controlled products because it:

- Contains technical and other information to inform workers about the potential hazards of controlled products;
- Provides control measures to protect workers;
- Provides technical references.

The following pages contain an explanation of each section on a MSDS and how to use the information on a MSDS to either design a safe workplace, or to carry out a basic inspection of a workplace.

MSDS HEADING	CONTENTS	HOW TO USE
CATEGORY 1 - PRODUCT INFORMATION This category of information provides the user with the identification of the product, the manufacturer, and the supplier of the product.		
Product Identifier	Identification of the product by generic name, trade name, common name, chemical name or code number specified by the supplier.	The product identifier ties together the labels and MSDSs. This is important in the training program.
Product Use	The supplier's intended use or uses for the product are listed here.	If the product is used for a purpose other than that recommended by the supplier, the user must review the hazards to ensure that they do not create an unexpected risk to themselves or to others.
Manufacturer's Identification	The manufacturer's name, address and emergency telephone number are listed. When the manufacturer has a Canadian place of business, it should be provided. When there is no Canadian place of business, the principle foreign place of business must be provided. Where there is an emergency telephone number, it must be in operation 24 hours a day for three years.	This is the place to go to for additional information on the safety of a product. Unclear directions or unanticipated uses should be checked with the manufacturer before proceeding. In the event of an emergency, or worker illness, particularly where trade secrets are claimed, the emergency telephone number should be used for further information.
Supplier's Name	Where the supplier is different from the manufacturer, the supplier name, address and emergency telephone number are listed. A distributor for a supplier does not have to provide additional information.	The same as for a manufacturer.
Chemical Name	Where the product contains one material, the chemical name of the material should be listed. The name should be a correct chemical name as recommended by the Chemical	This will provide a technically accurate name of the material that can be used for the search for additional information and avoid confusion between chemicals with similar names

MSDS HEADING	CONTENTS	HOW TO USE
	Abstract Service (CAS), or some other system that clearly identifies the material	
Chemical Family	A chemical family is a group of chemicals that have similar properties such as acids, bases, ketones, isocyanates, aromatic hydrocarbons.	Many toxicological properties are similar within families of chemicals, and the knowledge of what family a chemical belongs to may be useful in identifying a hazard.
Chemical Formula	This is a list of the number and type of atoms that make up a chemical. For example, water has two hydrogen and one oxygen atom and is written H ₂ O.	This can be used to identify the materials in the product.
Molecular Weight	This is calculated by adding the atomic weights of the atoms in the molecule.	The molecular weights can be used to help design control systems.
Synonyms	Many materials have more than one name, where other names are known, they should be listed.	If all common names are given, identification of a material is easier.
<p>CATEGORY 2 – HAZARDOUS INGREDIENTS This category provides information on the identity and concentration of the ingredients in the product. It also provides some indication of the toxicity of the material and its products.</p>		
Hazardous Ingredients	An ingredient must be listed if: <ul style="list-style-type: none"> • It is on the Ingredient Disclosure List at a concentration greater or equal to the level on the list; • It is a controlled product; • You have reasonable grounds to believe it is hazardous; or 	The list of ingredients tells you what is in the material. This allows you to cross check any information and determine the compatibility of the material with other materials or processes in the workplace. Knowing what ingredients are present provides an opportunity to check on the

MSDS HEADING	CONTENTS	HOW TO USE
	<ul style="list-style-type: none"> The hazard is unknown. <p>The ingredients of a naturally occurring complex mixture with a commonly known generic name do not have to be disclosed if the generic name is disclosed.</p> <p>Where a claim of Confidential Business Information is to be made, this is the most likely place to make the claim.</p>	<p>properties and hazards of the product where such information is lacking elsewhere in the MSDS.</p>
% Concentration	<p>The concentration of an ingredient is recorded if it equal to or greater than 1%. However, carcinogens, reproductive toxins, respiratory tract sensitizers, teratogens, embryotoxins or mutagens must be reported if equal to or greater than 0.1%.</p>	<p>The concentrations of ingredients lets you know what the main hazards are, and where to put your control emphasis.</p>
Product ID Number (PIN)	<p>This is a four digit number for pure chemicals, and is found in Schedule II of the Transportation of Dangerous Goods Regulations (Canada).</p>	<p>Emergency information on chemicals is organized by these numbers in the Emergency Response Guide for Dangerous Goods, issued by CANUTEC, the Canadian Transportation Emergency Centre.</p>
CAS Number	<p>This number is assigned to each chemical by the Chemical Abstract Services Division of the American Chemical Society. These numbers are in Column II of the Ingredient Disclosure List of the Hazardous Products Act.</p>	<p>Many chemicals have more than one name. Many names are similar, and this leads to confusion. However each number is unique, and if it is known, the correct identification of the chemical can be known.</p>
LD ₅₀ of Ingredient	<p>The amount of material required to kill 50% of the test population is reported as the weight of the substance compared to the animal weight</p>	<p>The LD₅₀ is a measure of acute lethality. A single dose of a material is given to a test animal, and the amount needed to kill 50% of</p>

MSDS HEADING	CONTENTS	HOW TO USE
	(mg/kg). The species of the test animal and the route of entry should be given	the population is determined. The material is usually administered orally or dermally. Since toxicity varies according to species and route of entry, the LD ₅₀ must be interpreted carefully to estimate the effect on humans. The LD ₅₀ cannot be used to determine chronic effects.
LC ₅₀ of Ingredient	The LC ₅₀ is similar to the LD ₅₀ , but in this case the test material is presented as a concentration in air and is expressed as parts per million (ppm) or mg/m ³ .	See LD ₅₀ .
WHMIS Classification	<p>The classes of hazard presented by the material should be reported. The classes are:</p> <ul style="list-style-type: none"> • Class A – Compressed Gas • Class B – <ul style="list-style-type: none"> – Div 1 – Flammable Gases – Div 2 – Flammable Liquids – Div 3 – Combustible Liquids – Div 4 – Flammable Solids – Div 5 – Flammable Aerosols – Div 6 – Reactive Flammables • Class C – Oxidizing Material • Class D – Poisonous/Infectious Materials <ul style="list-style-type: none"> – Div 1 – Very Toxic Materials – Div 2 – Toxic Materials • Class E – Corrosive Materials • Class F – Dangerously Reactive Materials 	This information will help define the hazards the material presents.
Exposure Level	Where an exposure standard is known, it should be given for each component. The	Exposure standards are a useful comparison of toxicological properties and therefore of risk,

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	exposure level and the source should be given.	The exposure standards are also needed to evaluate workers' exposure to the material.
CATEGORY 3 – PHYSICAL DATA This category provides information needed to recognize the presence of the material, and to design controls for normal and emergency conditions.		
Physical State	The physical state (gas, liquid, solid) should be given for normal temperatures.	The physical state of the material affects how easy the material is to contain, and therefore the likelihood of someone being exposed
Odour and Appearance	Odour should be described under the following headings and descriptors: <ul style="list-style-type: none"> • Quality – almond like, fruity, sharp, sweet, etc. • Intensity – strong, weak, mild, faint • Irritant properties Appearance should be described under the following headings: <ul style="list-style-type: none"> • Colour, including colourless • Surface texture – greasy, waxy, soft • Degree of aggregation – finely divided particulate, flakes, granules 	This part helps the user identify the material. Odour and appearance are two means of identifying materials without instruments.
Odour Threshold	The lowest detectable (by smell) concentration of a material in air. The units of measurement (ppm or mg/m ³) should be given.	Odour is a useful warning property if the threshold of odour is below the Occupational Exposure Limit. <u>Caution</u> , individual differences in ability to detect and identify odours is large.
Vapour Pressure	When a material evaporates, it exerts a pressure in the air around it. This pressure varies with the temperature and should be	The higher the vapour pressure the faster the material will evaporate, and the greater the risk it will present. Water has a vapour pressure of

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	given for the temperature at which the material is expected to be used. Vapour pressure is measured in millimeters of mercury (mmHg)	17.5 mmHg, and ether has a vapour pressure of 439.8 mmHg. Ether will therefore evaporate faster than water. Normal air pressure is 760 mmHg.
Vapour Density	This is the ratio of the weight of a pure vapour compared to the weight of air. No units are used in vapour density.	Dense vapours will settle to the floor. However, this will depend on vapour concentration, air temperature, air turbulence, and time since release. If the boiling point is much higher than room temperature (or the vapour pressure is low) the vapours will not be given off in sufficient volume for the vapour density to have a significant effect.
Evaporation Rate	The rate that a liquid vapourizes in air is measured relative to a specified material such as butyl acetate or ether. The liquid used as a standard must be named.	The evaporation rate gives an estimate of how fast a material is vapourized, and can be used to estimate risk to workers. The higher the evaporation rate, the greater the risk.
Boiling Point	This is the temperature at which a liquid becomes a gas, and is measured at a normal atmospheric pressure (760 mm Hg)	A low boiling point is an indication of potential risk, since a lower boiling point usually indicates a higher evaporation rate at a given temperature. A boiling point close to room temperature is an indicator of potential problems in the event of an emergency.
Freezing Points	The temperature at which liquid and solid phases of a product are in equilibrium.	Knowing the freezing point of a product may be useful in containing the material.
pH	A measure of acidity and alkalinity measured on a scale of 1 to 14. A pH of 7 is neutral, 0-3 is highly acidic, 11-14 is highly basic.	This is an indicator of how corrosive a material is. This will help in the selection of personal protection equipment.
Specific Gravity	The ratio of the weight of a volume of the product compared to the weight of an equal	The specific gravity can be used to determine if the material will sink or float on water.

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	amount of water. A specific gravity <1 means that the material is lighter than water.	
Density	The weight per unit volume of the material expressed in grams per millilitre.	Useful in designing ventilation systems.
Coefficient of Water/Oil Distribution	This is the measurement of how much material will dissolve into each of water and octanol, and is expressed as a ratio.	This information can be used to design spill clean-up procedures.
CATEGORY 4 – FIRE AND EXPLOSION DATA		
This section provides information on the flammability or explosiveness of the material. If the material meets the criteria of any of the six Divisions of Class B, this part must be filled out. If none of the criteria are met, it should be so indicated. This category includes solvents, organic peroxides, explosives, metal dusts, and other combustible materials.		
Flammability	<p>If a product is not a fire or explosion risk, that fact should be indicated in the first box.</p> <p>If the material is flammable or explosive, the conditions under which the conditions occur should be explained.</p>	This will tell you if there is a fire or explosion hazard, and what conditions to avoid.
Means of Extinction	The type of fire extinguisher or techniques needed to control a fire are found here. This includes extinguisher type (A, B, C, D) or other systems such as foams.	This information is needed to determine if a workplace is equipped to handle a new material, or if an existing material can safely be used with existing equipment.
Special Procedures	Any special precautions or fire fighting procedures are listed here. Examples are materials that react with water, compressed gas cylinders that can explode, or special protective equipment.	This information is needed for emergency response, and should be available to local fire departments.
Flashpoint and Method	The flashpoint is the minimum temperature that a liquid gives off enough vapour to ignite in the presence of an ignition source. The	The lower the flashpoint of the material, the greater the hazard. If the flashpoint is close to or less than the room temperature, there is a

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	method by which the flashpoint was determined (open or closed cup) must be mentioned.	significant fire hazard.
Flammable Limits in Air	<p>The Upper Flammable Level (UFL) and the Lower Flammable Level (LFL) are the upper and lower concentrations of a vapour that will ignite or support ignition. The limits are expressed as a percent by weight of vapour in air. If the concentration is above the UFL the mixture is too rich to ignite, and too lean if the concentration is below the LFL.</p> <p>Other names for the UFL and LFL are the Upper Explosive Level (UEL), and Lower Explosive level (LEL).</p>	This information is needed to determine the requirements for dilution ventilation. It may also be needed in an emergency following a spill or leak to determine the degree of fire hazard a given concentration of vapours present.
Autoignition Temperature	This is the lowest temperature at which a vapour or gas will ignite without a source of ignition.	This information is needed to ensure that materials are kept away from hot areas or surfaces. The closer the autoignition temperature is to room temperature, the greater the chance of fire.
TDG Flammability Classification	<p>If a material falls in any of the following TDG Classes or Divisions, it should be noted on the MSDS.</p> <ul style="list-style-type: none"> • Class 2- Div 1- Flammable Gases • Class 3- Div 1,2,3 – Flammable Liquids • Class 4- Div 1,2,3 – Flammable Solvents, Substances liable to spontaneous combustion, substances that emit 	This provides additional information on the flammability of a material and referencing TDG literature will provide instructions on emergency response.

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	flammable gasses on contact with water	
CATEGORY 5 – REACTIVITY DATA		
This section provides information on the stability of the products and the probability of dangerous reaction with other products. This information is useful in designing storage facilities as well as handling, and storage procedures to prevent hazardous situations.		
Chemical Stability	A chemical is unstable if it will vigorously polymerize, decompose, condense, or become self reactive under the physical conditions of shock, vibration, pressure or temperature. Whether or not a material is unstable, and under what conditions, must be reported.	When the conditions that can start a reaction are known, storage and handling procedures can be established that will avoid these conditions.
Incompatibility	If the material reacts dangerously with other products to produce toxic or corrosive byproducts, excessive heat, or explosion, these products should be listed	Incompatible materials must be kept apart. This will advise you as to what materials react with what. All materials in the workplace should be reviewed for incompatibilities, not just those on the MSDS.
Reactivity	Any reactions not mentioned in the previous two sections will be mentioned here.	This information can be used in the same manner as the two previous parts.
Hazardous Decomposition Products	Any dangerous products released if the product is allowed to age, overheat, burn, oxidize, or react will be reported here. Where aging is a factor, a shelf life will be provided.	This information may be needed to deal with emergency situations. If harmful decomposition products can be generated , emergency staff, including fire fighters, should be advised and prepared.
Hazardous Combustion Products	Any known hazardous products that are created when a product burns must be reported. Examples are carbon monoxide, hydrogen cyanide, acid gases or aldehydes.	Many products that are not a hazard in the workplace can release hazardous decomposition products when burned or subjected to excess heat. An example is a plastic container that will release acid gases or

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		toxic monomers when it is broken down by heat.
Explosion Data – Sensitivity to Impact	This is a description of the likelihood the product may explode as a result of a mechanical impacts or physical shock	Materials such as metal azides or actalides that are sensitive to an impact must be handled or stored carefully.
Explosion Data – Sensitivity to Static Discharge	Some gases, vapours, and dusts can be ignited by static charges. Where this is known, it will be reported here.	Materials that can be ignited by a static discharge must be handled carefully. They must be stored and poured under controlled conditions.
CATEGORY 6 – TOXICOLOGICAL PROPERTIES		
This category provides information on how a material is likely to enter the body, and on the short term (acute) and long term (chronic) effects on exposed workers.		
Route of Entry	<p>All major routes of entry to the body should be mentioned.</p> <ul style="list-style-type: none"> • Skin contact – when skin or mucosal surfaces are affected as with acid or other corrosive material. • Skin absorption – when the material can pass through the skin or mucosal membranes to affect other parts of the body, as with phenols. • Eye contact – when the material affects the eye such as a base or other corrosive material. • Inhalation – when the material is in the form of a gas, vapour, or fine particulate in normal use, inhalation is a possible route of entry. 	The route of entry, or how a material can enter the body is important knowledge for the design of control systems.

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	<ul style="list-style-type: none"> Ingestion – if the material is likely to cause adverse health effects if swallowed. 	
Effects of Acute Exposure	Acute exposures are short-term exposures, frequently of high exposure level. These effects appear during or shortly after the exposure has taken place. The symptoms of these short high level exposure should be reported.	<p>The symptoms are important for two reasons;</p> <ul style="list-style-type: none"> If the symptoms are recognized early enough, exposures can be stopped before serious damage can occur; and The proper identification of the symptoms may be necessary to identify the material that caused the problem so that correct first aid can be administered.
Effects of Chronic Exposure	A chronic exposure is one that takes place over a long period of time, with many repeated exposures. The effects of this exposure may not become apparent until years after the exposure started. The symptoms, especially the earlier ones, should be recorded.	Although the symptoms take a long time to show, an early warning may help. This information also gives the consequences of repeated exposures even though there may not be an immediate effect.
LD ₅₀	The amount of material required to kill 50% of the test population is reported as the weight of the substance compared to the animal weight (mg/kg). The species of the test animal and the route of entry should be given	The LD ₅₀ is a measure of acute lethality. A single dose of a material is given to a test animal, and the amount needed to kill 50% of the population is determined. The material is usually administered orally or dermally. Since toxicity varies according to species and route of entry, the LD ₅₀ must be interpreted carefully to estimate the effect on humans. The LD ₅₀ cannot be used to determine chronic effects.
LC ₅₀ of Ingredient	The LC ₅₀ is similar to the LD ₅₀ , but in this case the test material is presented as a concentration in air and is expressed as parts	See LD ₅₀ .

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	per million (ppm) or mg/m ³ .	
Exposure Limits	<p>The exposure limits are either:</p> <ul style="list-style-type: none"> • The Threshold Limit Value (TLV) set by the American Conference of Governmental Industrial Hygienists; or • Where a TLV or other exposure standard does not exist, a standard set by the employer, or in this case whoever makes the MSDS. <p>The exposure limit is in three parts:</p> <ul style="list-style-type: none"> • TWA – time weighted average concentration for an eight hour day; • STEL – short term exposure limit, the concentration that a worker can be exposed to for a short period of time (typically 15 minutes) without adverse effects; and • C – ceiling limit above which no one should be exposed at any time. 	<p>The exposure limits are the criteria by which air quality is judged. They are needed for the planning and execution of prevention plans. When compared to the odour threshold, they give an indication of the warning properties of the material.</p>
Irritancy of the Product	<p>The irritating effects of the material, such as erythma, burning or swelling at the point of contact on the skin, eyes or mucosal areas should be reported.</p>	<p>This information is useful in the selection of protective equipment, and the design of working procedures.</p>
Sensitizing Capability	<p>Sensitizers may not produce a noticeable effect on first exposure. However, repeated exposures can result in a reaction to the material at very low levels. Since these</p>	<p>Because a sensitized worker can have a severe reaction to small quantities of these materials, all exposures must be kept as close to zero as is reasonably practicable.</p>

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	reactions can be quite severe, any such tendency must be reported.	
Carcinogenicity	<p>Any material that is reported as causing cancer in one of the following lists is a carcinogen:</p> <ul style="list-style-type: none"> • Threshold Limit Values and Biological Indices, Appendices A1a, A1b, or A2 or; • IARC Monographs on the Evaluation of the Carcinogenic Risks of Chemicals to Humans, Groups 1 or 2. <p>If there is other evidence of the material being carcinogenic in other sources, they must also be reported here.</p>	<p>Like sensitizers, all carcinogens, teratogens, and mutagens must be given special consideration and worker exposure must be kept as close to zero as is reasonably practicable.</p> <p>Consideration should be given to substituting these products where alternative products or processes are available.</p>
Teratogenicity	These materials can cause defects in the newborn, and any evidence of the material having this effect shall be reported.	
Mutagenicity	These products can cause changes to the genes, and any evidence of the material having this property shall be reported.	
Synergistic Materials	Some materials interact with each other so that the combined effect is greater than either one alone. When there is evidence that this can occur, the materials that the product can interact with should be reported.	When one is aware of the possibility of synergistic effects between the product in question and other materials in the workplace, steps can be taken to reduce the worker risk, and appropriate changes can be made to the Occupational Exposure Limits (OELs).

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<p>CATEGORY 7 – PREVENTIVE MEASURES This section provides the basic information needed for the protection of the worker's health including personal protection, engineering controls, emergency procedures, and correct handling methods.</p>		
<p>Personal Protection Equipment</p>	<p>Personal protection equipment (PPE) frequently must be used to protect workers. The equipment must be suited to the hazards presented by the material in question. The chemicals can affect the materials that make up the PPE so that specific instruction should be given. This is particularly true where trade secrets are claimed.</p> <ul style="list-style-type: none"> • Gloves – Whenever a material that is a sensitizer, or irritant, or capable of being absorbed through the skin is in the product, gloves should be recommended. The material that the glove should be made of should be given. • Respiratory Protection – Whenever a material is an inhalation hazard under normal conditions of use or in an emergency situation, proper respiratory protection must be defined. • Eye – Where a material can affect the eye or be absorbed through the eye, proper eye protection must be given. • Footwear – Whenever a material may affect the skin of the foot or lower leg, or can be absorbed through the skin, or affect 	<p>Personal protection is not the first choice of worker protection. Only after engineering controls have been implemented as far as reasonable practicable should PPE be used, or it can be used as an interim control while engineering controls are being implemented. Where PPE is used it must be suited to the product. A pair of gloves that dissolve in the solvent will not provide adequate protection. In all cases, equipment must be the correct size for the worker, the worker must be trained in its use and limitations, and maintenance of the equipment must be provided.</p> <p>The need for these types of controls depends on the level of exposure in your workplace. Additional ventilation or respiratory protection may be needed depending on the level of exposure in your workplace.</p>

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	<p>normal footwear, the proper footwear should be provided, including the tread where the material may create a slipping hazard.</p> <ul style="list-style-type: none"> • Clothing – Where a material is a hazard through skin contact or absorption, the type of body protection (apron, coveralls, chemical suits, etc.) and the materials that they should be made of should be given. • Other – If the supplier is aware of any other protective equipment necessary to protect workers, it should be given. 	
Engineering Controls	The recommended engineering controls are mentioned here, isolation/enclosure, ventilation, house keeping, work procedures, and preferred handling procedures.	Engineering controls are the preferred methods for controlling workplace hazards. Data from the MSDS (toxicological, physical properties, and fire data) will be required to design proper controls.
Storage Requirements	<p>Information on storage should include:</p> <ul style="list-style-type: none"> • Temperature • Incompatible materials • Shelf life and effects of aging • Tests for stability or the effects of aging if appropriate • Stacking height 	Storage areas are frequently overlooked, and the directions here can be used as the basis for inspecting or designing storage areas.
Special Shipping Information	Special shipping instructions include sensitivity to temperature, shock or other conditions that are known.	This can provide direction when materials are shipped.
Leak and Spill	The safe work procedures for dealing with a	Workers near any material must be aware of

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Procedures	leak or spill should include: <ul style="list-style-type: none"> • Protective equipment for clean-up or emergency workers; • Neutralizing absorbing, or other clean-up supplies; and • Special safety procedures. 	what to do in the event of a leak or spill. All clean-up equipment and procedures must be available before the spill occurs. Staff must also be trained in their use. When designing leak and spill procedures, other nearby hazards such as other hazardous products or ignition sources must be considered.
Waste Disposal	The necessary information includes; <ul style="list-style-type: none"> • Container design; • Proper WHMIS labels; • Preferred disposal locations; • Handling procedures; and • Agencies to contact for specific disposal instructions. 	The procedures for disposing of wastes should be developed before wastes exist. This should be done for all materials in the workplace since a spill or leak can result in unexpected waste, The local agencies responsible for waste disposal should be consulted before wastes are generated so that proper action can be taken quickly and efficiently.
Handling Procedures and Equipment	If there are any special handling procedures that you should be aware off to protect workers, they will be mentioned here.	Where special work procedures are given, the workplace should be inspected to ensure that these procedures or equipment are in place.
CATEGORY 8 – FIRST AID MEASURES This section provides information on the first aid measures needed to deal with the effects of acute exposure		
Specific Measures	The measures to be taken to provide first aid treatment should be detailed. Each route of entry should have the appropriate treatment explained for it. Any special antidotes or equipment needed	Any special equipment or supplies mentioned in this section should be available in the workplace. The first aid personnel must be trained in standard first aid procedures as well as any special procedures mentioned in this section. All equipment and training must be in

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	<p>should be listed with any special applications information.</p> <p>Any special precautions or equipment required to be taken or used by the first aider must be explained.</p> <p>Any special information that may be needed by the person or facility (doctors, nurses, hospitals) providing the ultimate treatment should be listed.</p> <p>If a trade secret has been claimed, the information must be quite detailed and very precise since the details that the first aider needs to make their own decisions may not be available.</p>	<p>place before they are needed.</p>
<p>CATEGORY 9 – PREPARATION OF MSDS MSDSs must be current, not more than three years old. This section provides the information needed to ensure that this requirement is complied with.</p>		
<p>Prepared By</p>	<p>The name of the individual or group that made the MSDS must be given.</p>	<p>If additional information or clarification of the contents of the MSDS is required, the person who prepared the MSDS should be contacted.</p>
<p>Phone Number</p>	<p>The phone number of the person or group that prepared the MSDS must be given. If this is a 24 hour emergency number, it should be in service the three years the MSDS is current.</p>	<p>Additional information can be obtained easily and quickly by using this number. In case of an emergency involving confidential business information, this number should give access to those with the information.</p>

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Date	The date that the MSDS was created is recorded here.	If the date is over three years old, a new MSDS must be obtained.
CATEGORY 10 – REFERENCES This category is optional. References or the sources of the information used to create the MSDS do not have to be reported on the MSDS, however, they must be available for inspection if requested.		
References	References used in creating the MSDS could be listed here	Any references could be a source of additional information if requested.

EXPOSURE LIMITS

An important part of ensuring good workplace safety and health is the prevention of harmful exposure of workers to the aerosols, vapours and gasses of the workplace. To do this, we need standards or guidelines that tell us what is acceptable and what isn't. The primary standard that we have used since 1946 is the Threshold Limit Values (TLVs) published by the American Conference of Governmental Industrial Hygienists (ACGIH). Originally they were called the Maximum Allowable Concentrations but in 1956 this was changed to the Threshold Limit Values (TLVs) that we know today.

According to the ACGIH, the TLVs were "developed as guidelines to assist in the control of health hazards. These recommendations or guidelines are intended for use in the practice of industrial hygiene, to be interpreted and applied by a person trained in this discipline." They are guidelines, and are not to be used as fine lines between safe and dangerous concentrations.

Threshold Limit Values (TLVs) refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. Because of wide variation in individual susceptibility, however, a small percentage of workers may experience discomfort from some substances at concentrations at or below the threshold limit; a smaller percentage may be affected more seriously by aggravation of a pre-existing condition or by development of an occupational illness. In addition to differences in workers, differing working conditions can also affect how individuals or groups will react to a given exposure level.

When most people refer to the TLVs they mean the Threshold Limit Value -Time weighted Average, although there are three equally important major parts to the TLVs:

- *Threshold Limit Value - Time-Weighted Average (TLV-TWA)* - the time-weighted average concentration for a conventional 8-hour workday and a 40-hour workweek, to which it is believed that nearly all workers may be repeatedly exposed day after day, without adverse effect.
- *Threshold Limit Value - Short-term Exposure Limit (TLV-STEL)* - the concentration to which it is believed that workers can be exposed continuously for a short period of time without suffering from 1) irritation 2) chronic or irreversible tissue damage, or 3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency, and provided the TLV-TWA is not exceeded.
- *Threshold Limit Value - Ceiling (TLV-C)* - the concentration that should not be exceeded during any part of the working exposure.

The TLVs have been around for so long, and are so well known that the term TLV has taken on a generic meaning, and any exposure standard is called a TLV. Like any disposable tissue is called Kleenex and any snowmobile is called a SkiDoo. But the name TLV belongs to the ACGIH. That is why when the TLV list is adopted in regulations they are called Permissible Exposure Limit (PEL) or Occupational Exposure Limited (OELs), but not TLVs since that name belongs to ACGIH.

How Do We Use TLVs?

Most criticism of the TLVs seemed to come when someone collected a sample, compared it to the TLV and found the exposure to be below the TLV but the worker complaints continued. This happens when the TLV list is adopted but not the TLV policy.

The TLVs are adopted as regulatory standards in provincial legislation. This can be done three ways. The first is by including the list of materials and their TLV in the regulation. It may be called a PEL, OEL. The second way of adopting the TLVs is to adopt the TLVs from a specific year such as when the 1987-1988 were adopted in the Manitoba Workplace Health Hazard Regulation MR 53/88. The third method is by referencing the latest version of the TLVs in the regulation as was done in the Manitoba, Operation of Mines Regulation MR 228/94.

As safety and health professionals we then take our air samples and compare them to the PEL. Essentially, if the samples are under the PEL, we are in compliance, if they are over we are not in compliance with the legislation. Very simple and if it doesn't work, the TLVs must be wrong. It could not possibly be that we used them wrong.

It should be noted that the ACGIH does not advocate the use of TLVs as legal standards. However it recognizes that in certain circumstances individuals or organizations may wish to make use of the recommendations or guidelines as a supplement to their occupational safety and health program. ACGIH does not oppose this use of the TLVs. We sometimes concentrate on the list of TLVs and forget that they are only a part of the program.

What Are Some Of The Problems In Adopting The TLVs In Legislation?

One problem raised above is the need to keep the regulated standards current. Where specific TLVs are adopted, they must be updated each year. Often the commitment to workplace safety and health is not strong enough to see this task through, and outdated exposure limits are in place. Enlightened regulators are needed to keep the legislation up to date. In Manitoba the 1987-88 standards are

used in industry, and the current ones are used for mines and federal workers. There are two classes of workers in Manitoba.

Another problem is that you must always be as far below the TLVs as possible. However, when adopted as regulations, the TLVs become a level you can come up to. Also, if the concentration in air is below the PEL (or OEL), then by definition everything is all right. This ignores the Committee's warning that not all workers will be protected by the TLV, and that the TLVs must be interpreted and applied by a person trained in occupational hygiene.

A significant problem is the way the TLVs are adopted in legislation. The "list" is adopted, but not the principles that they are based on. Neither the Documentation of the TLVs and BEIs nor the Introduction to the TLVs are adopted in the legislation. Instead of adopting the TLV principles in the regulations, in practice we have transferred the regulatory short cuts to the TLVs, and then hold the TLV committee responsible for the results.

Somewhere in the process of adopting the "list" we have forgotten that TLVs are recommendations or guidelines and are intended for use in the practice of industrial hygiene. They are to be interpreted and applied by a person trained in this discipline, and are not pass-fail standards. The Introduction to the TLVs tells us to take into account preexisting conditions, occupational illnesses, age, genetic factors, personal habits and hypersensitivity in the worker. The introduction also advises us to take into account mixtures, skin absorption, work schedules, and the manner of sampling. The documentation provides chemical specific information that must be taken into account, such as protecting a fetus (carbon monoxide), potentiation (carbon tetrachloride), physical exertion (ozone), and exposure times (lead). Ignoring these issues puts workers at risk.

Let us look at some of the conditions that the authors of the TLVs mean when they say that they are guidelines to be used in the control of potential health hazards.

Additive effects of mixtures

This is one of the items to be considered in the TLV booklet and some legislation. Where there are two or more materials that effect same organ system and where there is no evidence to the contrary, the effects should be added.

Work schedules

This also is a commonly accepted consideration. Work schedules that are different from the 8-hour day and the 40-hour week, require judgement in order to provide workers the same level of protection that workers receive on conventional workshifts.

Other routes/exposures

This is a less well accepted condition. The TLVs are for airborne concentrations. However, many materials can be absorbed through the skin either as liquid contamination on the skin, or as vapours. Some conditions, such as exposure to phenol, can result in as great a dose being received through the skin as through the lungs.

Sensitizers

Some TLVs are set to prevent sensitization. Once a worker has become sensitized they can react to the material (such as diisocyanates) at levels well below the TLV.

Physical exertion

This is one of the factors mentioned in the documentation. Any condition that increases cardiopulmonary output of a worker should be investigated. The dose received by a worker is proportional to the amount of air breathed. Many exposure criteria are based on a ventilation rate of 21 litres per minute. Under heavy physical exertion, ventilation rates and therefore dose can be doubled. Thus, levels of physical exertion must be considered.

External exposures

The TLVs are based on the assumption that the worker is not exposed to the materials when away from the job. Air pollution, other sources of the material such as water, or diet could upset this assumption. Unusual work shifts could leave time for a second job that could result in additional exposures. The safety and health professional should be aware of the possibility of these conditions.

Sex and developmental differences

Anyone of childbearing age may require additional protection. The fetus could also be at special risk. The documentation will provide the practitioner with guidance.

Health

Many drugs contain the same or similar chemicals found in the workplace. Normal therapeutic doses can result in a body burden higher than allowed from workplace exposures. This should be considered. An illness that blocks normal metabolic processes or elimination processes can have a significant effect on the retention of chemicals in the body. A kidney ailment could result in lead levels higher than expected by preventing the elimination of lead. The safety and health professional must work with an occupational physician to determine if additional protection is required.

Age

Older workers are susceptible to certain illnesses such as arthritis, hypertension, and heart disease. Again, the safety and health professional must work with an occupational physician to determine if additional protection is required.

SUMMARY

We are not using the TLV system. We are using OELs and PELs, just part of the TLVs. We have been doing this for so long we forget that there is more to the TLVs than the "list" (except in Manitoba where the TLVs must be adjusted for conditions of the worker and the workplace).

Because TLVs have been around a long time, and the "list" if not the concepts have been adopted in all provincial legislation, they appear simple, and belong to everyone. Unfortunately, TLVs are guidelines to assist in the control of workplace hazards. They are not simply pass fail numbers. They must be used with the Documentation. Failure to do this can result in one of two errors:

- Underestimation of exposure by not considering all routes of exposure, additive effects with multiple chemicals, increased dose via inhalation during physical exertion, etc.; or
- Overestimation of the tolerance of the worker/workforce by not recognizing the implications of an atypical worker/workforce in terms of age, reproductive status, pre-existing medical condition, nonvocational exposure, etc..

Table 1 is an estimate of the size of potential overexposure if these errors are made. If we make one of these errors, we can only blame ourselves for the outcome for ignoring the warnings of the committee. We cannot blame the TLVs or the Committee if we do not use them.

TABLE 1: Potential errors in estimating dose due to overlooked conditions of the worker and conditions of the workplace.

Condition	Potential error in estimating effect
Unusual work schedule	0-50%
Physical exertion	0-44%
Dermal absorption	480%
Concurrent exposures	0-50%
Health effects	19%
External exposures	10%
Sensitivity	93%