Section 4

Toxicology
Any chemical you use incorrectly can result in over-exposure leading to adverse health effects immediately or in the future.

All hazardous materials can be handled in complete safety without being exposed or coming in contact with them. If you keep chemicals that harm you away from your body, they will not cause adverse health effects.

- The Health Hazard Data section of the MSDS will tell you what the effects of the substance might be.
- The Preventive Measures section will tell you how to avoid exposure and protect yourself.
- The First Aid Measures section will tell you what to do should an over-exposure occurs.

There are several factors, which determine and influence the degree of harm a hazardous material can cause to the body. Some of the major factors are:

1. Route of entry into the body
2. Length of exposure
3. Target of accumulation sites in the body
4. Metabolism and elimination of the material in the body
5. Biological or individual variation
6. Amount or dose entering the body

1. Route of Entry into the Body
Before any hazardous material can cause or elicit and adverse health effect, a person must not only be exposed to the material, but it must enter the body.

Hazardous materials can enter the body in three primary routes:

a) Inhalation

Entry into the Body: Inhalation is the most common route of entry of substances into the body. Dusts, fumes, gases, mists, vapours and smoke are breathed in and enter the respiratory tract. Very tiny blood vessels in the lungs are in constant contact with the air you inhale. Airborne contaminants can be easily absorbed through this tissue. If the particles are small enough, they can get into the lungs, where they can then be absorbed into the blood.

Protection: Air contaminant controls such as ventilation and fume hoods help keep hazardous dust, fumes and vapours away from your breathing zone. Make sure the ventilation system is always in good working condition, is turned on, and fans, motors, filters and vents are clean and well maintained.

Personal protective equipment, such as respirators, covering the nose and mouth can prevent you from inhaling the material.
b) Absorption

**Entry into the Body:** Some chemicals may contact the eye and the skin and be either absorbed into the body or cause local dermal effects (skin or eye irritation or burn). Hazardous materials can be absorbed into the body by dissolving the protective fatty/oily covering on the skin. Once skin fats/oils are removed, the natural barrier to infection is lost. The material may then be easily absorbed through the skin and enter the mucosal membranes and the bloodstream. Organic solvents such as methanol, acetone, varsol, toluene and alcohol are examples of materials that can dissolve fats/oils in the skin. Absorption through the skin can occur rapidly if the skin is cut or abraded.

Acids or alkalis spilled on the skin will first burn through the flesh and then enter the blood stream where they can poison the body.

Chemicals entering through the eye are less common but may occur by dissolving in the liquid surrounding the eyes. The eyes are richly supplied with blood vessels and many chemicals can penetrate the outer tissues and pass into the body. The eye may or may not be damaged during this process, depending on the corrosive nature of the chemical and its ability to penetrate into the eye.

**Protection:** Certain types of “barrier creams” prevent and reduce some materials from contacting the skin. Clothing, such as gloves, aprons, and boots shield the skin from chemical contact. The type of clothing worn must be suited to protect against the chemical used. Appropriate eye protection will prevent chemicals from entering the body by this route as well as preventing physical damage to the eye itself. Engineering controls, which isolate the material from you also, prevent skin contact.

c) Ingestion

**Entry into the Body:** Hazardous materials can enter the body through the digestive system by mouth if they swallowed.

They can reach the stomach when food or drink are left unprotected in the work area and then eaten by placing contaminated fingers or contaminated cigarettes in the mouth, and by failing to wash your hands before eating or smoking. Once swallowed, the substances can enter the digestive tract, and thus may enter the bloodstream.

All forms of hazardous materials, whether they exist as vapours, mists, dusts, smoke or fumes, can be swallowed.

**Protection:** Appropriate facilities for eating should be available and separate from the general workplace or workroom contamination.

Washing hands thoroughly after working and before eating.
2. **Length of Exposure:**
The amount of time you are exposed to a hazardous material is another important factor that may result in adverse health effects.

Depending on the hazardous material, the longer an over-exposure occurs, the more likely it is for the material to enter into your body thus leading to an adverse health effect.

3. **Target or Accumulation Sites in the Body:**
Hazardous materials in the workplace may cause harm in the body at four main sites:

- Where they enter the body - entry routes such as the lungs, skin and intestines.
- In the blood that carries them throughout the body.
- In the central nervous system; and
- In the organs which have the ability to concentrate toxicants and remove them for the body; i.e., the liver, kidneys and bladder (exit routes).

4. **Metabolism and Elimination from the Body:**
Many chemicals, which enter the body, are excreted unchanged. Others are broken down to other chemicals. The breakdown product may be more toxic or less toxic than the original chemical which entered the body.

Some chemicals and/or their by-products are stored temporarily in body organs and are removed over a short period of time as waste in the feces, urine, sweat or exhaled breath.

A few chemicals such as graphite or silica dusts can be inhaled into the lungs where they lodge for many years and may never be completely removed.

The longer a given hazardous material remains in the body, the greater potential that material has for causing harmful health effects.

5. **Biological Variation:**
Several characteristics of the exposed person can influence the degree of poisoning which can or cannot occur:

- Age
- Sex
- Species
- Body temperature
- Nutritional status
- Individual susceptibility
- Pathological status
6. **Amount or Dose Entering the Body:**

The amount of hazardous material entering the body is the most important factor, which determines whether or not a material will cause adverse health effects. The greater the amount of material which enters the body, the greater the potential for that material to cause harm. For example, an excessively large dose of table salt (sodium chloride) is capable of causing death, but we do not consider it to be toxic in future quantities in which it is normally consumed.

Exposure limits are used to gauge safe levels of exposure.

**Exposure Limits (TLV)**

Exposure limits are airborne concentrations of a material to which it is believed that nearly all workers may be exposed without experiencing any adverse effects. However, because some workers may be sensitive to the material, a percentage of workers may experience discomfort at or below the exposure limit and a smaller percentage may be affected more seriously by the aggravation of a pre-existing condition or illness.

Exposure limits known as Threshold Limit Values (TLV) have been established and these will be found in either the Regulation Respecting Control of Exposure to Biological and Chemical Agents (Reg. 654/86) or the respective Designated Substance Regulation.

There are 3 different types of TLVs:

1. **Time Weighted Average (TWA)**
   - The time weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be exposed, day after day, without adverse effect.

2. **Short Term Exposure Limit (STEL)**
   - A 15 minutes time weighted average exposure, which should not be exceeded at any time during a workday even if the 8-hour time weighted average, is within the TLV. Exposures at the STEL should not be longer than 15 minutes and should not be repeated more than 4 times a day. There should be at least 60 minutes between successive exposures at the STEL.

3. **Ceiling Exposure Limit (CEL)**
   - This applies to fast-acting and irritating substances, the concentration that should not be exceeded at any time even for an instant.
Health Effects

The health effects that can be produced by hazardous materials are many and very broadly, from a slight irritation to a burn, from effects that disappear in minutes or hours to permanent damage of body tissue. Health effects are categorized into two types:

1. **Acute Toxicity**
   These are health effects that develop either immediately or a short time after and exposure, usually within 24 hours. Health effects may be temporary (skin irritation, sickness or nausea), or they may be permanent (blindness scars from acid burns, mental impairment).

   - **Irritancy** - This is the capability to cause localized effects such as irritation, redness, or swelling at the site of contact on the skin, eyes, or mucosal areas. The severity of irritation can be mild, moderate, or severe. Chemical families that generally exhibit primary irritant qualities include amines and ketones. This information is important for the selection of skin and eye protection and emergency wash facilities.

2. **Chronic Toxicity**
   These are health effects that usually result from long term exposure to a small dose over many years (10+ years).

   The resulting injury or disease occurs because the exposure has taken place repeatedly over many years. It does not seem to be caused by sudden one-time exposures; i.e., the inhalation of asbestos fibers may cause asbestosis 20 years after the period of exposure.

   - **Sensitizing Capability** - A sensitizer is a substance that on first exposure likely causes little or no reaction in persons or test animals, but that on repeated exposure may cause a marked response not necessarily limited to the contact site. Skin sensitization is the most common form of sensitization in the industrial setting, although respiratory sensitization is also known. Isocyanates are an example of a family of sensitizers. Appropriate dermal and respiratory protective controls must be disclosed on the MSDS to prevent sensitization of workers.

   - **Carcinogenicity** - Carcinogenicity refers to the capability of a product to cause cancer in animals or people that are exposed to it. Substances classified as carcinogens appearing on current classification lists issued by either of two agencies, the American Conference of Governmental Industrial Hygienists or the International Agency for Research on Cancer.

     The “Guidelines for the Classification of Occupational Carcinogens” describes the three categories of carcinogens to which substances or industrial processes may be assigned:
     a) A1 - Confirmed Human Carcinogen
     b) A2 - Suspected Human Carcinogen
     c) A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans.
- **Teratogenicity and Embryotoxicity** - Teratogenicity and embryotoxicity refer to the capability of a product to produce injuries in offspring of pregnant women exposed to the product at a concentration that has no adverse effect on the mother. The MSDS will indicate any adverse effect on fetal development or reproductive parameters. Injuries include death, malformation, permanent metabolic or physiological dysfunction, growth retardation, or psychological or behavioural alteration that occurs during pregnancy, at birth, or in the postnatal period. The embryonic stage of the human fetus, during the first two to eight weeks of development, is particularly at risk of injury from such products. Methyl mercury is an example of a teratogen.

- **Reproductive Toxicity** - This is the ability of a material to cause reproductive toxicity (mutations, birth defects, sterility). Reproductive toxicity has implications for the capability to produce offspring as well as for teratogenicity and embryotoxicity.

- **Mutagenicity** - Mutagenicity is the capability of a product to cause mutations in the genetic material of living cells. Changes to reproductive (germ) cells may result in heritable genetic effects. Changes to non-reproductive (body or somatic) cells may be associated with increased risk of other effects such as cancer. Males or females of a species may be at risk of adverse effect upon exposure to a product that is mutagenic to the species. Results of tests on bacteria, insects, and cells, as well as in vivo tests on living mammals and epidemiology studies on human populations, must be disclosed on the MSDS.