Appendix B-Toxicology Overview

Chemical Toxicity

Toxicology is the study of the nature and action of chemical substances on living systems. Toxicity is the ability of a chemical molecule or compound to produce injury once it reaches a susceptible site in or on the body. Hazard is the probability or likelihood that injury will occur considering the manner in which the substance is used.

Dose-Response Relationships

The potential toxicity (harmful action) inherent in a substance is manifest only when that substance comes in contact with a susceptible living biological system. A chemical normally thought of as "harmless" will evoke a toxic response if added to a biological system in sufficient amount. The toxic potency of a chemical is defined by the relationship between the dose (the amount) of the chemical and the response that is produced in a biological system.

Routes of Entry into the Body

There are three main routes by which hazardous chemicals enter the body:

- absorption through the respiratory tract through inhalation.
- absorption or injection through the skin or eyes.
- absorption through the digestive tract. This can occur through eating or smoking with contaminated hands or in contaminated work areas.

Most exposure standards, Threshold Limit Values (TLVs) and Permissible Exposure Limits (PELs), are based on the inhalation route of exposure. They are normally expressed in terms of either parts per million (ppm) or milligrams per cubic meter (mg/m³) concentration in air.

If a significant route of exposure for a substance is through skin contact, the MSDS will have a "skin" notation associated with the listed exposure limit. Examples include: some pesticides, carbon disulfide, phenol, carbon tetrachloride, dioxane, mercury, thallium compounds, ethylene, hydrogen cyanide.

Health Effects

Acute poisoning is characterized by rapid absorption of the substance and the exposure is sudden and severe. Normally, a single large exposure is involved. Examples: carbon monoxide or cyanide poisoning.

Chronic poisoning is characterized by prolonged or repeated exposures of a duration measured in days, months or years. Symptoms may not be immediately apparent. Examples: lead or mercury poisoning or pesticide exposure.

“Local” refers to the site of action of an agent and means the action takes place at the point or area of contact. The site may be skin, mucous membranes, the respiratory tract, gastrointestinal system, eyes, etc. Absorption does not necessarily occur. Examples: some strong acids or alkalis.
“Systemic” refers to a site of action other than the point of contact and presupposes absorption has taken place. For example, an inhaled material may act on the liver. Example: arsenic affects the blood, nervous system, liver, kidneys and skin.

Cumulative poisons are characterized by materials that tend to build up in the body as a result of chronic exposure. The effects are not seen until a critical body burden is reached.

Example: heavy metals (such as Lead).

Synergistic responses: When two or more hazardous material exposures occur, the resulting effect can be greater than the effect of the individual exposures. Example: exposure to both asbestos and tobacco smoke, producing lung cancer or mesothelioma.

Other Factors Affecting Toxicity

Rate of entry and route of exposure (how fast the toxic dose is delivered and by what means) are important factors. A person’s age can affect the capacity to repair tissue damage. Previous exposures can lead to tolerance or increased sensitivity.

General state of health, physical condition, and life style, can affect the toxic response. Preexisting disease can result in increased sensitivity.