***Industrial hygiene***

Industrial hygiene is that science and art devoted to the anticipation, recognition, evaluation, and control of those environmental factors or stresses arising in or from the workplace that may cause sickness, impaired health and well-being, or significant discomfort among workers or among the citizens of the community.

The industrial hygienist is involved in the monitoring and analysis required to detect the extent of exposure, and the engineering and other methods used for hazard control.

Industrial hygiene includes the development of corrective measures in order to control health hazards by either reducing or eliminating the exposure. These control procedures may include the substitution of harmful or toxic materials with less dangerous ones, changing of work processes to eliminate or minimize work exposure, installation of exhaust ventilation systems, good housekeeping (including appropriate waste disposal methods), and the provision of proper personal protective equipment.

An effective industrial hygiene program involves the anticipation and recognition of health hazards arising from work operations and processes, evaluation and measurement of the magnitude of the hazard (based on past experience and study), and control of the hazard.

**Typical roles of the industrial hygienist include:**

➢ Investigating and examining the workplace for hazards and potential dangers

➢ Making recommendations on improving the safety of workers and the surrounding community

➢ Conducting scientific research to provide data on possible harmful conditions in the workplace

➢ Developing techniques to anticipate and control potentially dangerous situations in the workplace and the community

➢ Training and educating the community about job related risks

➢ Advising government officials and participating in the development of regulations to ensure the health and safety of workers and their families

➢ Ensuring that workers are properly following health and safety procedures

## ENVIRONMENTAL FACTORS OR STRESSES

The various environmental factors or stresses that can cause sickness, impaired health, or significant discomfort in workers can be classified as chemical, physical, biological, or ergonomic.

**Chemical hazards.** These arise from excessive airborne concentrations of mists, vapors, gases, or solids in the form of dusts or fumes. In addition to the hazard of inhalation, some of these materials may act as skin irritants or may be toxic by absorption through the skin.

**Physical hazards.** These include excessive levels of nonionizing radiation, ionizing radiation, noise, vibration, and extremes of temperature.

**Ergonomic hazards.** These include improperly designed tools, work areas, or work procedures. Improper lifting or reaching, poor visual conditions, or repeated motions in an awkward position can result in accidents or illnesses in the occupational environment. Designing the tools and the job to fit the worker is of prime importance. Engineering and biomechanical principles must be applied to eliminate hazards of this kind .

**Biological hazards.** These are any living organism or its properties that can cause an adverse response in humans. They can be part of the total environment or associated with a particular occupation.

## Chemical Hazards

The majority of occupational health hazards arise from inhaling chemical agents in the form of vapors, gases, dusts, fumes, and mists, or by skin contact with these materials. The required information can be obtained from the Material Safety Data Sheet (MSDS) that must be supplied by the chemical manufacturer or importer for all hazardous materials under the OSHA hazard communication standard. If the MSDS or the label does not give complete information but only trade names, it may be necessary to contact the manufacturer to obtain this information.

Many industrial materials such as resins and polymers are relatively inert and nontoxic under normal conditions of use, but when heated or machined, they may decompose to form highly toxic by-products.

Breathing of some materials can irritate the upper respiratory tract or the terminal passages of the lungs and the air sacs, depending upon the solubility of the material. Contact of irritants with the skin surface can produce various kinds of dermatitis. Other gases and vapors can prevent the blood from carrying oxygen to the tissues or interfere with its transfer from the blood to the tissue, thus producing chemical asphyxia or suffocation. Carbon monoxide and hydrogen cyanide are examples of chemical asphyxiants. Some substances may affect the central nervous system and brain to produce narcosis or anesthesia. In varying degrees, many solvents have these effects. Substances are often classified, according to the major reaction they produce, as asphyxiants, systemic toxins, pneumoconiosis producing agents, carcinogens, irritant gases, and so on.

## Solvents :

Solvent vapors enter the body mainly by inhalation, although some skin absorption can occur. The vapors are absorbed from the lungs into the blood and are distributed mainly to tissues with a high content of fat and lipids, such as the central nervous system, liver, and bone marrow.

Solvents include aliphatic and aromatic hydrocarbons, alcohols, aldehydes, ketones, chlorinated hydrocarbons, and carbon disulfide.

The severity of a hazard in the use of organic solvents and other chemicals depends on the following factors:

- How the chemical is used
- Type of job operation, which determines how the workers are exposed
- Work pattern
- Duration of exposure
- Operating temperature
- Exposed liquid surface
- Ventilation rates
- Evaporation rate of solvent
- Pattern of airflow

- Concentration of vapor in workroom air
- Housekeeping.

Dangerous materials are chemicals that may, under specific circumstances, cause injury to persons or damage to property because of reactivity, instability, spontaneous decomposition, flammability, or volatility. Under this definition, we will consider substances, mixtures, or compounds that are explosive, corrosive, flammable, or toxic.

Dangerous gases are those that can cause lethal or injurious effects and damage to property by their toxic, corrosive, flammable, or explosive physical and chemical properties. Storage of dangerous chemicals should be limited to one day's supply, consistent with the safe and efficient operation of the process

**TOXICITY VERSUS HAZARD**

Toxicity and hazard differ.Toxicologists consider toxicity as the ability of a substance to produce an unwanted effect when the substance has reached a sufficient concentration at a certain site in the body; **hazard** is regarded as the probability that this concentration will occur at that site. Many factors contribute to determining the degree of hazard—route of entry, quantity of exposure, physiological state, environmental variables, and other factors. Assessing a hazard involves estimating the probability that a substance will cause harm.

In addition to establishing toxicity, evaluation of a chemical hazard involves establishing the amount and duration of exposure, the physical characteristics of the substance, the conditions under which exposure occurs, and the determination of the effects of other substances in a combined exposure. All of these may significantly influence the toxic potency of a substance.

Chemical injury can be local or systemic, and the toxicological reactions can be slight or severe. Local injury results from direct contact of the irritant with tissue. The skin can be severely burned or the surface of the eye can be injured to the extent that vision is impaired. In the respiratory tract, the lining of the trachea and the lungs can be injured as a result of inhaling toxic amounts of vapors, fumes, dusts, or mists.

## ENTRY INTO THE BODY:

In discussing toxicity, it is necessary to know how a substance enters the body and, if relevant, the bloodstream. For an adverse effect to occur, the toxic substance must first reach the organ or bodily site where it causes damage. Common "routes of entry" are inhalation, skin absorption, ingestion, and injection. Depending on the substance and its specific properties, however, entry (absorption) can occur by more than one route, such as inhaling a solvent that can also penetrate the skin.

### ❖ Inhalation

For industrial exposures, a major, if not predominant route of entry is inhalation. Any airborne substance can be inhaled.

The respiratory system is composed of two main areas: the upper respiratory tract airways (the nose, throat, trachea, and major bronchial tubes leading to the lobes of the lungs) and the alveoli, where the actual transfer of gases across thin cell walls takes place. For particles, only those smaller than about 5 μm in diameter are likely to enter the alveolar sac.

The total amount of a toxic compound absorbed via the respiratory pathways depends on its concentration in the air, the duration of exposure, and the pulmonary ventilation volumes, which increase with higher workloads.

### ❖ Skin Absorption

An important route of entry for some chemicals is absorption through skin. Contact of a substance with skin results in these four possible actions:

➢ The skin can act as an effective barrier

➢ The substance can react with the skin and cause local irritation or tissue destruction

➢ The substance can produce skin sensitization

➢ The substance can penetrate skin to reach the blood vessels under the skin and enter the bloodstream.

The cutaneous absorption rate of some organic chemicals rises when temperature and perspiration increase. Therefore, absorption can be higher in warm climates or seasons. High temperatures generally increase skin absorption by increasing vasodilation and sweating. If the skin is damaged by abrasion dermatitis, the normal protective barrier to absorption of chemicals is lessened and penetration occurs more easily.

### ❖ Ingestion

The problem of ingesting chemicals is not widespread in industry; most workers do not deliberately swallow materials they handle. Nevertheless, workers can ingest toxic materials as a result of eating in contaminated work areas; contaminated fingers and hands can lead to accidental oral intake when a worker eats or smokes on the job. Toxicity after ingestion is generally lower than the inhalation toxicity for the same dose and substance because absorption of many substances across the intestinal wall and into the bloodstream is relatively poor. Food and liquid mixed with a toxic substance not only provide dilution, but can combine with it to form less soluble substances. Also, action of digestive acids and enzymes can chemically alter the substance and reduce its toxicity.

### ❖ Injection

Although infrequent in industry, a substance can be injected into some part of the body. This can be done directly into the bloodstream, peritoneal cavity, pleural cavity, skin, muscle, or any other place a needle or high-pressure orifice can reach.
The effects produced vary with the location of administration In industrial settings, injection is an infrequent route of worker chemical exposure.
There is increasing attention to prevention of skin puncture and injection injuries associated with bloodborne pathogens (hepatitis B, HIV, and hepatitis C). Risk of infection is significant following accidental skin puncture by a needle or instrument contaminated with infected blood or tissue.

### Lethal Dose

If a number of animals are exposed to a toxic substance, when the concentration reaches a certain level, some but not all of those animals will die. Results of such studies are used to calculate the lethal dose (LD) of toxic substances. The LD50 is the calculated dose of a substance that is expected to kill 50 percent of a defined experimental animal population, as determined from the exposure to the substance by any route other than inhalation.
Several designations can be used, such as LD50, LD0, LD100, and so on. The designation LD0, which is rarely used, is the concentration that produces no deaths in an experimental group and is the highest concentration tolerated in animals; LD100 is the lowest concentration that kills 100 percent of the exposed animals. Although LD50

is the concentration that kills half of the exposed animals, it does not mean that the other half are in good health.

## THRESHOLD LIMIT VALUES

Threshold Limit Values® (TLVs) are exposure guidelines established for airborne concentrations of many chemical compounds. The health and safety professional or other responsible person should understand something about TLVs and the terminology in which their concentrations. TLVs are 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 effect. Control of the work environment is based on the assumption that for each substance there is some safe or tolerable level of exposure below which no significant adverse effect occurs. These tolerable levels are called Threshold Limit Values.
Three categories of Threshold Limit Values are specified as follows:

- **TIME-WEIGHTED AVERAGE (TLV–TWA)**

The permissible exposure limit (PEL) is a legal limit for exposure of an employee to a substance (i.e. chemicals, dusts, fumes, gases, mists, or vapors) or agent (i.e. occupational noise). PELs are expressed in parts per million (ppm) or milligrams per cubic meter (mg/m3). A PEL is usually given as a time-weighted average (TWA), which is the average exposure workers have to a substance without experiencing significant adverse health effects over the standardized work period (an eight-hour a day, 40-hour per week work schedule).

**SHORT-TERM EXPOSURE LIMIT (TLV–STEL)**

This is the concentration to which it is believed workers can be exposed continuously for a short period of time without suffering from:

➢ Irritation

➢ Chronic or irreversible tissue damage

➢ Narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue, or materially reduce work efficiency and provided that the daily TLV–TWA is not exceeded