Industrial Safety

Health and toxic substances

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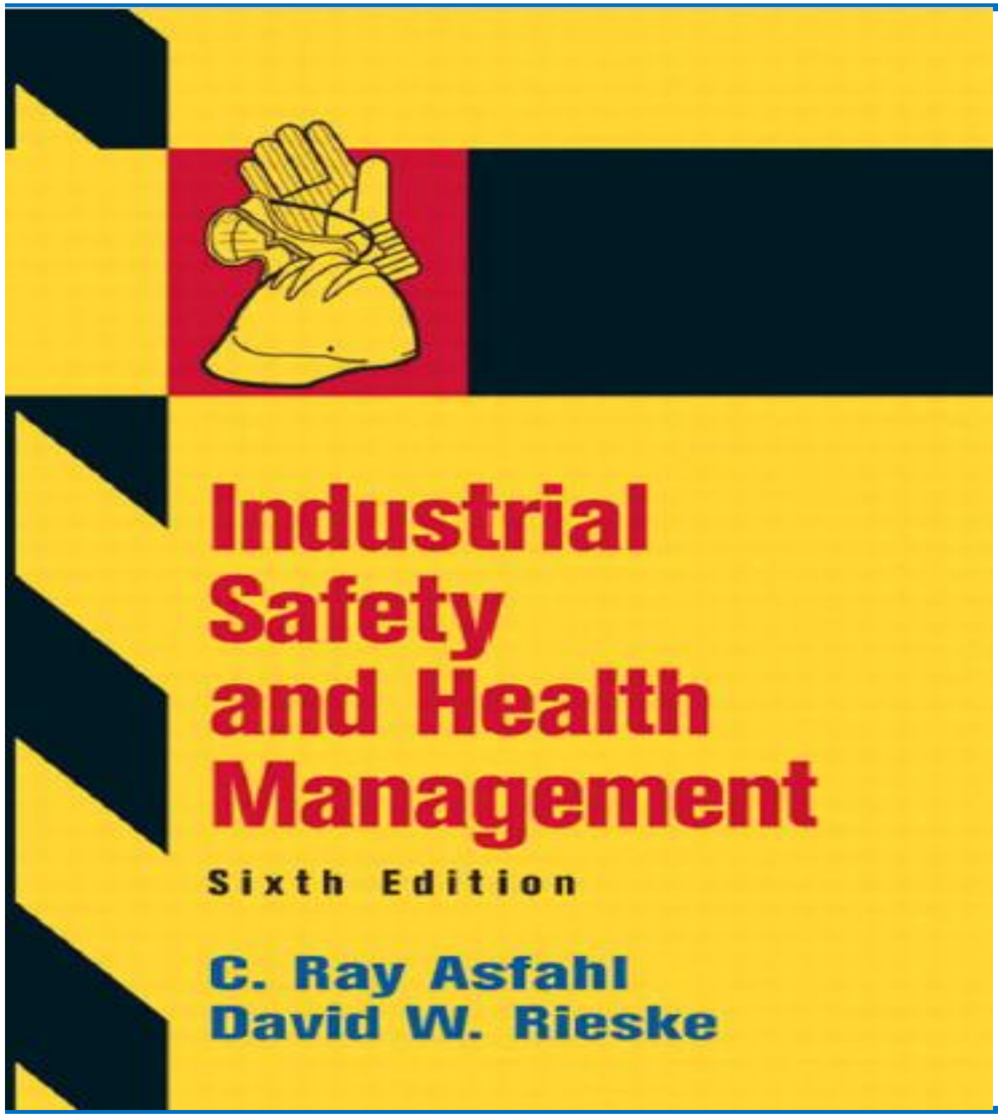
PPE
Personal Protective Equipment

OSHA®

Think Safety. Act Safely.

CHAPTER 9 Health and Toxic Substances



Baseline Examinations

- Almost everyone has taken a pre-employment physical examination
- Employee’s baseline health status is established by this examination
- This status give a green or red light whether to accept this employee in the job or not from medical point of view

Toxic substances

- Exposure to toxic substances is the classical “health problem”.
- The term “hazardous materials” is sometimes used to refer to toxic substances.
- The term “materials” is associated with safety hazards, while the term “substances” is associated with health hazards
- Safety and health managers need to have a general knowledge of what various types of toxic substances can do to the body.

Irritants

- Inflame the surfaces of the parts of the body by their corrosive action.
- Irritants not only affect the skin, but also the lungs.
- When the irritant is some type to dust, the lung disease that result is called pneumoconiosis.
- This term – pneumoconiosis – is a general term that includes reactions to simple nuisance dusts that cause fibrosis of scar tissue that impairs the efficiency of the lung.
- Iron oxide dust, tin dust, cotton dust, aluminum dust, asbestos dust

Irritants

- Ammonia has a strong odor.
- Ammonia gas the moisture on the mucous membranes of the body combine to form ammonium hydroxide, a strongly caustic agent. It affects nose and lungs.
- Chlorine gas is a well-known irritant such as fluorine and bromine.
- Chronic exposure to irritants over a long period can cause scar tissue to develop in the lungs.
- Scaring agents are in the form of tiny solid particles, and their action on the lungs is mechanical.

Systemic Poisons

- Are more insidious than irritants.
- Poisons attack vital organs or systems of organs.
- Lead is the most dangers poisons. It attacks the blood, the digestive system, and the central nervous system including the brain.
- Other types of systemic poisons are: mercury, cadmium, and manganese. They attack the kidneys and liver.
- Other important types are carbon disulfide, and methanol. They attack the nervous system of the body.

Depressants

- Certain substances act as depressants or narcotics on the central nervous system.
- Unlike systemic poisons discussed earlier, the effect of the depressants on the central nervous system is temporary.
- Most familiar depressant is ethanol.
- Acetylene, the most widely used fuel gas for welding, has a great effect as safety hazard (flammable and explosive) more than health hazard.
- Benzene is very popular as industrial solvent. It acts as depressant on the central nervous system. Also, it is a dangerous fire and explosion hazard.

Asphyxiants

- Simple asphyxiants
  - Asphyxiats prevent oxygen from reaching the body's cells.
  - Any gas can be an asphyxiant if there is enough of it to crowd out the essential proportion of oxygen in the air.
  - Carbon dioxide is one of the most important simple asphyxiant, although in normal quantities it is a harmless constituent of air.
- Chemical asphyxiants
  - It interferes with oxygenation of the blood in the lungs or the body's tissues.
  - Carbon monoxide is the most important chemical asphyxiant. *engine exhaust)
  - It is difficult to detect carbon monoxide using instruments. Also, it is colorless, tasteless, and non irritating.

Carcinogens

- Carcinogens are substances that are known to cause or are suspected to cause cancer.
- One of the frightening things about carcinogens is that cancer has such a long latency period. Sometimes a lapse of 20 or even 30 years occurs between exposure and the appearance of cancerous.
- Vinyl chloride is a type of carcinogens. It is sever explosion hazard. When it burns, it is very difficult to extinguish.
- Chronic inhalation cause a form of cancer of the liver.

Air contaminates

- The greatest concern with toxic substances in the workplace.
- Four types:
  - Gases, easily contaminate the air because air consists of gases and gases readily mix.
  - Vapors, are normally liquids or even perhaps solids that release small quantities of gases into surrounding air.
  - Mists, tiny droplets of liquids, so small that they remain suspended in the air for long periods, as in cloud.
  - dusts

Threshold limit values

- Since no poison is lethal in small enough doses, and all poisons are lethal in large enough does, no clear cut line separates the harmful from the benign worker environment.
- Threshold Limit Values (TLV) refers to the level of concentration below which the worker cloud be exposed to during the entire workday without significant harm.
- TLV varies according to the type of poison and air contaminant. (TVL booklet)
- These values is agreed by the American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit values

- Recommended Exposure Levels (RELs)
- The same as TLV, but it is agreed by National Institute for Occupational Safety and Health.
- Permissible Exposure Limits (PEL)

Threshold Limit Values

- There is no clear-cut line separates the harmful from the benign worker environment.
- For airborne contaminants, it becomes necessary to identify some levels of concentration below which one need not worry about worker exposures.
- Threshold Limit Value (TLV) evolved and refers to the level of concentration below which the worker could be exposed to during the entire workday without significant harm.
- Every toxic substance has its own TLV

Threshold Limit Values

- For known substances, there is a listed TLV, which is a value agreed on by a committee of the American Conference of Governmental Industrial Hygienists (ACGIH) and is listed in the TLV booklet.

Recommended Exposure Levels

- The same as TLV by it is agreed by NIOSH.
- OSHA relies primarily on the ACGIH list of TLVs.
- NIOSH agency performs research and make recommendations to OSHA for new standards.
- NIOSH proposed “Recommended Exposure Levels (RELs)”, which suggest the limits of exposure to substances it considers harmful.

Measures of Exposure

- How to measure the level of exposure that the workers are subjected to ?
- Time-weighted Averages (TWAs)
  - Is a measure of air-contaminant exposures
  - It is a computed weighted-average concentration over an 8-hour shift.

$$E = \frac{\sum_{i=1}^{n} C_i \, T_i}{8} = \frac{C_1T_1 + C_2T_2 + \cdots + C_nT_n}{8}$$

  - E= equivalent 8-hours time-weighted-average concertation
  - C_i=observed concentration of the contaminant in time period i
  - T_i=length of time period i
  - n=number of time periods studied

Measures of Exposure (Example)

- Calculate the 8-hour full shift TWA for the concentrations shown

Time period (i)	Observed concentration	Length of period (hrs)	C X T
1	2	1.5	3
2	4	2.5	10
3	7	1	7
4	5	2	10
5	3	1	3
Total		8	33

$$E = \frac{33}{8} = 4.125$$

Measures of Exposure (Example)

- The previous case considers only one toxic substances, what if a mixture of substances?
- To consider the effect of combinations of toxic substances:

$$E_m = \sum_{i=1}^{n} \frac{C_i}{L_i}$$

  - E_m= calculated equivalent ration for the entire mixture
  - C_i=Concentration of contaminant i
  - L_i=Permissable Expsure Level (PEL) for contaminant i
  - n=number of contaminants present in atmosphere
- E_m is not permitted to exceed 1

Measures of Exposure (Example)

- Calculate the equivalent concentration of the following mixture:

	Nitric acid	Sulfuric acid	Acetic acid
Contaminant	1	2	3
Concentration	4	0.9	22
Limit	5	1	25

$$E_m = \sum_{i=1}^{n} \frac{C_i}{T_i} = \frac{4}{5} + \frac{0.9}{1} + \frac{22}{25} = 2.58$$

- The concentration of the mixture exceeds the PEL, even though the individual PELs are not exceeded

Previous problems are Case studies

- 9.3
- 9.4

Ceiling Levels and STELs

- Ceiling value or Maximum Acceptable Ceiling (MAC), is an exposure limit that should never be exceeded
- Short Term Exposure Limit (STEL), the maximum concentration permitted for a specified duration, usually 15 minutes

TOLUENE	
TWA	200 ppm
MAC	300 ppm
STEL	500 ppm for 10 minutes

Units

- For most of gases, the units are ppm or parts per million (volume measurement)
- For liquids and some solids, it is measured by mg/m^3 (Weight measurement)

$$ppm = \frac{mg/m^3 \times 24.45}{MW}$$

- Where MW is the molecular weight of the substance

Standard Completion Project

- For few substances, OSHA has taken more comprehensive approach by issuing ***detailed standards***, each of which is devoted to the control of one particular hazardous substances.
- These standards are called “Standard Completion Project”, and they are revised every particular time.

Detecting Contaminants

- How to detect contaminants in your workplace?
  - Sense of Smell, however, it is not enough to detect some toxic substances. (carbon dioxide, nitrogen, methane)
  - Examine technical literature to determine which industries might release what substances
  - Analyze the process within the plant to determine potential leaks into the industrial atmosphere
  - Air sampling and testing are the way to determine concentrations as accurately as possible.

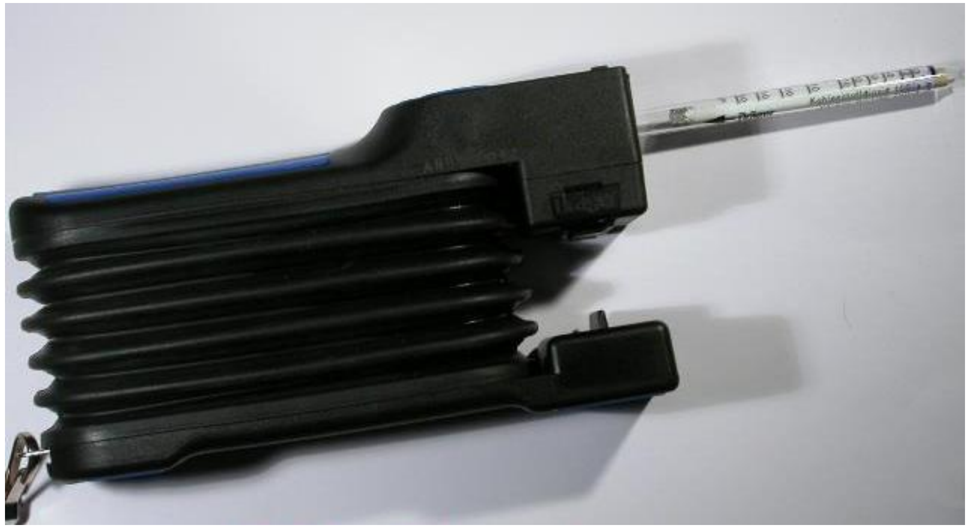
Measurement Strategy

- Once the existence of an air-contaminant risk has been determined, a procedure is needed to go about taking samples, measuring employee exposure, and instituting controls.
- Safety has stimulated the electronics and instrumentation industries to develop new and more precise instruments for determining concentrations. From ppm to ppb.
- Old methods:
  - Mouse in cage are used in mines, if the animal died, the workers were alerted to the hazard.
  - A flame safety lamp was used to test for oxygen deficiency; the flame would die if the oxygen proportion in the atmosphere was too law

Measurement instruments

- Now:
  - Direct-reading instruments
  - Sampling with detector tubes
  - Sampling with subsequent laboratory
  - Dosimeters
- Direct-reading instruments provide on-the-spot reading to determine whether an atmosphere is safe from dangerous exposures.
- Sampling with detector tubes is feasible for on-site assessment of existing concentrations. Detector tube contains a chemical that reacts to the suspected contaminant if present.

Measurement instruments



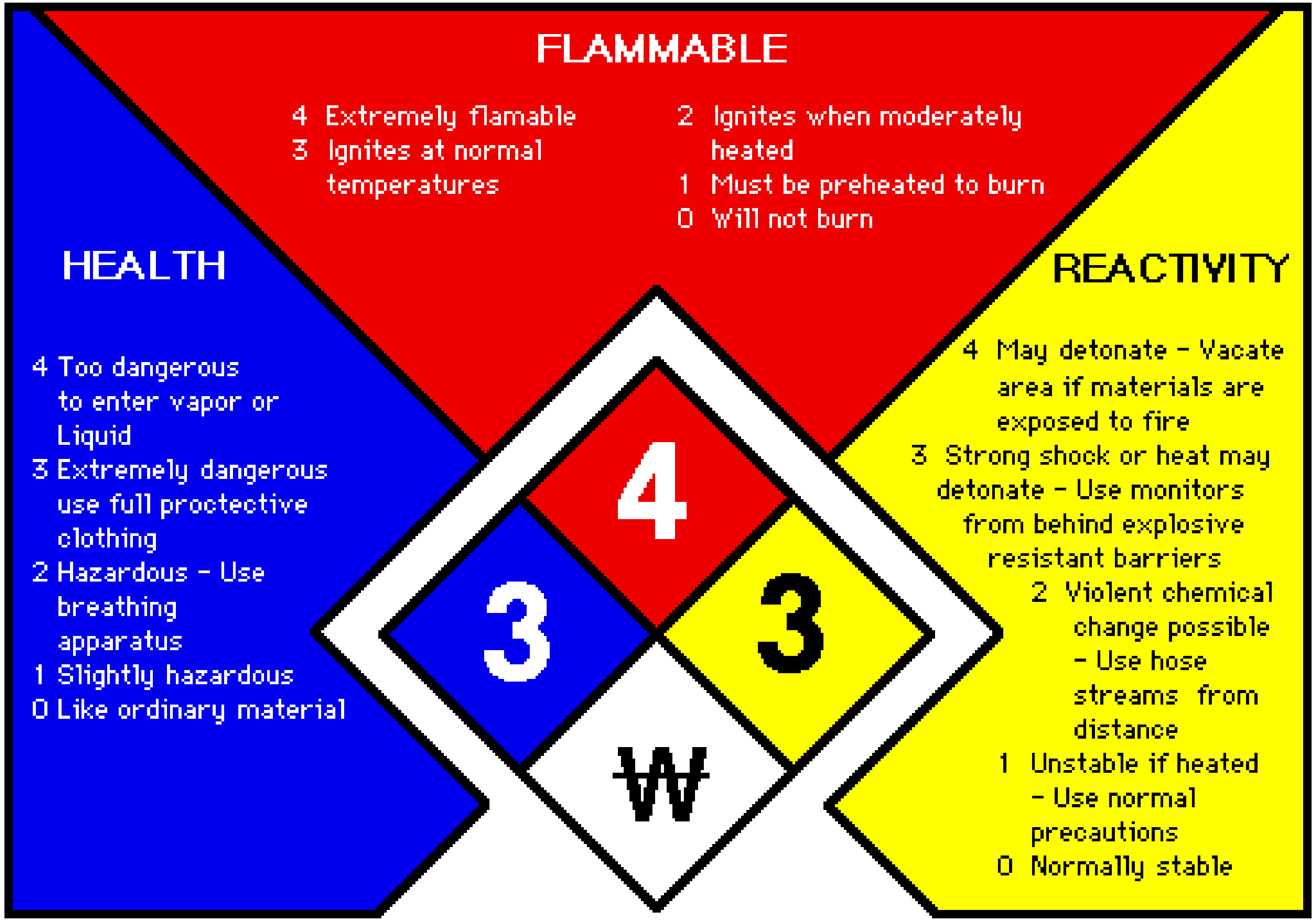
Measurement instruments

- For more obscure contaminants and for rarer concentrations, sampling devices and laboratory analysis must be used.
- Dosimeters are small collectors worn on the worker's body or clothing and that collects a time-weighted-average exposure over a specified time period, such as a full shift.

MSDS Diamond

- The National Fire Protection Association (NFPA) developed a ***hazard identification system*** for emergency responders that is still in use today.
- The NFPA diamond provides a quick visual representation of the **health** hazard, **flammability**, **reactivity**, and **special hazards** that a chemical may pose during a fire

MSDS Diamond



MSDS Diamond

- The NFPA diamond consists of four color-coded fields: blue, red, yellow, and white. The blue, red, and yellow fields—which represent health hazard, flammability, and reactivity, respectively—use a numbering scale ranging from 0 to 4. A value of 0 means that the material poses essentially no hazard, whereas a rating of 4 indicates extreme danger. The white field is used to convey special hazards.
- higher values in the NFPA system indicate higher hazards

MSDS Diamond

BLUE Diamond Health Hazard	RED Diamond Fire Hazard
4 Deadly **3** Extreme Danger **2** Hazardous **1** Slightly Hazardous **0** Normal Material	**4** Below 73 °F **3** Below 100 °F **2** Above 100 °F Not Exceeding 200 °F **1** Above 200 °F **0** Will Not Burn
YELLOW Diamond Reactivity	**WHITE Diamond Special Hazard**
4 May Detonate **3** Shock and Heat; May Detonate **2** Violent Chemical Change **1** Unstable if Heated **0** Stable	**ACID** – Acid **ALK** – Alkali **COR** – Corrosive **OXY** – Oxidizer ☢ – Radioactive **W** – Use No Water