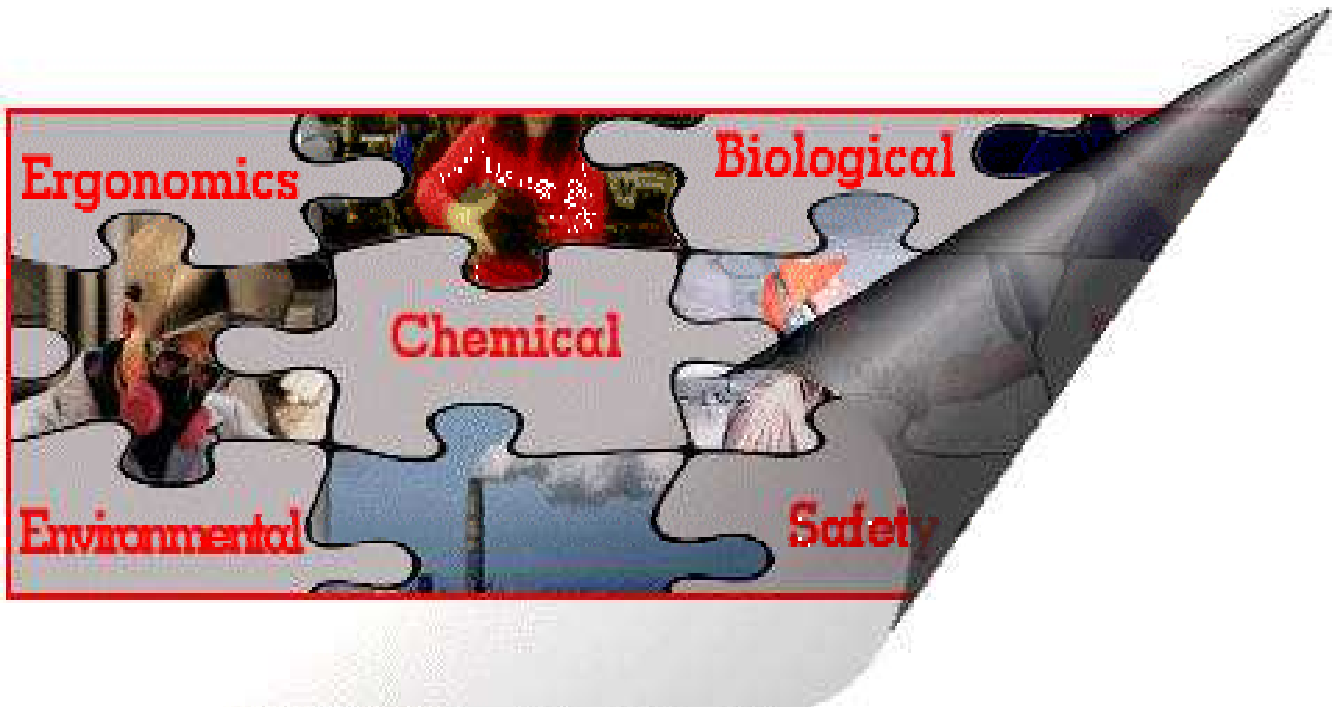


Introduction to

Industrial Hygiene *for* **Non-IH** *the*

A Practical Guide Without the Big Words



Presented by the Public Education Section
Department of Business and Consumer Business
Oregon OSHA



OR-OSHA Mission Statement

To advance and improve workplace safety and health for all workers in Oregon.

Consultative Services

- Offers no-cost on-site safety and health assistance to help Oregon employers recognize and correct safety and health problems in their workplaces.
- Provides consultations in the areas of safety, industrial hygiene, ergonomics, occupational safety and health programs, new-business assistance, the Safety and Health Achievement Recognition Program (SHARP), and the Voluntary Protection Program (VPP).

Enforcement

- Offers pre-job conferences for mobile employers in industries such as logging and construction.
- Provides abatement assistance to employers who have received citations and provides compliance and technical assistance by phone.
- Inspects places of employment for occupational safety and health rule violations and investigates workplace safety and health complaints and accidents.

Appeals, Informal Conferences

- Provides the opportunity for employers to hold informal meetings with OR-OSHA on workplace safety and health concerns.
- Discusses OR-OSHA's requirements and clarifies workplace safety or health violations.
- Discusses abatement dates and negotiates settlement agreements to resolve disputed citations.

Standards & Technical Resources

- Develops, interprets, and provides technical advice on safety and health standards.
- Provides copies of all OR-OSHA occupational safety and health standards.
- Publishes booklets, pamphlets, and other materials to assist in the implementation of safety and health standards and programs.
- Operates a Resource Center containing books, topical files, technical periodicals, a video and film lending library, and more than 200 databases.

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- Conducts conferences, seminars, workshops, and rule forums.
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Industrial Hygiene for the non-IH

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Industrial Hygiene for the non-IH

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- B. What an IH does
- C. Older than Methuselah...a bit of history
- D. A specialty in great demand...some reasons why

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- A. OSHA sets standards
- B. IH's do the research for OSHA
- C. Four Roles of the OSHA IH

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- A. Perform a Work-site Analysis
- B. Evaluate Possible Controls and make recommendations
- C. Work with the employer to implement and verify effectiveness of controls
- D. Role of the Safety Committee

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- B. Risk
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 - 2. Dose
 - 3. Route of Exposure
- C. Dose-Response
- D. Exposure Standards and Guidelines

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Industrial Hygiene for the non-IH

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- B. Recognize
- C. Evaluate
- D. Control
- E. Step-by-Step Example

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Industrial Hygiene for the non-IH

A Practical Guide Without the Big Words

Introduction

OSHA regulations set limits regarding hazards an employee can be exposed to in the course of a workday. These regulations require the employer to ensure a safe, healthful workplace and, in many cases, ***to document how they did it.***

Many of these hazards are elusive. You can look, listen, sniff, touch and taste all you want and still be clueless about whether a hazard actually exists.

Since it's impossible to tell just by using your senses, an employer must find other means to deal with these hazards, and...voila! Enter the Industrial Hygienist!

It's reassuring to know that it's not your job to get good at sampling with complex equipment and performing higher math computations.

Your Responsibility is to Get Good at recognizing when you need to request the services of an IH. Let them do a thorough job of characterizing the hazard(s). Then use their results as a guide for implementing effective controls.

Workshop Objectives:

By the end of this workshop you should be able to demonstrate:

1. Knowledge and understanding of the skills of an IH and when to request assistance.
2. Ability to anticipate potential hazards where the skills of an IH are recommended.
3. Basic understanding of the major hazard categories an IH is called upon to evaluate.
4. How to decide when to request the services of an IH.

A. What Industrial Hygiene is...



...the science of **Anticipating, Recognizing, Evaluating, and Controlling** workplace conditions that may cause workers

I Injuries or I Illnesses

Chapter 1: The Basics

- A. What Industrial Hygiene is...
- B. What an IH does...
- C. Older than Methuselah; a bit of history...
- D. A specialty in great demand; some reasons why...

Chapter 1

Our ancestors were well aware of the safety hazards associated with swords, catapults with no guards and the crunch of two-ton pyramid blocks on sandal toes.

A broken arm or leg was usually pretty obvious, even to the untrained eye. It was the stuff they *couldn't* see that worried them most.

They had no way of knowing about things they couldn't see. **And yet...**they knew something wasn't right.

As early as the Fourth Century **B.C.** they recognized something was wrong in the lead mines.

Legends abounded about mines being inhabited by "demons", which sucked air out of miners' lungs and blew out candles.

People believed these demons could be controlled by fasting and prayer.



B. What an IH does...

An industrial hygienist might well be described as part medical scientist, part detective, part engineer.

Medical Scientist

→ Extensive training gives an IH the knowledge and skill to look at a work process or condition and make educated guesses about what hazards might exist.

Detective

→ The IH is a detective, seeking information about workplace hazards. Environmental monitoring and analytical methods are used to detect the extent of worker exposure.

Engineer

→ Finally, the IH recommends engineering and work-practice controls as well as other methods to control potential health hazards.

Chapter 1: The Basics

A. What Industrial Hygiene is...

B. What an IH does...

C. Older than Methuselah; a bit of history...

D. A specialty in great demand; some reasons why...

The Industrial Hygienist:



A _____
R _____
E _____
C _____

...workplace hazards or stressors that cause sickness, impaired health or significant discomfort in workers through chemical, physical, biological and/or ergonomic exposures.

C. Older than Methuselah...a bit of history

1. In the Beginning...

- **400 B.C.**...Hippocrates takes note of lead toxicity in the mining industry.
- **100 A.D.**...Pliny the Elder, a Roman scholar gets a clue about sickness from working with zinc and sulfur.

He invents the world's first face mask made from pigs' bladders. Workers are less than excited about this new technology.
- **200 A.D.**...Galen, a Greek Physician, accurately describes the pathology of lead poisoning. He also recognizes the hazardous exposures of copper miners to acid mists.

Chapter 1: The Basics

- A. What Industrial Hygiene is...
- B. What an IH does...
- C. Older than Methuselah; a bit of history...
- D. A specialty in great demand; some reasons why...

2. Halfway to Now...the Middle Ages

- **1500 A.D.**...*Paracelsus* shows up and coins the word "toxicon". He becomes known as the father of Toxicology when he is quoted by CNN: →
- **1556 A.D.**...Books get written. The German scholar, *Agricola*, in his book *De Re Metallica*, describes the diseases of miners and prescribes preventive measures.

The book includes suggestions for mine ventilation and worker protection, discusses mining accidents and describes diseases associated with mining, such as silicosis.
- **1700 A.D.**...*De Morbis Artificum Diatriba (The Diseases of Workmen)* is written by *Bernardo Ramazzini*. He's considered to be the father of Industrial Hygiene.

"All substances are poisons; there is none which is not a poison. The right dose differentiates a poison from a remedy"

C. Older than Methuselah...a bit of history

3. Modern Times, like, you know, the Twentieth Century

- **circa 1900...Dr. Alice Hamilton** pushes for social responsibility for workers' health and safety. She startles mine and factory owners and state officials with evidence of a direct correlation between worker illness and their exposure to toxins.
- **1908-1911....**States pass the first compensation acts for certain civil employees.
By 1948, most states have some type of compensation coverage for workers contracting occupational diseases.
- **1913...**The New York Department of Labor and Ohio Department of Health establish the first state industrial hygiene programs.

Chapter 1: The Basics

- A. What Industrial Hygiene is...
- B. What an IH does...
- C. Older than Methuselah; a bit of history...**
- D. A specialty in great demand; some reasons why...

Three Federal Legislative Milestones

- 1. The Metal and Nonmetallic Mines Safety Act of 1966***
- 2. The Federal Coal Mine Safety and Health Act of 1969***
- 3. The Occupational Safety and Health Act of 1970***

**D. IH is a specialty in great demand.
Four reasons why...**

- ➔ The IH has a unique ability to provide specific recommendations to reduce exposures or eliminate problems altogether.
- ➔ Employers need to comply with OSHA requirements.
- ➔ Management needs to verify their work environments are “non-hazardous” with measurable, objective data.
- ➔ Public Relations...the public’s right to know; demand is increasing to know and understand the potential hazards of industrial and manufacturing facilities within or near their communities in order to anticipate potential problems.

Chapter 1: The Basics

- A. What Industrial Hygiene is...
- B. What an IH does...
- C. Older than Methuselah; a bit of history...
- D. A specialty in great demand; four reasons why...**



OSHA has relied on the skills of the IH from the beginning.

Hardly ever, it seems, can you have a discussion about OSHA requirements without the mention of Industrial Hygiene.

There are several good reasons why...

A. OSHA sets standards...

- It develops and sets mandatory safety and health requirements applicable to the more than six million workplaces in the U.S.

B. OSHA relies on the IH to do the research.

C. The IH has Four Roles in OSHA:

- Develop and recommend what standards OSHA should adopt;
- Set up field enforcement procedures and conduct enforcement inspections;
- Provide no-cost consultative expertise to employers;
- Issue technical interpretations of OSHA regulations and standards;

Chapter 2: How are IH and OSHA related?

A. OSHA sets standards.

B. IH's do the research.

C. Four Roles of the OSHA Industrial Hygienist

Chapter 2

A. Worksite Analysis: Four steps...

A worksite analysis is an essential first step that helps the IH determine what jobs and work stations are sources of potential problems. During the worksite analysis the IH...

- ➔ Identifies possible exposures, problem tasks and risks. A decision is made regarding which conditions should be measured.
- ➔ Develops a sampling strategy and uses nifty space-age equipment to measure how much of the hazard is there.
- ➔ Researches how the particular chemicals or physical hazards being measured adversely affect worker health (usually by reviewing a technical manual or looking at a table of data).
- ➔ Compares the sampling results with accepted standards and guidelines to decide whether controls are needed.

Chapter 3: The IH Approach

A. Work-site Analysis

- B. Evaluates possible controls and makes recommendations.
- C. Works with the employer to implement and verify effectiveness of controls.
- D. Role of the Safety Committee

B. Evaluate possible controls and make recommendations

Industrial Hygienists recognize there are several means available to control employee exposure to occupational hazards.

→ **Engineering controls**, which might...

- Exclude the hazard's presence altogether;
- Reduce the hazard by replacing it with something less harmful;
- Enclose or confine work processes;
- Eliminate it by installing general and local ventilation systems.

→ **Administrative controls**, such as scheduling production and/or worker tasks in ways that minimize exposure levels...

- Eight workers running a jackhammer one hour each;
- Operating the high-noise floor sander during the swing shift, when fewer workers are present.

Chapter 3: The IH Approach

- A. Work-site Analysis
- B. Evaluates possible controls and makes recommendations.**
- C. Works with employer to implement and verify effectiveness of controls.
- D. Role of the Safety Committee

B. Evaluates possible controls and makes recommendations (continued)

- **Work practice controls**, which alter the manner in which a task is performed...
 - Following proper procedures that minimize exposures while operating production and control equipment;
 - Regular inspection and maintenance of equipment;
 - Good housekeeping procedures;
 - Effective supervision;
 - Not allowing eating, drinking, smoking, applying cosmetics, etc., in regulated areas;

- **Personal Protective Equipment (PPE)** should be considered...
 - As secondary to implementing all feasible engineering and work practice controls.
 - When effective engineering and/or work practice controls aren't feasible to achieve the permissible exposure limit;
 - During the interim time while engineering controls are being instituted; and
 - In emergency situations.

Chapter 3: The IH Approach

- A. Work-site Analysis
- B. Evaluates possible controls and makes recommendations.**
- C. Works with employer to implement and verify effectiveness of controls.
- D. Role of the Safety Committee

C. Works with employer to implement and verify effectiveness of controls.



We've said that the IH's role is to do four things:
(ARE-Cee, remember?)

1. _____
2. _____
3. _____
4. _____

BUT...an IH can be effective only if his/her services are utilized and the results acted upon.

For that to occur, someone needs to suspect that a problem *may or could* exist at the job site and request the services of an industrial hygienist.

Which brings us to...*you!*

LOOK HERE



D. The Role of the Safety Committee

1. Hazard Identification/JHA skills used to perform preliminary worksite analyses.
2. Taking action *proactively* to request the services of an IH.
3. Accepting the responsibility for ensuring the IH's recommendations are implemented.

Chapter 3: The IH Approach

A. Work-site Analysis
B. Evaluates possible controls and makes recommendations.

C. Works with employer to implement and verify effectiveness of controls.

D. The Role of the Safety Committee

Chapter 3

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PEL

Area sample

TLV-STEL

Flow-rate

toxicology

Air-flow rate

Dose-response relationship

Mg/m³

LD₅₀

TLV-C

Fibers/cm.

PART II: What an IH Knows... ...so you don't have to!

Skin notation

IDLH

TLV-TWA

$$\text{Average Concentration} = \frac{(C_1+T_1) + (C_2+T_2) + (C_N+T_N)}{\text{total sample time}}$$

Muco-ciliary escalators

Wipe sample
(are you kidding me?)

TWA

Dose-mortality curve

Representative sample

Integrated sample

Excursion limit

macrophage

Respirable dust

Dose-response curve

Personal sample

$$\text{TWA} = \frac{C_a + T_a + C_b + T_b \dots C_n + T_n}{8}$$

Threshold shift

Pump Calibration

The high-flow gilian pump is a constant flow sampler designed to overcome the flow rate variation problems inherent in many sampling situations. Increased media resistance, such as filter loaded with dust or crimped hose blahblah, yada yada yada page after page... ↪

Soap bubble meter

Rotameter

Total dust

Area sample

Octave band analyzer

Nuisance particulates

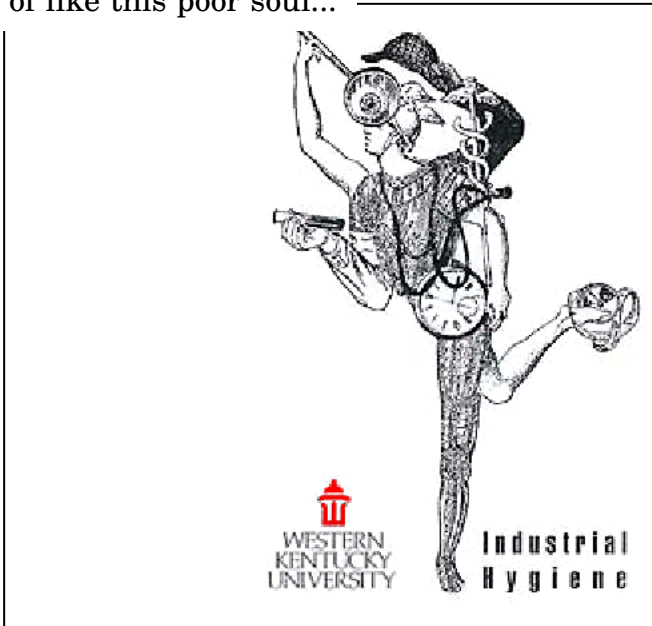
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Introduction: Understanding the tools an IH uses

Industrial hygienists are the cement between the physical, biological and medical sciences.

They must be Jacks or Jills of all trades in order to do the job.

By the time they are fully trained, they are wearing so many hats they look kind of like this poor soul...



You don't need to master all the skills and knowledge they already possess.

What you **do** need is an understanding of the basic tools and terminology an IH uses.

PART II: What an IH Knows...so you don't have to

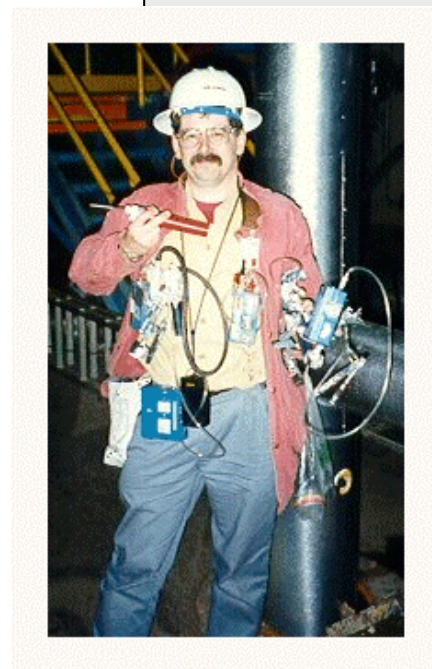
Introduction

Chapter 4: Toxicology

Chapter 5: Exposure Monitoring

Chapter 6: Information Resources the IH uses

Chapter 4



Meet Mike...a real-life example of an OR-OSHA industrial hygienist!

Chapter 4: Toxicology: the basics of chemical exposure and health effects

A. Background

This is the backbone of an IH's capabilities.

→ **Definition: the science that studies the ill effects of chemicals on living things.**

We promised there would be no big words; however...

In order to understand the basics, you at least need to recognize and understand what certain terms mean when you hear them used.

The practice of industrial hygiene is based on the concept that, for each substance there is a level of exposure below which significant injury, illness or discomfort rarely or never occurs.

The IH protects the health of workers by assessing potential chemical and physical agent exposures and controlling the environmental conditions so that the risk of exposure is minimized.

Chapter 4: Toxicology

- A. Background
- B. Risk
- C. Dose-response
- D. Exposure Standards and Guidelines

B. Risk...

→ *...the probability that a substance will produce harm under the conditions of use.*

→ Numerous factors influence how much risk actually exists, such as:

- toxicity of the chemical
- frequency of exposure
- route of exposure
- individual differences in a person's susceptibility to the chemical's effects
- Dose

Chapter 4: Toxicology

A. Background

B. Risk

1. Toxicity

2. Dose

3. Route of exposure

C. Dose-Response

D. Exposure Standards and Guidelines

1. Toxicity...

The ability of a substance to:

- ...damage an organ system, such as the liver or kidneys or...
- ...disrupt a biochemical process, such as the body's blood-forming mechanism or...
- ...disturb an enzyme system at some site in the body removed from the site of contact with the substance.

Toxin

Anything that can produce an adverse biological effect.

It may be chemical, physical, or biological in form.

Examples:

Chemical = cyanide

Physical = radiation

Biological = bloodborne pathogens

B. Risk (continued)...

1. Toxicity (continued)...

➤ Systemic vs. Organ-specific

- ❖ **A systemic toxin** affects the entire body or many organs.
- ❖ **Example: potassium cyanide**
This is a systemic toxin that affects virtually every cell and organ in the body by interfering with the cell's ability to utilize oxygen.
- ❖ **An organ-specific toxin** affects only specific tissues or organs while not producing damage to the body as a whole. These are known as **target organs or tissues**.
- ❖ **Example: Benzene**
This is mainly toxic to blood-forming tissues.
- ❖ **Example: Lead**
Lead is also target-specific; however it has **three target organs** (central nervous system, kidney and blood-forming system).

Chapter 4: Toxicology

- A. Background
- B. Risk**
 - 1. Toxicity
 - a. Systemic vs. Organ-specific
 - b. Acute vs. Chronic
 - 2. Dose
 - 3. Route of exposure
- C. Dose-Response
- D. Exposure Standards and Guidelines

B. Risk (continued)...

1. Toxicity (continued)...

➤ Acute Toxicity

- ❖ Occurs almost immediately after an exposure.
- ❖ Usually a single dose or series of doses within a 24 hour period.
- ❖ Death is a major concern in acute exposures. Examples are:
 - ◆ In 1989, 5,000 people died and 30,000 were permanently disabled due to exposure to methyl isocyanate from an industrial accident in India.
 - ◆ Many people die each year from inhaling carbon monoxide from faulty heaters.

➤ Chronic Toxicity

- ❖ Accumulated damage to specific organ systems over time. It's often months or years before recognizable symptoms appear.
- ❖ Damage due to sub-clinical, individual exposures may go unnoticed.
- ❖ With repeated exposures or long-term continual exposure, the damage slowly builds up.
- ❖ Ultimately, the damage becomes so severe the organ can no longer function normally.

Chapter 4: Toxicology

A. Background

B. Risk

1. Toxicity

a. Systemic vs.
Organ-specific

b. Acute vs.
Chronic

2. Dose

3. Route of exposure

C. Dose-Response

D. Exposure Standards and Guidelines

B. Risk (continued)...

1. Toxicity (continued)...

Chronic Toxicity (continued)...

❖ Examples of chronic toxic effects:

- ♦ **Cirrhosis in alcoholics** who have ingested ethanol for several years;
- ♦ **Chronic kidney disease** in workmen with several years' exposure to lead;
- ♦ **Chronic bronchitis** in long-term cigarette smokers;
- ♦ **Pulmonary fibrosis** in coal miners (black lung disease);
- ♦ **Pulmonary fibrosis and cancer** in asbestos workers (asbestosis);

Other Categories of Toxicity

- ❖ **Mutagenesis:** Genetic mutations
- ❖ **Carcinogenesis:** Uncontrolled growth
- ❖ **Teratogenesis:** Birth Defects

Chapter 4: Toxicology

A. Background

B. Risk

1. Toxicity

- a. Systemic vs. Organ-specific

b. Acute vs. Chronic

2. Dose

3. Route of exposure

C. Dose-Response

D. Exposure Standards and Guidelines

B. Risk (continued)...

2. Dose...

- ➔ ...The amount of the toxin that enters the body.
- ➔ **Total Dose** depends on:
 - **Number of doses**
 - **Concentration** of the toxin;
 - **Frequency**
 - **Time period** exposed to it.

For example:

- ◆ 650 mg. of Tylenol as a single dose
- ◆ 500 mg. of penicillin every 8 hours for 10 days
- ◆ 10 mg. DDT per day for 90 days

Chapter 4: Toxicology

A. Background

B. Risk

1. Toxicity

- a. Systemic vs. Organ-specific

2. Dose

- a. Number of doses
- b. Concentration
- c. Frequency
- d. Length of exposure

3. Exposure Route

C. Dose-Response

D. Exposure Standards and Guidelines

B. Risk (continued)...

3. Route of Exposure...how the toxin enters or comes in contact with the body.

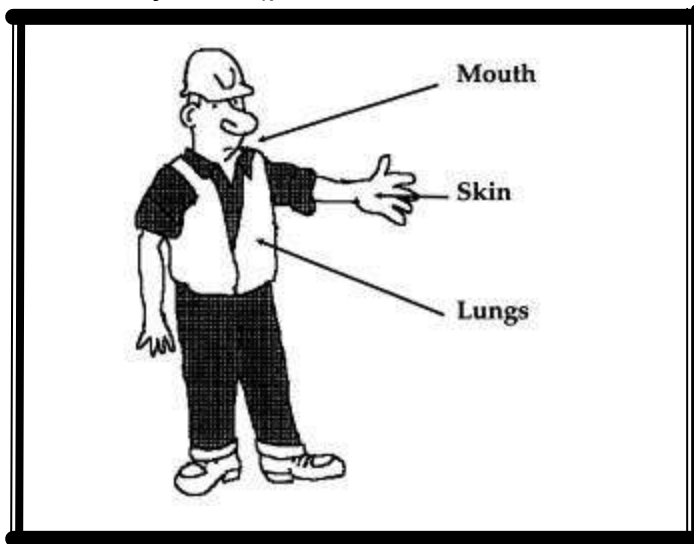
So far we've seen that the toxicity, the concentration of a substance, and length of exposure are important in determining the effects of a toxin on the body.

The other major factor is how the chemical enters or comes in contact with the body.

There are four routes of exposure of concern with occupational exposures.

Four Routes of Exposure:

- 1 Skin
- 2 Lungs (inhalation)
- 3 Mouth (ingestion)
- 4 Injection (parenteral)



Chapter 4: Toxicology

A. Background

B. Risk

1. Toxicity

- a. Systemic vs. Organ-specific

2. Dose

- a. Concentration
- b. Length of exposure

3. Route of Exposure

C. Dose-Response

D. Exposure Standards and Guidelines

(Fifth Route of Exposure??)

5 Eyes

Because of the importance and role of vision in the workplace setting and its unusually high absorption capabilities, the eye is sometimes described as a route of entry.

B. Risk (continued)...

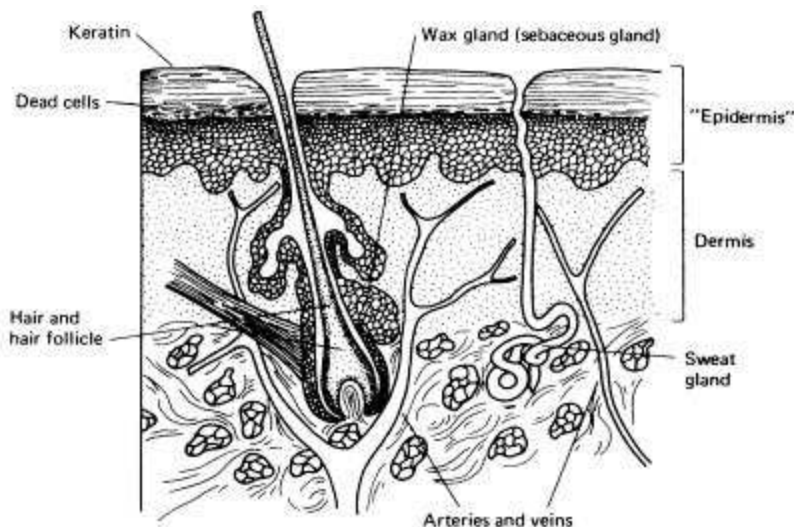
3. Exposure Route (continued)...

→ Skin Absorption.

The skin is the largest organ of the body and a common exposure site for liquid and airborne chemicals.

It is a multilayered organ which has good protective features. Chemicals that contact the skin can cause either local or systemic damage, or both.

- **Local** effects occur at the site of contact, like an acid burn.
- **Systemic** effects occur when compounds penetrate the skin, enter the bloodstream, and cause damage to other organs of the body distant from the site of entry.



A cross-section of skin illustrates that the inner layers of the skin contain blood vessels. This is how toxic substances are transported to other parts of the body.

Chapter 4: Toxicology

A. Background

B. Risk

1. Toxicity

2. Dose

3. Exposure Route Skin Absorption

C. Dose-Response

D. Exposure Standards and Guidelines

B. Risk (continued)...**3. Exposure Route (continued)...****→ Skin Absorption (continued)**

How likely is it that a chemical will be absorbed across the skin? It depends on the chemistry of the substance: the size of the molecules of the chemical, the polarity (electric charge) of the molecules, and the condition of the skin itself.

You're familiar with the fact that water and oil don't mix together but stay in separate layers when combined. In simplified terms this helps explain whether a chemical is easily absorbed through the skin.

The skin is made up of alternating fatty and watery layers. A compound that dissolves readily in fats is more likely to pass through the skin.

Many organic solvents like trichloroethylene, toluene, and xylene dissolve in fat and are therefore easily absorbed.

Fat-soluble compounds, in addition to passing through the skin more easily, can also dissolve the natural fats and oils in the skin (de-fatting), making it easier for other substances to cross the barrier of the skin and be absorbed into the body.

Chapter 4: Toxicology

A. Background

B. Risk

1. Toxicity

2. Dose

**3. Exposure Route
Skin Absorption**

C. Dose-Response

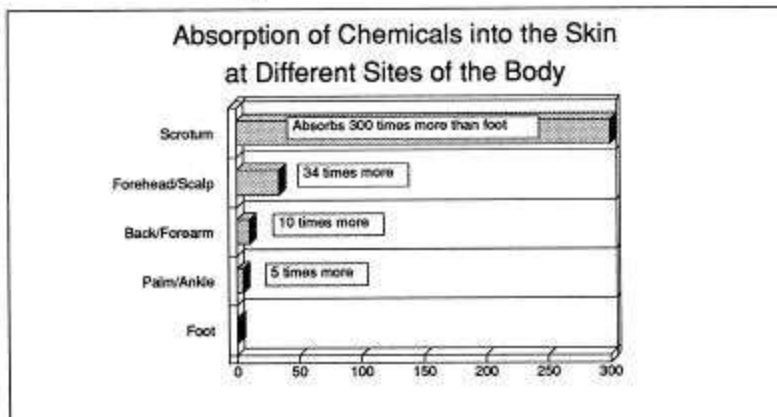
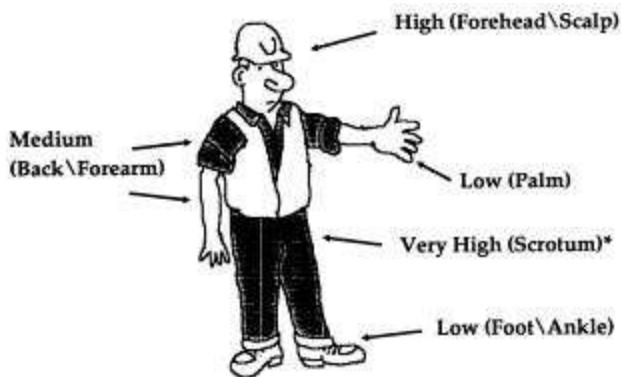
D. Exposure Standards
and Guidelines

B. Risk (continued)...

3. Exposure Route (continued)...

→ Skin Absorption (continued)...

Absorption rates of toxic substances through the skin varies tremendously depending upon which part of the skin body is involved.



Source: E. Hodgson and P.E. Levi, *A Textbook of Modern Toxicology* (Elsevier: New York, 1987), p. 34-35.

* For men (Studies of female workers yet to be done.)

Chapter 4: Toxicology

A. Background

B. Risk

1. Toxicity

2. Dose

**3. Exposure Route
Skin Absorption**

C. Dose-Response

D. Exposure Standards and Guidelines

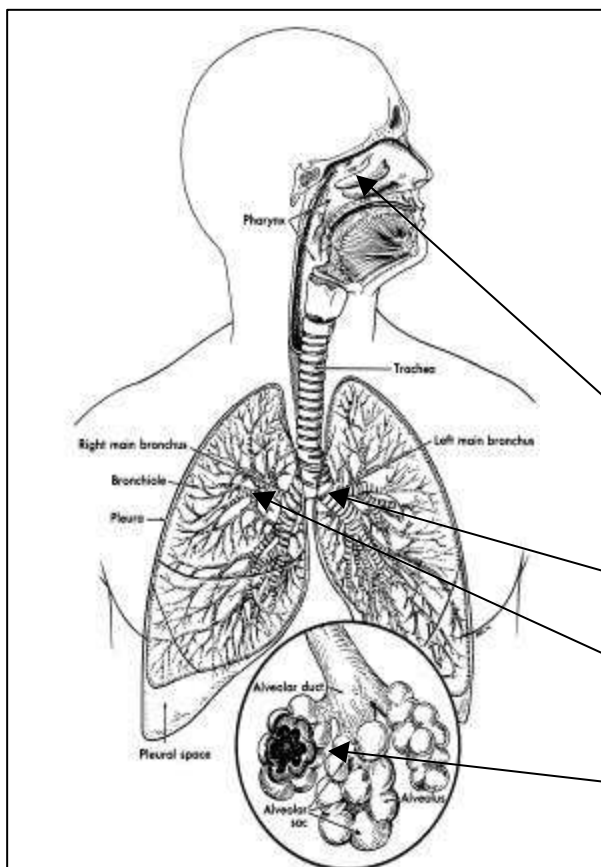
B. Risk (continued)...

3. Exposure Route (continued)...

→ Inhalation

The respiratory system is the major route of exposure for airborne chemicals and dusts.

The next figure shows the respiratory system looking like an upside down tree with smaller and smaller branches as it extends deeply into the lungs.



The respiratory system consists of four main regions:

- ❖ **Nasopharyngeal** Nasal passages and pharynx
- ❖ **Tracheobronchi** Windpipe (trachea) and its main upper branches (bronchi)
- ❖ **Bronchioles** Smaller branches called bronchioles
- ❖ **Alveoli** The smallest branches in which the lung terminates

The pharynx, trachea, and lungs. The inset shows the grapelike alveolar sacs where air and blood exchange oxygen and carbon dioxide through the thin walls of the alveoli. The capillaries (not shown) surround the alveoli.

Source: C.P. Anthony and N.J. Kolthoff. *Textbook of Anatomy and Physiology*, ninth edition. C.V. Mosby Co., 1975. Reprinted with permission.

Chapter 4: Toxicology

A. Background

B. Risk

1. Toxicity

2. Dose

3. Exposure Route

Skin Absorption

Inhalation

C. Dose-Response

D. Exposure Standards and Guidelines

Chapter 4

B. Risk (continued)...

3. Exposure Route (continued)...

→ Inhalation...Air Contaminants in the Respiratory System: The Lung's Defenses

Just as with skin contact, contaminants that enter through the respiratory route can cause local damage to the lungs or systemic damage by entering the bloodstream through the lungs and being carried to other organs in the body.

Most serious damage is caused by contaminants which penetrate deep into the lower regions of the lung. The upper regions of the respiratory system have strong defenses against inhaled air contaminants.

- ❖ **In the nasopharyngeal region**, coarser dust particles larger than 5 microns (1 micron equals one millionth of a meter) are filtered out. Also the nasal passages are covered by a mucous layer which protects the underlying tissue from damage.

Some gases can also be filtered out in this region. The efficiency with which gases are removed here depends on how easily the gas dissolves in water.

Highly water soluble gases, like sulfur dioxide and ammonia, react with the mucous layer in the nasal passages. They can be very irritating to these tissues, but they are prevented from reaching the lower lungs where even more serious damage could occur.

This mechanism explains why some gases which have lower solubility in water will penetrate more deeply into the lungs and cause a delayed but very serious reaction.

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B. Risk (continued)...

3. Exposure Route (continued)...

→ Inhalation...Air Contaminants in the Respiratory System: The lung's defenses (continued)...

- ❖ The **tracheobronchial region** (windpipe and branches) has additional defense mechanisms. The main one is the **mucociliary** apparatus.

Particulates are collected in the mucous layer which covers the trachea and moved up and out of the region by the upward beating of the cilia, tiny hair-like projections which propel the particles toward the mouth.

Gases like ozone and chlorine can also be absorbed and removed by the mucociliary apparatus, but high concentrations of these gases will damage the mucous layer and destroy the cilia.

- ❖ **As we move down to the bronchiolar region**, the defenses become more limited and less effective. There is little mucous covering and no cilia.

Particulates which penetrate this far, generally those of 1-3 microns, stay in this region for weeks, as opposed to the tracheobronchial region where residence time is measured in hours or days.

The extensive branching gives lots of opportunity for particles and fibers to impact on cell walls and implant in the bronchioles.

Chapter 4: Toxicology

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B. Risk (continued)...

3. Exposure Route (continued)...

→ Inhalation...Air Contaminants in the Respiratory System: The Lung's Defenses (continued)...

❖ **Finally, in the *alveolar* region**, very small particles one micron or less, can deposit. Once particles are deposited in the terminal air sacs it can take months or years for them to be cleared.

A fluid which lines the air sacs offers some protection to particulates and gases, but it is easily broken down by exposure to toxic substances.

Then there is little to prevent the toxic compound from entering the blood. How much will enter the bloodstream depends on the compound's solubility in blood.

The breathing pattern is also a factor. Slow, deep breathing increases the chance of the contaminant reaching the lower regions.

Fast, shallow breathing increases turbulence in the upper airways and increases the chance of the compound reacting and being eliminated before it reaches the air sacs.

The slightly water-soluble irritant gases do their greatest harm in the alveolar region, usually by delayed effects.

In high concentrations some of the ***nitrogen oxides*** can cause burning of the lungs or death with a delay of four to 48 hours. ***Phosgene*** is another very dangerous irritant gas which can cause severe delayed reactions.

Chapter 4: Toxicology

A. Background

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Inhalation

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D. Exposure Standards and Guidelines

B. Risk (continued)...

3. Exposure Route (continued)...

→ **Inhalation...The physical form of the Air Contaminant**

❖ **Air contaminants take different forms.**

The form of the substance is important in determining how easily and how far it can penetrate into the respiratory system.

It also determines what type of protective respirator will work against the contaminant.

- **Particulates (Solid particles)**

- Dusts (wood and paper dust, lime, silica)

- Fumes (metal fumes from welding)

- Fibers (asbestos, fiberglass)

- **Gases**

- Carbon monoxide from motors

- Chlorine in bleach plants

- Hydrogen sulfide around digestors

- **Vapors** (The gaseous phase of a substance that is a liquid or solid at room temperature);

- Terpenes

- Solvents in paints, cleaners, and adhesives

- **Mists** (Sprays of liquid droplets)

- Spray paints

- Felt wash caustic mists

- Cutting oil mist

Chapter 4: Toxicology

A. Background

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1. Toxicity

2. Dose

- 3. Exposure Route**

Skin Absorption

Inhalation

C. Dose-Response

D. Exposure Standards and Guidelines

B. Risk (continued)...

3. Exposure Route (continued)...

→ Ingestion...Oral Route

Toxic materials can also be swallowed and enter the body through the gastrointestinal tract.

The workplace provides ample opportunities for accidental ingestion of chemicals through eating or smoking under certain conditions. Lead is frequently taken into the body this way, making personal hygiene an important consideration when working around lead.

Absorption of a chemical compound into the bloodstream through the gastrointestinal tract, like the skin, depends on its chemistry, charge, and fat solubility.

Ingested compounds may be worked on by intestinal micro-organisms to convert them into compounds that are more toxic, less toxic, or of the same toxicity as the original compound.

Most compounds absorbed from the small intestine go first to the liver, the “metabolic factory” of the body. Here, again, they may be metabolized, or converted, into compounds of greater, lesser, or the same toxicity, or they may remain unchanged.

The compound or its metabolites then enter the bloodstream. Some compounds, mostly fat soluble and large molecule synthetic organic compounds, bypass the liver and more directly enter the bloodstream.

Chapter 4: Toxicology

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B. Risk (continued)...

3. Exposure Route (continued)...

→ Influence of Route of Exposure on Toxicity

Most chemicals are not equally toxic by all three routes. One reason is the pathway that the chemical follows through the body.

The example just discussed of ingested chemicals which do or don't go through the liver soon after ingestion illustrates how this factor might affect toxicity.

If the pathway through the body doesn't affect toxicity, then the entry route of highest toxicity is that which permits the largest quantity of the chemical to enter.

In general the lungs offer the least resistance to the entry of chemicals, ingestion is somewhere in the middle, and the skin provides the best barrier.

Chapter 4: Toxicology

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C. Dose-Response

The **dose-response relationship** is one of the most important principles of toxicology. By response we can mean anything from a headache to death. The dose-response relationship can be described in **two ways**:

As the dose of a toxic chemical is increased...

(1)...the percentage of the exposed population that show a toxic reaction will increase. This is where the term

LD₅₀ comes in.

(2)...the effect on an individual becomes more severe. This leads us to the term **Dose-Response**.

Warning...warning...warning...

HUMONGOUS WORDS AHEAD!



In order to better understand how an IH approaches a hazard assessment, the information on the next two pages is helpful.

We'll keep it brief and to the point.

Chapter 4: Toxicology

- A. Background
- B. Risk
- C. Dose-Response**
- D. Exposure Standards and Guidelines

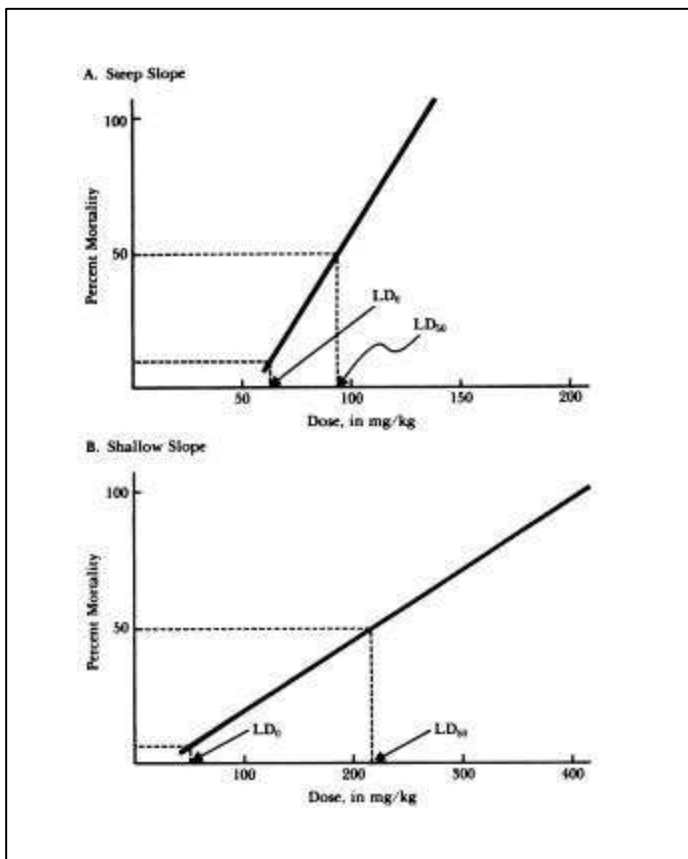
(1) LD₅₀ (literally “Lethal Dose - 50 percent”)

Figures 1a and 1b show dose-mortality curves for two chemicals—let’s call them chemicals A and B.

Dose-mortality is a specific type of dose-response curve where death is the response.

What do we mean by the LD₅₀s—just under 100 milligrams per kilogram of body weight (mg/kg) for chemical A, and 215 mg/kg for chemical B shown on these graphs?

Answer: The LD₅₀ or Lethal Dose₅₀ is the dose at which 50 percent of the experimental animals in a toxicology study die.



Chapter 4: Toxicology

- A. Background
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What does it mean that the slope of the line for chemical A is so much steeper than that for chemical B?

Answer: A steep slope means there is little variability in response among individual test animals or humans.

A shallow slope means that some individuals might be harmed at levels far below LD₅₀.

It is easier to predict a safe dose for all humans from a steep slope rather than a shallow slope.

LD₅₀ (continued)...

So to summarize...

The amount of a substance required to kill you is termed the **Lethal Dose**.

An **LD₅₀** is the amount of a substance (i.e., the dose), per kilogram of body weight, necessary to kill 50% of a particular non-human animal population.

Needless to say, **LD₅₀** values vary wildly, as in these examples...

Agent or Chemical	LD ₅₀ (mg/Kg)
Sucrose (table sugar)	29,700
Ethyl Alcohol (booze)	14,000
Sodium Chloride (table salt)	3,000
Vitamin A	2,000
Vanillin	1,580
Aspirin	1,000
Chloroform	800
2,4-D	375
Ammonia	350
Caffeine	192
Phenobarbital (a barbiturate)	162
DDT	113
Arsenic	48
Sodium Cyanide	6.4
Strychnine	2.5
Nicotine	1.0
Dioxin (TCDD)	0.001
Botulinum toxin	0.00001

Chapter 4: Toxicology

- A. Background
- B. Risk
- C. Dose-Response**
- D. Exposure Standards and Guidelines

The use of LD₅₀'s to categorize chemicals as to their toxicity is illustrated in the following table.

Rating	LD50	Examples	Volume
Extremely toxic	<1 mg/kg	Botulinum toxin	<7 drops
Highly toxic	1-50 mg/kg	parathion	1 tsp-1 ounce
Slightly toxic	500-5000 mg/kg	morphine	ounce to pint
Practically nontoxic	5000-15000 mg/kg	ethanol	pint to quart
Relatively harmless	>15000 mg/kg	water	> 1 quart

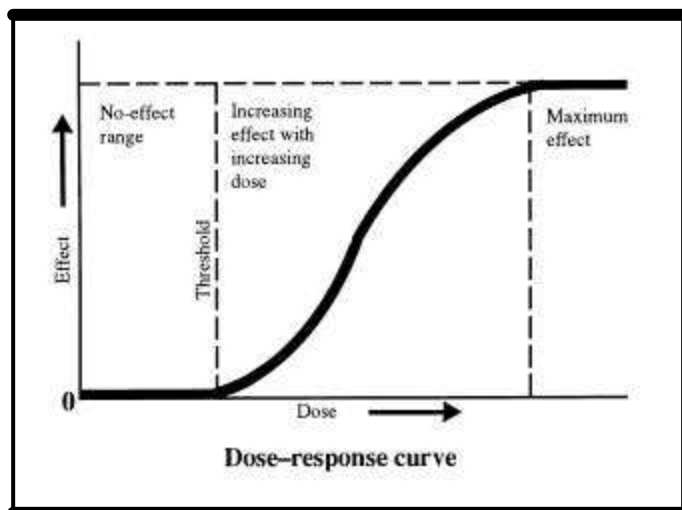
C. Dose-Response (continued)

- 2) *As the dose of a toxic chemical is increased...the effect on an individual becomes more severe.*

The next figure illustrates the changing effect of increasing dose on an individual.

Here the effect of exposure on the individual starts at the **threshold of response**. Below the threshold there is no detectable response.

As the dose increases the individual may experience different types of effects depending on the chemical.



Chapter 4: Toxicology

- A. Background
- B. Risk
- C. Dose-Response**
- D. Exposure Standards and Guidelines

C. Dose-Response (continued)

Here is the sequence of effects for two common chemicals as the dose increases:

Carbon Monoxide

- ◆ no effect
- ◆ headache, nausea and dizziness
- ◆ unconsciousness
- ◆ death

Formaldehyde

- ◆ no effect
- ◆ slight irritation of the eyes and nose
- ◆ increasing irritation of eyes and nose
- ◆ lachrymation (tearing) of the eyes
- ◆ difficult breathing, serious inflammation of the breathing passages
- ◆ pulmonary edema (fluid buildup in lungs)
- ◆ death

Be aware that these are the dose-response effects from **short-term** exposures.

Formaldehyde, for example, is also believed to cause cancer in humans exposed over long periods of time.

Chapter 4: Toxicology

- A. Background
- B. Risk
- C. Dose-Response**
- D. Exposure Standards and Guidelines

D. Exposure Standards and Guidelines (toxic compared to...what??)

The IH's job is to measure the levels of potentially toxic chemical and physical agents present at a worksite and to compare these levels to some reference value known to be the maximum safe level for humans.

These levels have been determined over the years through extensive research and lab testing by government, academic and private-sector researchers.

Exposure standards and guidelines usually provide numerical exposure levels for toxic agents beyond which injury can be expected to occur.

Chapter 4: Toxicology

- A. Background
- B. Risk
- C. Dose-Response
- D. **Exposure Standards and Guidelines**

Standards vs. Guidelines

→ Standards (OSHA codes)

- ❖ **Legally acceptable exposure levels** or controls issued as a result of Congressional or Executive mandate.
- ❖ They result from formal rulemaking and are legally enforceable.
- ❖ Violators are subject to punishment, including fines and imprisonment.

→ Guidelines

- ❖ **Recommended maximum exposure** levels which are voluntary and not legally enforceable.
- ❖ Guidelines may be developed by regulatory and non-regulatory agencies, or by professional societies.

For Academics!

Exposure standards or guidelines are:

- Unacceptable levels of exposure that must be avoided
- Acceptable levels of exposure that should not be exceeded

D. Exposure Standards and Guidelines (toxic compared to... what??)

Two main Sources:

1. NIOSH/OSHA Standards
2. ACGIH

1. NIOSH/OSHA

- NIOSH (National Institute for Occupational Safety and Health)
- Think of NIOSH as OSHA's research lab for determining what is hazardous and at what levels. (Hint: lots of government IH's work here.)
- OSHA takes NIOSH recommendations, then accepts, modifies and may or may not enact into law after public debate.

OSHA PEL

2. ACGIH

- ACGIH (American Conference of Governmental Industrial Hygienists)
- They adopt guidelines for toxics independent of any governmental agency.
- They publish a booklet each year called *Threshold Limit Values and Biological Exposure Indices*.

ACGIH TLV

Chapter 4: Toxicology

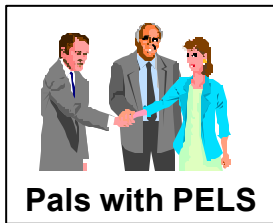
- A. Background
- B. Risk
- C. Dose-Response
- D. Exposure Standards and Guidelines

Chapter 4

D. Exposure Standards and Guidelines (toxic compared to... what??)

PELs and TLVS...

1. "OSHA IS YOUR FRIEND...your PAL."



PELS

- ❖ OSHA's legal standards for workplace exposures are known as...**PELs**, or *Permissible Exposure Limits*.
- ❖ Most OSHA PELs are for airborne substances with allowable exposure limits averaged over an 8-hour day, 40-hour week.

This is known as the...

Time-Weighted-Average (TWA) PEL

Three types of OSHA PEL's...

- ❶ TWA PEL
- ❷ STEL PEL
- ❸ CEILING LIMIT PEL

Chapter 4: Toxicology

- A. Background
- B. Risk
- C. Dose-Response
- D. Exposure Standards and Guidelines**

Key Points:

- ❶ Only OSHA-enacted standards are enforceable.
- ❷ If it doesn't say PEL, it's only a recommended guideline.
- ❸ Many toxic agents exist for which OSHA has not enacted standards.

D. Exposure Standards and Guidelines (toxic compared to... what??)

2. ACGIH TLV's (they're researchers... They LoVe Science. TLV's, get it? C'mon! I'm doing the best I can with this stuff.)

TLV's...Threshold Limit Values

- ➔ Intended to be used as **guides** in the control of health hazards, not as fine lines between safe and dangerous concentrations.
- ➔ Existed prior to the formation of OSHA in 1970. The ACGIH TLV committee had already been recommending TLV's for several years.
- ➔ When OSHA formed in 1970, it "jumpstarted" its regulations by immediately adopting ACGIH's existing occupational health guidelines for its PEL's.

Chapter 4: Toxicology

- A. Background
- B. Risk
- C. Dose-Response
- D. **Exposure Standards and Guidelines**

Three types of TLV's...

- ① TLV-TWA
- ② TLV-STEL
- ③ TLV-C (Ceiling Limit)



Three types of OSHA PEL's...

- ① TWA-PEL
- ② STEL-PEL
- ③ CEILING LIMIT PEL

Chapter 5: Exposure Monitoring

(they get to play with all those fancy gadgets!)

Background

Monitoring is the measurement of exposures or contaminant concentrations during a given time period.

During the preliminary workplace survey, the substances or conditions to which workers are exposed must be determined.

The basic problem in exposure assessment is to recognize all exposures, to evaluate each as acceptable or unacceptable, and to control all unacceptable exposures.

The problem, then, is to determine the intensity of the exposure. To do this the IH collects samples of air or uses direct-reading instruments. Every effort must be made to obtain samples that represent the worker's exposure.

A. FIVE QUESTIONS an IH must address:

To decide what constitutes a representative sample, the IH must answer five basic questions:

1. Where to sample
2. Whom to sample
3. How long to sample
4. How many samples to take
5. When to sample (day/night, or what month/season)

Chapter 5: Exposure Monitoring

Background

A. Five questions

B. Three Monitoring Objectives

- 1. Baseline:** What is the range and distribution of worker exposure(s);
- 2. Diagnostic:** What are the sources and tasks that pose the greatest potential exposures in the workplace;
- 3. Compliance:** Is this workplace in compliance with OSHA standards;

Monitoring and the Sampling Plan

- **Each sample is acquired at a particular** location over a specific time interval. By its nature, sampling can only provide a snap shot of the actual situation.
- **The more snap shots taken, the easier it is** to create the big picture and the more accurate its results.

Chapter 5: Exposure
Monitoring

Background

A. Five questions

B. Monitoring Objectives

C. Monitoring Tools

C. Monitoring Methods and Tools

1. Gas and Vapor Substances

→ *Instantaneous monitoring*

- ❖ Grab Sample Technique
- ❖ Direct Reading instruments Colorimetric Indicator tubes Electronic Devices

→ *Laboratory Analysis Required*

- ❖ Air samples
- ❖ Surface Wipe samples
- ❖ Biological samples

→ *Area Monitoring*

→ *Personal Monitoring*

2. Particulate Substances

→ *Laboratory Analysis Required*

- ❖ Nuisance Dust
- ❖ Respirable Dust
- ❖ Fibers

Chapter 5: Exposure Monitoring

Background

A. Five questions

B. Monitoring Objectives

C. Monitoring Methods and Tools

Chapter 6: Information Resources (they don't just make that stuff up!)

→ **NIOSH Pocket Guide to CHEMICAL HAZARDS**

<http://www.cdc.gov/niosh/homepage.html>

→ **ACGIH Threshold Limit Values and Biological Exposure Indices**

<http://www.acgih.org>

→ **In Oregon the Center for Research on Occupational and Environmental Toxicology (CROET) at Oregon Health Sciences University performs a great service by maintaining a web site with links to many occupational safety and health resources, including those dealing with chemical hazards and occupational diseases. Their web site is:**

<http://www.ohsu.edu/croet>

→ **Other Internet Resources**

- ❖ <http://www.ilpi.com/msds/index.shtml>
- ❖ <http://www.chem.uky.edu/resources/msds.html>
- ❖ <http://physchem.ox.ac.uk:80/MSDS/>
- ❖ <http://www.ohsu.edu/croet/msds.html>
- ❖ <http://www.osha.gov>
- ❖ <http://www.aiha.org/>
- ❖ <http://freeweb.pdq.net/ennis/ih/>
- ❖ <http://siri.uvm.edu/>
- ❖ <http://safetyinfo.com/>

Good Sources
for MSDS
Sheets

Chapter 6: Information Resources

Chapter 6

Exercise: Using the NIOSH Pocket Guide

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1	2	3	4	5	6	7	8	
Chemical name, structure/formula, CAS and RTECS Nos., and DOT ID and guide Nos.	Synonyms, trade names, and conversion factors	Exposure limits (TWA unless noted otherwise)	IDLH	Physical description	Chemical and physical properties		Incompatibilities and reactivities	Measurement method (See Table 1)
					MW, BP, SOL, Fl.P, IP, Sp, Gr, flammability	VP, FRZ, UEL, LEL		
Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate (CH ₃ O) ₂ P(O)OCHBr ₂ CB ₂ Cl ₂ 300-76-5 TB9450000	Dibrom® ; 1,2-Dibromo-2,2-dichloroethyl dimethyl phosphate; Naled	NIOSH 3 mg/m ³ [skin] OSHA† 3 mg/m ³	200 mg/m ³	Colorless to white solid or straw-colored liquid (above 80°F) with a slightly pungent odor. [insecticide]	MW: 380.8 BP: Decomposes Sol: Insoluble Fl.P: NA IP: ? Sp.Gr(77°F): 1.96 Noncombustible Solid	VP: 0.0002 mm MLT: 80°F UEL: NA LEL: NA	Strong oxidizers, acids, sunlight , water [Note: Corrosive to metals. Hydrolyzed in presence of water.]	None available
Dimethylformamide HCON(CH ₂) ₂ 68-12-2 LQ2100000	Dimethyl formamide; N,N-Dimethylformamide; DMF	NIOSH/OSHA 10 ppm (30 mg/m ³) [skin]	500 ppm	Colorless to pale-yellow liquid with a faint, amine-like odor.	MW: 73.1 BP: 307°F Sol: Miscible Fl.P: 136°F IP: 9.12 eV Sp.Gr: 0.95 Class II Combustible Liquid	VP: 3 mm FRZ: -78°F UEL: 15.2% LEL(212°F): 2.2%	Carbon tetrachloride; other halogenated compounds when in contact with iron; strong oxidizers; alkyl aluminums; inorganic nitrates	Si gel; Methanol; GC/FID; III [#2004]
2265 26	1 ppm = 3.04 mg/m ³							

To illustrate the use of the Pocket Guide we'll look for information on **dimethylformamide (DMF)**, one of the ingredients in **Slimetrol**. You will find dimethylformamide (DMF) on p. 114 of the Guide. The entry for **DMF** is displayed across the top of this page and page 48.

The symbols and abbreviations used in entries for all the chemicals are explained in the text and tables on pp. ix-xxxvi at the beginning of the Pocket Guide.

1 Chemical Name and Formula

Chemicals are listed alphabetically. Just under the name is the chemical formula, which is a clue to its structure. The two numbers below the formula are the identification numbers given to DMF by the *Chemical Abstracts Service (CAS)* and the *Registry of Toxic Effects of Substances (RTECS)*, another NIOSH publication. These numbers could be used to access additional information from print or computer sources.

The two numbers at the very bottom are the Department of Transportation (DOT) identification number (4 digits) and the two-digit Emergency Guide number which refers to a section in the DOT *Emergency Response Guidebook*.

2 Synonyms, Trade Names, and Conversion Factors

This column shows other names by which dimethylformamide is known. The conversion factor shows how to convert concentrations of DMF between parts per million and milligrams per cubic meter, the two units in which we measure airborne contaminants.

3 Exposure Limits

This entry gives the exposure limits set for DMF by various bodies. In this case the legal OSHA permissible exposure limit (PEL) and the recommended NIOSH limit are the same, 10 ppm or 30 mg/m³. The [skin] notation means that the skin is a significant route of exposure for this chemical.

Using the NIOSH Pocket Guide

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Exercise: Using the NIOSH Pocket Guide (continued)...

4 IDLH

Air concentrations of a chemical that are “Immediately Dangerous to Life and Health” are listed here. Clearly this is a level which no one should be exposed to. If a chemical is believed to be a carcinogen (cancer-causing), the abbreviation “Ca” would be in this column, with the IDLH level in brackets under it.

5 Physical Description

This entry provides a description of appearance and odor. These descriptors can be used as clues for identification.

6 Chemical and Physical Properties

These are many of the same properties that are often listed on an MSDS. They are, in order:

- molecular weight
- boiling point (°F)
- solubility in water
- flash point
- ionization potential
- vapor pressure (mm Hg)
- freezing point
- upper explosive limit
- lower explosive limit
- specific gravity
- flammability/combustibility rating

7 Incompatibilities and Reactivities

Other chemical or physical agents that DMF should not be stored with or come in contact with.

8 Measurement Method

This is the suggested sampling and analysis method(s) for measuring the chemical’s concentration in air. Table 1 lists all the abbreviations used in this column.

Using the NIOSH Pocket Guide

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Personal protection and sanitation (See Table 3)		Recommendations for respirator selection — maximum concentration for use (MUC) (See Table 4)	A Route	B Symptoms (See Table 5)	Health hazards	
					C First aid (See Table 6)	D Target organs (See Table 5)
Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contam Remove: When wet or contam Change: Daily Provide: Eyewash	NIOSH/OSHA 30 mg/m ³ : DMFu/HIE/SA 75 mg/m ³ : SA:CF/PAPRDMFu 150 mg/m ³ : HIEF/SAT:CF/PAPRTHIE/ SCBAF/SAF 200 mg/m ³ : SA:PD,PP §: SCBAF:PD,PP/SAF:PD,PP:ASCBA Escape: HIEF/SCBAE	Inh Abs Ing Con	Irrit eyes, skin; miosis, lac; head; chest tight , wheez, lar spasm; salv; cyan; anor, nau, vomit, abdom cramp, diarr, weak, twitch, para, gidd, ataxia, convuls; low BP, card irreg	Eye: Irr immed Skin: Soap wash immed Breath: Resp support Swallow: Medical attention immed	Eyes, skin, resp sys, CNS, CVS, blood chol	
[Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate]						
Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contam Remove: When wet or contam Change: N.R.	NIOSH 100 ppm: SA* 250 ppm: SA:CF* 500 ppm: SA:CF*/SCBAF/SAF §: SCBAF:PD,PP/SAF:PD,PP:ASCBA Escape: GMFOV/SCBAE	Inh Abs Ing Con	Irrit eyes, skin, resp sys; nau, vomit, colic; liver damage, enlarged liver ; high BP; face flush; derm; in animals: kidney, heart damage	Eye: Irr immed Skin: Water flush prompt Breath: Resp support Swallow: Medical attention immed	Eyes, skin, resp sys, liver, kidneys, CVS	
[Dimethylformamide]						

Exercise: Using the NIOSH Pocket Guide (continued)...

9 Personal Protection and Sanitation

The key words next to skin, eyes, etc. tell workers what kind of personal protective clothing and equipment are needed for this hazard. Requirements for eyewashes and showers for some chemicals are found here.

10 Recommendations for Respirator Selection

Each line lists a maximum concentration for use (MUC) number followed by the type of respirator that can be used up to that MUC. For DMF a supplied air respirator (SA) can be used up to 100 ppm, while a supplied air respirator in continuous flow mode (SA:CF) may be used up to 250 ppm. All symbols and codes are defined in Table 4.

Using the NIOSH Pocket Guide

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Exercise: Using the NIOSH Pocket Guide (continued)...

11 Health Hazards

There are four health hazard columns:

A Route

This column lists the routes of entry for the chemical. The three possible routes are: (1) inhalation; (2) skin absorption; and (3) ingestion.

“**Con**” indicates that skin or eye contact is potentially hazardous.

B Symptoms

Symptoms that may result from exposure are listed here. Abbreviations are explained in Table 5. DMF symptoms are irritation of eyes, skin and respiratory system; nausea, vomiting, and colic; liver damage and enlarged liver; high blood pressure; face flush; dermatitis. Kidney and heart damage is seen in animal experiments.

C First Aid

Actions which should be taken immediately following exposure by different routes are described here. Eyes should be irrigated immediately, skin flushed promptly with water. For inhalation exposure provide fresh air, mouth-to-mouth and medical attention if necessary. If DMF is swallowed, immediate medical attention is needed.

D Target Organs

These are the body organs most likely to be affected by the chemical. For DMF these include eyes, skin, respiratory system, liver, kidneys, and cardiovascular system (heart and blood vessels).

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PART III: Recognizing Health Hazards

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A. Background

The first function of an industrial hygiene management system is to recognize health hazards that can cause work-related illness.

To recognize something, you must first know what you are looking for. With this in mind, a brief discussion of the types of health hazards is important.

B. Four classes of health hazards:

1. Chemical
2. Physical
3. Ergonomic
4. Biological

Chapter 7: Classes of Health Hazards

A. Background

B. Four Classes of health hazards

1. Chemical Hazards...

- Generally represent the majority of exposures.
- Can be substances used in your processes; or
- Purchased chemicals from outside sources.
- Can exist in the form of solids, liquids, gases, mists, dusts, fumes and vapors.

2. Physical Hazards...

- Noise
- Vibration
- Temperature extremes
- Electromagnetic Radiation
 - A. Ionizing (X-rays)
 - B. Non-ionizing (Lasers, microwaves, infrared and radio waves)
- Illumination

B. Four classes of Health Hazards

(continued)...

3. Ergonomic Hazards...

- **Physical Stressors** such as repetitive motion, heavy lifting, awkward or static postures, fatigue, excessive force, direct pressure and overexertion.
- **Psychological Stressors** such as monotony, perceptual confusion or overload.

4. Biological Hazards

- Microbiological, such as bacteria, viruses, fungi, molds, and protozoa;
- Macrobiological, such as insects, parasites, plants and animals.
- On occasion, this hazard involves a...

→ **Fourth route of entry: = Parenteral (via injection)**

Chapter 7: Types of Health Hazards

A. Background

B. Four classes of health hazards

C. Using physical-state terms to describe chemical hazards

The Three States of Matter

Solid *Solids have a definite shape and volume.*

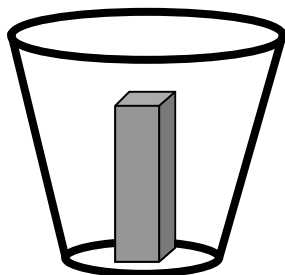
Particles can be solid or liquid. Hazardous solid particles include silica, asbestos, lead, fumes, bacteria, fungi, fiberglass, wood, beryllium, phosphorus, and miscellaneous dusts.

Liquid *Liquids have an indefinite shape and take on the shape of the container in which they are contained.*

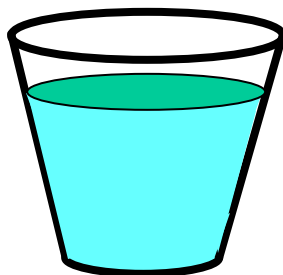
Liquid particles vary in size from aerosols, to mists and the much larger drops. Aerosols are an inhalation hazard. Larger particles are a skin absorption or ingestion hazard. Hazardous liquids or liquid particles include solvents such as turpentine, benzene, and alcohol. Flammable or combustible liquids, and numerous organic and inorganic compounds such as paint thinners, coatings, paints, dry cleaning liquids, and pesticides.

Gas *Gases take on both the shape and volume of their containers.*

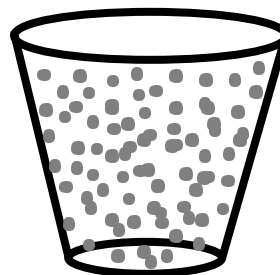
Gases are materials whose physical state is a gas at normal temperature (All materials exist in the gas phase if the temperature is high enough). Vapors are gases formed when liquid evaporates. Hazardous simple asphyxiant gases include helium, nitrogen, hydrogen, and methane. Hazardous chemical asphyxiant gases include carbon monoxide, hydrogen cyanide, and hydrogen sulfide. The hazards of other gases is determined by their health and toxic effects. Some of these include hydrogen fluoride, sulfur dioxide, phosgene and ozone.



A solid has a definite shape and volume regardless of the container into which it is placed.



A quantity of liquid has a definite volume, but takes on the shape of its container.



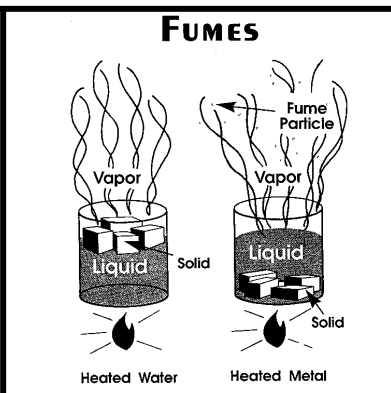
A quantity of gas has the shape and volume of the container it occupies.

Using Physical-State Terms to describe Chemical Hazards

Chemicals are present in the form of liquids, solids, vapors, gases, dusts, fumes and mists. The hazard potential presented by a chemical depends on which form it takes, as well as characteristics such as solubility, particle size and toxic properties.

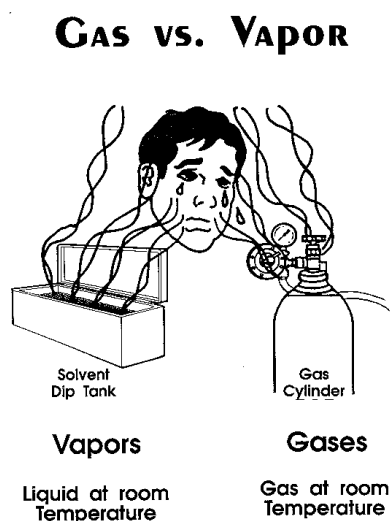
Fumes

- ◆ **Volatilized solids** that condense when they contact air.
- ◆ Very small, solid particles created when hot vapor reacts with the air to form an oxide.
- ◆ Often associated with welding operations



Gas vs. Vapor

- ◆ **Gases** are materials whose physical state is a gas at room temperatures.
 - Commonly formed by arc-welding and internal combustion engines
 - Exist where gases such as chlorine and fluorine are being used in a working process.
- ◆ **Vapors** are gases formed when liquid evaporates.
 - Organic molecules such as gasoline, benzene and solvents are commonly observed examples.
 - Solvents with low boiling points form vapors readily at room temperature.



Using Physical State-Terms to describe Chemical Hazards

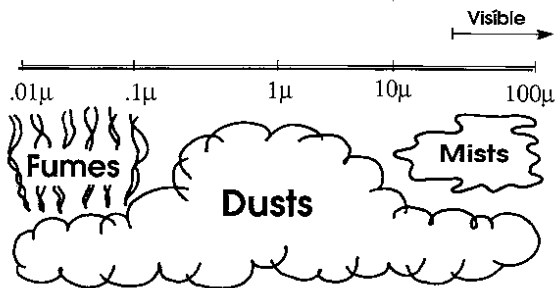
Dusts

- ◆ **Solid particles** generated by handling, crushing grinding, impacting, detonation and breaking apart by heating organic or inorganic materials.
- ◆ **Respirable dust** means the particles are in a size range that permits them to penetrate deep into the lungs upon inhalation.

Mists/Aerosols

- ◆ **Suspended liquid droplets** created when vapor condenses back to a liquid, or during splashing and atomizing.
- ◆ **Examples include** acid mists from electroplating, oil mist produced during cutting and grinding, and mists from spray-finishing operations.

PARTICLE DIAMETERS



$$1 \text{ Micron} = 1\mu = \frac{1}{1,000,000} \text{ Meter}$$

$$1 \text{ Red Blood Cell} = 7\mu$$

$$1 \text{ Bacterium} = 1\mu$$

Fibers

- ◆ **Solid particles** having a slender, elongated shape several times as great as their diameter.
- ◆ Commonly found in construction, mining, friction products and insulation materials.
- ◆ **Examples include** asbestos, fiberglass and fibrous talc.

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PART IV: Role of the Safety Committee

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Background / Review

It might appear that, with all its complexity, Industrial Hygiene is a discipline better left to the professional. In fact, nothing could be further from the truth.

We may not have all the training an IH possesses; however, that doesn't prevent us from thinking like one! So, let's review briefly how an IH thinks. Remember this?



IH is the science of...

- A _____
- R _____
- E _____
- C _____

workplace conditions that may cause workers...

- I _____ or
- I _____

If it works for the IH, why not use this approach to organize our safety committee efforts?



Chapter 8: Action Steps for the Safety Committee

Background / Review

- A. Anticipate
- B. Recognize
- C. Evaluate
- D. Control
- E. Step-by-step Example
- G. Where to find an IH

Chapter 8

A. Anticipate the Hazards.

- ➔ **Become familiar with your** industry and the health hazards most commonly associated with it.
- ➔ **Take pro-active steps,** once your safety and health management system is in place, to prevent/control the introduction of new health hazards.

B. Anticipate the Hazards (continued)...

Common Processes with their Associated Health Hazards	
Process	Potential Hazards
➤ Combustion and burning	✓ Byproducts of combustion released into the atmosphere; noise from the burner
➤ High temperature operations with or without combustion	✓ High heat due to ambient temperature and/or radiant heat
➤ Heating and using microwaves	✓ High heat; noise, including ultrasonic, non-ionizing radiation
➤ Melting metal	✓ Metal fumes and dusts
➤ Electric discharge into the air (arcs/sparks)	✓ Ozone, nitrogen oxide, radiation from flames and the products of having the electrode destroyed.
➤ Electric discharge in a vacuum, e.g., x-rays, electron beam microscopes, oscillating circuits	✓ Ionizing radiation
➤ Grinding, crushing	✓ Dusts of materials involved; noise
➤ Conveying, shifting, sieving, screening, bolting dry material	✓ Dusts of materials involved
➤ Mixing dry material	✓ Dusts of material involved
➤ Mixing wet material	✓ Solvent vapors, mists, dusts and noise
➤ Wet grinding	✓ Mists, dust and noise
➤ Dry grinding, e.g., milling, sand-blasting	✓ Dust and noise
➤ Cold-bending, forming, metal and nonmetal cutting	✓ Lubricant chemicals, mists and noise
➤ Hot mending, forming, metal and nonmetal cutting	✓ Decomposing products of lubricant, lubricant chemicals, heat, noise and dust
➤ Handling small parts	✓ Repetitive motion trauma
➤ Coating operations preceded by solvent degreasing - electroplating	✓ Metallic salts, alkalis, nickel and cobalt dermatitis, chromium
➤ Coating operations preceded by solvent degreasing - painting	✓ Solvents and toxic pigments
➤ Coating operations preceded by solvent degreasing - ceramic coating	✓ Toxic pigments and heat
➤ Coating operations preceded by solvent degreasing - mechanical coating with metals	✓ Dusts, fumes, heat and radiation
➤ Explosive processes	✓ Gases from explosion, carbon monoxide, and nitrogen oxides and dusts from material
➤ Warehousing	✓ Carbon monoxide, nitrogen oxide, chemicals

B. Recognize the hazards.

- ➔ Planned Inspections
- ➔ Job Hazard Analyses
- ➔ Review Hazard Communication Plan
 - ❖ Chemical Inventory List
 - ❖ MSDS Sheets
- ➔ Understand the four classes of hazards

Chapter 9: Action Steps
for the Safety
Committee

Background / Review

- A. Anticipate
- B. Recognize**
- C. Evaluate
- D. Control
- E. Step-by-step Example
- G. Where to find an IH

Basic Hazard Recognition Procedures

There is a basic, systematic procedure for recognizing and evaluating health hazards, which includes questions such as these:

- What is produced?
- What raw materials are used?
- What materials are added in the process?
- What equipment is involved?
- What is the cycle of operations?
- What operational procedures are used?
- Is there a written procedure for the safe handling and storage of materials?
- What about dust control? Cleanup after spills, and waste disposal?
- Are the ventilating and exhaust systems adequate?

Basic Hazard-Recognition Procedures (continued)...

- Does the facility layout minimize exposure?
- Is the facility well-equipped with safety appliances such as showers, masks, respirators and emergency eye wash fountains?
- Are safe operating procedures outlined and enforced?
- Is a complete hazard communication plan in effect that meets OSHA requirements?

Chapter 9: Action Steps
for the Safety
Committee

Background / Review

- A. Anticipate
- B. Recognize**
- C. Evaluate
- D. Control
- E. Step-by-step Example
- G. Where to find an IH

D. *Evaluate* the Hazards

- Qualitative Review of the worksite
- Quantitative Sampling and Review by the IH

E. *Control* the Hazards

- Job Hazard Analysis and Procedures
- Implement a strong Hazard Communication program

- Engineering and Change Management Processes
- Purchasing Systems
 - ❖ **Design a purchasing process** which does not permit any chemical agent or piece of equipment on-site without prior review and approval

- Personal Protective Equipment
- Employee Training and Orientation
- Effective Safety Committee

Chapter 9: Action Steps for the Safety Committee

Background / Review

- A. Anticipate
- B. Recognize
- C. Evaluate**
- D. Control**
- E. Step-by-step Example
- G. Where to find an IH

Some Practical Methods for Controlling Health Hazards

- 1. Air contaminants**
 - a. Substituting or replacing
 - b. Isolation of the operation
 - c. Eliminating or reducing employee exposure
 - d. Changing the process or operation
 - e. Local exhaust
 - f. Ventilation
 - g. Wetting-down the process
 - h. Housekeeping
 - i. Personal protective equipment
 - j. Personal hygiene
- 2. Industrial Skin Diseases**
 - a. Substituting or replacing
 - b. Engineering controls
 - c. Work practices and procedures
 - d. Personal protective equipment
 - e. Job placement
- 3. Noise**
 - a. Reduction at its source
 - b. Reduction of noise transmitted
 - c. Personal protective equipment
 - d. Administrative/work practice controls
 - e. Regular maintenance
- 4. Vibration**
 - a. Source reduction
 - b. Isolation
 - c. Dampening
 - d. Regular maintenance
- 5. Cold**
 - a. Proper clothing
 - b. Good physical condition
 - c. Buddy system
 - d. Worker scheduling
- 6. Heat**
 - a. Ventilation
 - b. Equipment and process change
 - c. Work-saving devices
 - d. Heat shields and barriers
 - e. Worker selection
 - f. Work scheduling
 - g. Worker training
 - h. Replacement of body fluids
 - i. Acclimatization
 - j. Personal protective equipment
 - k. Proper job procedures
- 7. Radiation**
 - a. Education and training
 - b. Heat shields and reflective clothing
 - c. Personal protective equipment
 - d. Proper job procedures
 - e. Effective maintenance
- 8. Illumination**
 - a. Use of brighter, more reflective materials, fixtures, bulbs, etc.
 - b. Maintenance (fixtures, bulbs, etc.)
 - c. Proper light placement
- 9. Biological Hazards**
 - a. Employee education and training
 - b. Monitoring
 - c. Personal hygiene
 - d. Insect and microbe
 - e. Proper job procedures
 - f. Personal protective equipment
 - g. Proper sanitary facilities
 - h. Good housekeeping
- 10. Ergonomics**
 - a. Design and Engineering
 - b. Education and training
 - c. Administrative controls, e.g., shift scheduling)
 - d. Labor-saving devices
- 11. Psychosocial Hazards**
 - a. Management/supervisory leadership training
 - b. Coaching/counseling/employee assistance programs
 - c. Positive behavior reinforcement
- 12. Control techniques that depend heavily upon a positive safety culture**
 - a. Good Housekeeping
 - b. Personal hygiene
 - c. Employee training/education
 - d. Proper job procedures
 - e. Proper job instruction
 - f. Job observation
 - g. Rule compliance
 - h. Protective equipment compliance
 - i. Proper posting and labeling
 - j. Proper storage of hazardous materials
 - k. Group communications
 - l. Workplace inspections

E. Step-by-step example...Recognition of a worksite dust problem

1. Is there visible dust in the air? Are employees' clothes covered with dust?
2. What is the source of the dust?
3. What is the composition of the dust?
4. Locate the MSDS sheet for the substance that is the dust source. Look at the hazardous ingredients section.
5. Determine whether the dust is nuisance dust or toxic dust.
6. How many employees are involved in the work process creating the dust? Are other employees in the adjacent areas also affected?
7. Are the employees wearing any PPE? What kind? Obtain product information for the PPE being used to compare against MSDS recommendations.
8. What is the work duration for employees involved in the process. Is the exposure intermittent or continuous throughout their shifts.
9. Is there any part of the operation that seems to emit more dust than another? If so, this may become part of the IH's sampling strategy.
10. Make note of other behaviors of employees, such as smoking, eating and/or drinking in the work area.

Chapter 9: Action Steps for the Safety Committee

Background / Review

- A. Anticipate
- B. Recognize
- C. Evaluate
- D. Control
- E. Step-by-step Example**
- G. Where to find an IH

Contact the industrial hygienist and be prepared to present the results of your preliminary survey.

G. Where to Find an IH

- OSHA Consultative Section

- Your workers compensation insurance provider

- Private consultants in the yellow pages

Chapter 9: Action Steps for the Safety Committee

Background / Review

- A. Anticipate
- B. Recognize
- C. Evaluate
- D. Control
- E. Step-by-step Example
- G. Where to find an IH**

Congratulations!

We have completed the materials, and have addressed the four workshop objectives. The Oregon OSHA Training Section would like to extend an invitation to you to attend additional workshops that we provide and to contact us at any time that you might have questions. In closing we ask that you complete the following:

1. The class evaluation

2. The registration form

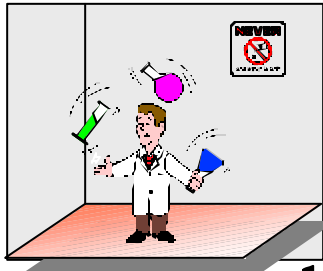
Thank You! Go make a difference.

Appendices

- 1. How to read an MSDS**
- 2. Apply this new skill to two real-life examples**
- 3. Toxic and Hazardous Substances: Oregon Rules for Air Contaminants (OAR 437-001-0382) (provided as a separate handout)**

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1. How to read an MSDS



Exercise!

Using the **MSDS** on the next pages, follow along as it is discussed in detail, or feel free to review it on your own.

Material Safety Data Sheets

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For all hazardous chemicals

Readily available during normal work hours

Immediately accessible during emergencies

Providing the MSDS:

- Initial shipment
- First shipment after update

Failure to provide the MSDS

- OR-OSHA investigates when suppliers or manufacturers refuse to provide MSDSs

Remote work sites

- MSDS may be kept at central location
- Must be readily available
- Must be immediately accessible

Kept in any form

- Paper
- Computer

MATERIAL SAFETY DATA SHEET

PROPANE

SECTION I - Product Identification

PRODUCT NAME: PROPANE
FORMULA: N/A
FORMULA WT: N/A
COMMON SYNONYMS: N/A

SECTION II - Hazardous Components

PROPANE

SECTION III - Physical Data

BOILING POINT: -44F VAPOR PRESSURE(MM HG): N/A
MELTING POINT: N/A VAPOR DENSITY(AIR=1): 1.55
SPECIFIC GRAVITY: N/A EVAPORATION RATE: NA
(H20=1) (BUTYL ACETATE=1)
SOLUBILITY(H20): N/A % VOLATILES BY VOLUME: 100
APPEARANCE & ODOR: COLORLESS-ROTTEN EGG ODOR.

SECTION IV - Fire and Explosion Hazard Data

FLAMMABILITY CLASSIFICATION: UNK
FLASH POINT: -156F
FLAMMABLE LIMITS: UPPER - 9.5 % LOWER - 2.1 %
FIRE EXTINGUISHING MEDIA: STOP FLOW OF GAS OR OXYGEN
SPECIAL FIRE-FIGHTING PROCEDURES: USE WATER TO COOL TANK
UNUSUAL FIRE AND EXPLOSION HAZARDS: AUTO IGNIT TEMP 874F;HEAVIER THAN AIR
(VAPOR DENSITY 1.5) MAY TRAVEL A
CONSIDERABLE DISTANCE TO AN IGNITION
SOURCE AND FLASHBACK

SECTION V - Health Hazard Data

EFFECTS OF OVEREXPOSURE: POSS FREEZ BURN;MOD CONCENTRATION
W/AIR CAUSES UNCON
MEDICAL CONDITIONS PRONE
TO AGGRAVATION BY EXPOSURE: UNK
PRIMARY ROUTE(S) OF ENTRY: INHALE
EMERGENCY AND FIRST AID PROCEDURES: INHALE/FRESH AIR

Propane Cont.

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SECTION VI - Reactivity Data

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR
CONDITIONS TO AVOID: NA
INCOMPATIBLES: NONE
DECOMPOSITION PRODUCTS: NONE

SECTION VII - Spill and Disposal Procedures

DISPOSAL PROCEDURE:
VENT TO ATMOSPHERE IN FLAME FREE, SPARK FREE AREA OUTDOORS
OTHER PRECAUTIONS:
NONE

SECTION VIII - Protective Equipment

VENTILATION:
NA
RESPIRATORY PROTECTION: NONE W/NORMAL USE
EYE PROTECTION: NONE
SKIN PROTECTION: NONE
OTHER EQUIPMENT: NONE
HYGIENIC PRACTICES: NONE

SECTION IX - Storage and Handling Precautions

SPECIAL PRECAUTIONS:
TEMPS <120F IN WELL VENTED AREA AWAY FROM SPARK AND FLAME

SECTION X - Transportation Data and Additional Information

N/A

(TM) and (R) : Registered Trademarks

N/A = Not Applicable OR Not Available

The information published in this Material Safety Data Sheet has been compiled from our experience and data presented in various technical publications. It is the user's responsibility to determine the suitability of this information for adoption of necessary safety precautions. We reserve the right to revise Material Safety Data Sheets periodically as new information becomes available.

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Praxair™ Material Safety Data Sheet



1. Chemical Product and Company Identification

Product Name: Propane (MSDS No. P-4646-C)

Trade Name: Liquefied Petroleum Gas

Chemical Name: Propane **Synonyms:** Dimethylmethane, propylhydride, propylhydride

Formula: C₃H₈

Chemical Family: Alkanes

Telephone: Emergencies:

CHEMTREC

Routine:

1-800-645-4633*

1-800-424-9300*

1-800-PRAXAIR

Company Name: Praxair, Inc.

39 Old Ridgebury Road

Danbury CT 06810-5113

*Call emergency numbers 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information contact your supplier, Praxair sales representative, or call 1-800-PRAXAIR (1-800-772-9247).

2. Composition/Information on Ingredients

For custom mixtures of this product request a Material Safety Data Sheet for each component. See Section 16 for important information about mixtures.

INGREDIENT NAME Propane

CAS NUMBER 74-98-6

PERCENTAGE >99%*

OSHA PEL 1000 ppm

ACGIH TLV Simple asphyxiant

**The symbol ">" means greater than.*

3. Hazards Identification

EMERGENCY OVERVIEW

DANGER! Flammable liquid and gas under pressure.

Can form explosive mixtures with air.

May cause frostbite.

May cause dizziness and drowsiness.

Self-contained breathing apparatus may be required by rescue workers.

Odor: Faintly disagreeable



THRESHOLD LIMIT VALUE: Simple asphyxiant (ACGIH 1997)

EFFECTS OF A SINGLE (ACUTE) OVEREXPOSURE:

INHALATION—Asphyxiant. Effects are due to lack of oxygen. Moderate concentrations may cause headache, drowsiness, dizziness, excitation, excess salivation, vomiting, and unconsciousness. Lack of oxygen can kill.

SKIN CONTACT—No harm expected from vapor. Liquid may cause frostbite.

SWALLOWING—An unlikely route of exposure; this product is a gas at normal temperature and pressure. Frostbite of the lips and mouth may result from contact with the liquid.

EYE CONTACT—No harm expected from vapor. Liquid may cause frostbite.

EFFECTS OF REPEATED (CHRONIC) OVEREXPOSURE: No harm expected.

OTHER EFFECTS OF OVEREXPOSURE: Contact with liquid may cause frostbite.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: The toxicology and the physical and chemical properties of propane suggest that overexposure is unlikely to aggravate existing medical conditions.

SIGNIFICANT LABORATORY DATA WITH POSSIBLE RELEVANCE TO HUMAN HEALTH HAZARD EVALUATION: None known.

CARCINOGENICITY: Propane is not listed by NTP, OSHA, or IARC.

4. First Aid Measures

INHALATION: Remove to fresh air. Give artificial respiration if not breathing. If breathing is difficult, qualified personnel may give oxygen. Call a physician.

SKIN CONTACT: For exposure to liquid, immediately warm frostbite area with warm water, not to exceed 105°F (41°C). In case of massive exposure, remove clothing while showering with warm water. Call a physician.

SWALLOWING: An unlikely route of exposure. This product is a gas at normal temperature and pressure.

EYE CONTACT: For contact with the liquid, immediately flush eyes thoroughly with water for at least 15 minutes. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. See a physician, preferably an ophthalmologist, immediately.

NOTES TO PHYSICIAN: There is no specific antidote. Treatment of overexposure should be directed at the control of symptoms and the clinical condition of the patient.



5. Fire Fighting Measures

FLASH POINT : -156°F (-104°C)
(test method): TCC

AUTOIGNITION TEMPERATURE 842°F (450°C)

FLAMMABLE LIMITS
IN AIR, % by volume LOWER 2.1% UPPER 9.5%

EXTINGUISHING MEDIA: CO₂, dry chemical, water spray, or fog.

SPECIAL FIRE FIGHTING PROCEDURES:

DANGER! Flammable liquid and gas under pressure. Evacuate all personnel from danger area. Immediately spray cylinders with water from maximum distance until cool, taking care not to extinguish flames. Remove sources of ignition if without risk. Remove all cylinders fire area if without risk; continue cooling water spray while moving cylinders. Do not extinguish any flames emitted from cylinders; stop flow of gas if without risk, or allow flames to burn out. Self-contained breathing apparatus may be required by rescue workers. On-site fire brigades must comply with OSHA 29 CFR 1910.156.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Flammable gas. Forms explosive mixtures with air and oxidizing agents. Heat of fire can build pressure in cylinder and cause it to rupture. No part of a cylinder should be subjected to a temperature higher than 125°F (52°C). Propane cylinders are equipped with a pressure-relief device. (Exceptions may exist where authorized by DOT.) If venting or leaking propane catches fire, do not extinguish flames. Flammable gas may spread from leak, creating an explosive re-ignition hazard. Vapors can be ignited by pilot lights, other flames, smoking, sparks, heaters, electrical equipment, static discharge or other ignition sources at locations distant from product handling point. Explosive atmospheres may linger. Before entering area, especially confined areas, check atmosphere with an appropriate device.

HAZARDOUS COMBUSTION PRODUCTS: Carbon monoxide, carbon dioxide

6. Accidental Release Measures

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STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

DANGER! Flammable liquid and gas under pressure. Forms explosive mixtures with air. (See section 5.) Immediately evacuate all personnel from danger area. Use self-contained breathing apparatus where needed. Remove all sources of ignition if without risk. Reduce vapors with fog or fine water spray. Shut off flow if without risk. Ventilate area or move cylinder to a well-ventilated area. Flammable vapors may spread from leak. Before entering area, especially confined areas, check atmosphere with an approved device.

WASTE DISPOSAL METHOD: Prevent waste from contaminating the surrounding environment. Keep personnel away. Discard any product, residue, disposable container or liner in an environmentally acceptable manner, in full compliance with federal, state, and local regulations. If necessary, call your local supplier for assistance.

7. Handling and Storage

PRECAUTIONS TO BE TAKEN IN STORAGE: Store and use with adequate ventilation. Separate propane cylinders from oxygen, chlorine, and other oxidizers by at least 20 feet or use a barricade of non-combustible material. This barricade should be at least 5 feet high and have a fire resistance rating of at least ½ hour. Firmly secure cylinders upright to keep them from falling or being knocked over. Screw valve protection cap firmly in place by hand. Post "No Smoking or Open Flames" signs in storage and use areas. There must be no sources of ignition. All electrical equipment in storage areas must be explosion-proof. Storage areas must meet national electric codes for Class 1 hazardous areas. Store only where temperature will not exceed 125°F (52°C). Store full and empty cylinders separately. Use a first-in, first-out inventory system to prevent storing full cylinders for long periods. For full details and requirements, see NFPA 50A, published by the National Fire Protection Association.

PRECAUTIONS TO BE TAKEN IN HANDLING: Protect cylinders from damage. Use a suitable hand truck to move cylinders; do not drag, roll, slide, or drop. All piped propane systems and associated equipment must be grounded. Electrical equipment must be non-sparking or explosion-proof. Leak check system with soapy water; never use a flame. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. Never insert an object (e.g., wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. Open valve slowly. If valve is hard to open, discontinue use and contact your supplier. Never strike an arc on a compressed gas cylinder. Never ground a cylinder or make it a part of an electrical circuit. For other precautions in using propane, see section 16.

8. Exposure Controls/Personal Protection



VENTILATION/ENGINEERING CONTROLS:

LOCAL EXHAUST—An explosion-proof local exhaust system is acceptable. See SPECIAL.
MECHANICAL (general)—Inadequate; see SPECIAL.

SPECIAL—Use only in a closed system.

OTHER—None

RESPIRATORY PROTECTION: Respiratory protection must conform to OSHA rules as specified in 29 CFR 1910.134.

SKIN PROTECTION: Wear work gloves for cylinder handling and to prevent exposure to liquid.

EYE PROTECTION: Select in accordance with OSHA 29 CFR 1910.133.

OTHER PROTECTIVE EQUIPMENT: Metatarsal shoes for cylinder handling. Select in accordance with OSHA 29 CFR 1910.132 and 1910.133. Regardless of protective equipment, never touch live electrical parts.

9. Physical and Chemical Properties

MOLECULAR WEIGHT: 44.097 **EXPANSION RATIO:** Not applicable

SPECIFIC GRAVITY (air=1): At 70°F (21.1°C) and 1 atm: 1.5223

SOLUBILITY IN WATER: vol/vol at 100°F (37.8°C): 0.065

GAS DENSITY: At 70°F (21.1°C) and 1 atm: 0.116 lbs/ft³ (1.86 kg/m³)

VAPOR PRESSURE: At 70°F (21.1°C): 109.73 psig (756.56 kPa)

PERCENT VOLATILES BY VOLUME: 100 **EVAPORATION RATE (Butyl Acetate=1):** High

BOILING POINT (1 atm): -43.67°F (-42.03°C)

pH: Not applicable

FREEZING POINT (1 atm): -305.84°F (-187.68°C)

APPEARANCE, ODOR, AND STATE: Colorless gas at normal temperature and pressure.
faintly disagreeable odor.

10. Stability and Reactivity

STABILITY: Stable

INCOMPATIBILITY (materials to avoid): Oxidizing agents, chlorine dioxide

HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition and burning may produce CO/CO₂

HAZARDOUS POLYMERIZATION: Will Not Occur

CONDITIONS TO AVOID: None known.



11. Toxicological Information

No information available.

12. Ecological Information

No adverse ecological effects expected. Propane does not contain any Class I or Class II ozone-depleting chemicals. Propane is not listed as a marine pollutant by DOT.

13. Disposal Considerations

WASTE DISPOSAL METHOD: Do not attempt to dispose of residual or unused quantities. Return cylinder to supplier.

14. Transport Information

DOT/IMO SHIPPING NAME: Propane

HAZARD CLASS: 2.1

IDENTIFICATION NUMBER: UN 1978 **PRODUCT RQ:** Not applicable

SHIPPING LABEL(s): FLAMMABLE GAS **PLACARD (When required):** FLAMMABLE GAS

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position, in a well-ventilated vehicle. Cylinders transported in an enclosed, nonventilated compartment of a vehicle can present serious safety hazards. Shipment of compressed gas cylinders that have been filled without the owner's consent is a violation of federal law [49 CFR 173.301(b)].

15. Regulatory Information

The following selected regulatory requirements may apply to this product. Not all such requirements are identified. Users of this product are solely responsible for compliance with all applicable federal, state, and local regulations.

U.S. FEDERAL REGULATIONS:

EPA (Environmental Protection Agency)

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (40 CFR Parts 117 and 302):

Reportable Quantity (RQ): None

SARA: Superfund Amendment and Reauthorization Act:

SECTIONS 302/304: Require emergency planning based on Threshold Planning Quantity (TPQ) and release reporting based on Reportable Quantities (RQ) of extremely hazardous substances (40 CFR Part 355):

Threshold Planning Quantity (TPQ): None.

Extremely Hazardous Substances (40 CFR 355): None.

SECTIONS 311/312: Require submission of Material Safety Data Sheets (MSDSs) and chemical inventory reporting with identification of EPA hazard categories. The hazard categories for this products are as follows:

IMMEDIATE: Yes

PRESSURE: Yes

DELAYED: No

REACTIVITY: No

FIRE: Yes

SECTION 313: Requires submission of annual reports of release of toxic chemicals that appear in 40 CFR Part 372. Propane does not require reporting under Section 313.

40 CFR 68: Risk Management Program for Chemical Accidental Release Prevention: Requires development and implementation of risk management programs at facilities that manufacture, use, store, or otherwise handle regulated substances in quantities that exceed specified thresholds.

Propane is listed as a regulated substance in quantities of 10,000 lbs (4553 kg) or more.

TSCA: Toxic Substances Control Act: Propane is listed on the TSCA inventory.

OSHA (OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION):

29 CFR 1910.119: Process Safety Management of Highly Hazardous Chemicals: Requires facilities to develop a process safety management program based on Threshold Quantities (TQ) of highly hazardous chemicals. Propane is not listed in Appendix A as a highly hazardous chemical; however, any process that involves a flammable gas on site in one location, in quantities of 10,000 lbs (4553 kg) or more is covered under this regulation unless the gas is used as fuel.

STATE REGULATIONS:

CALIFORNIA: This product is not listed by California under the Safe Drinking Water Toxic Enforcement Act of 1986 (Proposition 65).

PENNSYLVANIA: This product is subject to the Pennsylvania Worker and Community Right-To-Know Act (35 P.S. Sections 7301-7320).

16. Other Information

Be sure to read and understand all labels and instructions supplied with all containers of this product.

SPECIAL PRECAUTIONS: *Flammable liquid and gas under pressure.* May form explosive mixtures with air. Use piping and equipment adequately designed to withstand pressures to be encountered. Use only in a closed system. Use only spark-proof tools and explosion-proof equipment. Ground all equipment. Keep away from heat, sparks, and open flame. *Gas can cause rapid suffocation due to oxygen deficiency.* Store and use with adequate ventilation.

Close cylinder valve after each use; keep closed even when empty. ***Never work on a pressurized system.*** If there is a leak, blow the system down in an environmentally safe manner in compliance with all federal, state, and local laws, then repair the leak. ***Never ground a compressed gas cylinder or allow it to become part of an electrical circuit.***

NOTE: Prior to using any plastics, confirm their compatibility with Propane.



MIXTURES: When you mix two or more gases or liquefied gases, you can create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an industrial hygienist, or other trained person when you evaluate the end product. Remember, gases and liquids have properties that can cause serious injury or death.

HAZARD RATING SYSTEMS:

NFPA RATINGS:

HEALTH = 1

FLAMMABILITY = 4

REACTIVITY = 0

SPECIAL = SA (CGA recommends this to designate simple asphyxiant)

HMIS RATINGS:

HEALTH = 0

FLAMMABILITY = 4

REACTIVITY = 0

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:

THREADED: CGA-510 (gas withdrawal) CGA-555 (liquid withdrawal)

PIN-INDEXED YOKE: None

ULTRA-HIGH-INTEGRITY

CONNECTION: None

Use the proper CGA connections. **DO NOT USE ADAPTERS.** Additional limited-standard connections may apply. See CGA Pamphlet V-1.

Ask your supplier about free Praxair safety literature as referenced on the label for this product; you may also obtain copies by calling 1-800-PRAXAIR. Further information about propane can be found in the following pamphlets published by the Compressed Gas Association, Inc. (CGA), 1725 Jefferson Davis Highway, Arlington, VA 22202-4102, Telephone (703) 412-0900.

AV-1 Safe Handling and Storage of Compressed Gases

P-1 Safe Handling of Compressed Gases in Containers

P-14 *Accident Prevention in Oxygen-Rich, Oxygen-Deficient Atmospheres*
SB-2 *Oxygen-Deficient Atmospheres*
SB-8 *Use of Oxy-fuel Gas Welding and Cutting Apparatus*
V-1 *Compressed Gas Cylinder Valve Inlet and Outlet Connections*
--- *Handbook of Compressed Gases, Third Edition*



Praxair asks users of this product to study this Material Safety Data Sheet (MSDS) and become aware of product hazards and safety information. To promote safe use of this product, a user should (1) notify employees, agents and contractors of the information on this MSDS and of any other known product hazards and safety information, (2) furnish this information to each purchaser of the product, and (3) ask each purchaser to notify its employees and customers of the product hazards and safety information.

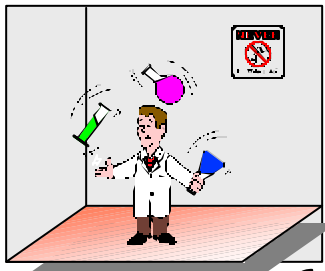
The opinions expressed herein are those of qualified experts within Praxair, Inc. We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of use of the product are not within the control of Praxair, Inc., it is the user's obligation to determine the conditions of safe use of the product.

Praxair MSDSs are furnished on sale or delivery by Praxair or the independent distributors and suppliers who package and sell our products. To obtain current Praxair MSDSs for these products, contact your Praxair sales representative or local distributor or supplier. If you have questions regarding Praxair MSDSs, would like the form number and date of the latest MSDS, or would like the names of the Praxair suppliers in your area, phone or write the Praxair Call Center (**Phone:** 1-800-PRAXAIR;
Address: Praxair Call Center, Praxair, Inc., PO Box 44, Tonawanda, NY 14150-7891).

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2. Apply this new skill to two real-life examples



Exercise!

Using the MSDS resources included, review the two examples and analyze what hazards may exist.

Example 1:

The foreman on the paper machine has been looking for a better way to remove “stickies,” the residues that get left on the rolls of the paper machine. A vendor comes in the mill and offers him a product he says works really well. It’s a solvent called methyl ethyl ketone, or MEK. The foreman wants you to take a bottle of it and a rag and see how it works.

Example 2: A Rash of Problems

At the monthly meeting of the central safety committee yesterday a committee member from the paper machine mentioned that one of the machine tenders has been complaining about a rash on his arms over the past few weeks. At first he thought it was poison oak that he’d picked up on a hunting trip, but it keeps coming back. The mill nurse then said that a pipefitter from maintenance came in to her office with redness on his forearms, hands, and neck just last week. She’d given him some cream for the itching and also recommended a barrier cream to protect the skin, and she hadn’t heard anything since. The committee chair requested that when people left the meeting they talk to workers in their departments to see if there was anyone else having these types of problems and report them to the safety office.

The next morning two more reports came in. A worker in the additives area near the wet end of number one paper machine had gone last week to his personal doctor who diagnosed him with dermatitis (skin disease) and possibly an allergic reaction, but the doctor said he needed to do more tests to know for sure. Another maintenance worker who worked on the shutdown of number one two weeks ago has a rash on his arms and neck.

These two cases illustrate two common situations in health and safety. In the first example we haven’t had any health problems yet but someone wants to use a material in the workplace that may pose some hazards.

In the skin rash example we have several workers who have an illness that seems like it could be related to something in the workplace, **but we’re not sure (1) if the problem is work-related and (2) if it is, what is responsible.**

Where to Start Your Investigation

Example 1: Investigating MEK

Here we have a chemical ingredient we want to investigate. When you know the name of the chemical the first step is to obtain a material safety data sheet (MSDS) for the substance. OSHA's Hazard Communication regulation requires that an MSDS be available for all potentially hazardous materials. MSDSs vary in completeness, quality, and clarity. Certain sections of the MSDS can be particularly helpful in investigating health risks. These include:

Hazardous ingredients: *Tells you the chemical identity of the material and the individual components if it is a mixture. You can then use these chemical names to investigate further using other references as described below.*

Chemical and physical properties: *Can tell you about how the material will behave in a spill or leak, and may give some clues about the risk of significant amounts of the chemical becoming airborne.*

Health hazard data: *Tells you about acute and chronic effects of exposure by different routes, i.e. skin, breathing, swallowing, and may give permissible exposure limits.*

Other sections will also describe how the chemical reacts with other materials, first aid measures when exposure occurs, and protective equipment to be used to prevent overexposure.

The MSDS for MEK is found on the next two pages. In this case the MSDS is for a substance made up of a single ingredient and it is fairly complete in describing the hazards to be aware of. **What are the main health effects of MEK?**

Section V of the MSDS tells us:

- *Irritation of eyes, nose, and respiratory tract*
- *Headache, dizziness, unconsciousness at very high exposure levels*
- *Skin irritation and cracking*



MATERIAL SAFETY DATA SHEET METHYL ETHYL KETONE

SECTION I - Product Identification

PRODUCT NAME: METHYL ETHYL KETONE FORMULA: CH₃COCH₂CH₃ FORMULA WT: 72.11 CAS NO.: 00078-93-3 NIOSH/RTECS NO.: EL6475000 COMMON SYNONYMS: 2-BUTANONE; MEK; ETHYL METHYL KETONE; METHYLACETONE PRODUCT CODES: 9214,9323,9211,5385,9319,Q531

Precautionary Labeling

BAKER SAF-T-DATA(TM) SYSTEM HEALTH - 2 FLAMMABILITY - 3 (FLAMMABLE) REACTIVITY - 2 CONTACT - 1 LABORATORY PROTECTIVE EQUIPMENT SAFETY GLASSES; LAB COAT; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER PRECAUTIONARY LABEL STATEMENTS WARNING FLAMMABLE HARMFUL IF INHALED CAUSES EYE IRRITATION KEEP AWAY FROM HEAT, SPARKS, FLAME. AVOID BREATHING VAPOR. KEEP IN TIGHTLY CLOSED CONTAINER. USE WITH ADEQUATE VENTILATION. IN CASE OF FIRE, USE WATER SPRAY, ALCOHOL FOAM, DRY CHEMICAL, OR CARBON DIOXIDE. FLUSH SPILL AREA WITH WATER SPRAY.

SECTION II - Hazardous Components

COMPONENT % CAS NO. METHYL ETHYL KETONE 90-100 78-93-3

SECTION III - Physical Data

BOILING POINT: 80 C (176 F) VAPOR PRESSURE(MM HG): 100 MELTING POINT: -86 C (-123 F) VAPOR DENSITY(AIR=1): 2.4 SPECIFIC GRAVITY: 0.80 EVAPORATION RATE: 2.7 (H₂O=1) (BUTYL ACETATE=1) SOLUBILITY(H₂O): APPRECIABLE (MORE THAN 10 %) % VOLATILES BY VOLUME: 100 APPEARANCE & ODOR: LIQUID WITH ACETONE-LIKE ODOR.

SECTION IV - Fire and Explosion Hazard Data

FLASH POINT: -7 C (20 F) NFPA 704M RATING: 1-3-0 FLAMMABLE LIMITS: UPPER - 10 % LOWER - 1.8 % FIRE EXTINGUISHING MEDIA USE ALCOHOL FOAM, DRY CHEMICAL OR CARBON DIOXIDE. (WATER MAY BE INEFFECTIVE.) SPECIAL FIRE-FIGHTING PROCEDURES FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE MOVE CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL. UNUSUAL FIRE & EXPLOSION HAZARDS VAPORS MAY FLOW ALONG SURFACES TO DISTANT IGNITION SOURCES AND FLASH BACK. CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE. CONTACT WITH STRONG OXIDIZERS MAY CAUSE FIRE.

SECTION V - Health Hazard Data

THRESHOLD LIMIT VALUE (TLV/TWA): 590 MG/M³ (200 PPM) SHORT-TERM EXPOSURE LIMIT (STEL): 885 MG/M³ (300 PPM) TOXICITY: LD₅₀ (ORAL-RAT)(MG/KG) - 2737 LD₅₀ (IPR-MOUSE)(MG/KG) - 616 LD₅₀ (SKN-RABBIT) (G/KG) - 13 EFFECTS OF OVEREXPOSURE INHALATION OF VAPORS MAY CAUSE COUGHING, CHEST PAINS, OR NOSE AND THROAT IRRITATION. INHALATION OF VAPORS MAY CAUSE NAUSEA, VOMITING, HEADACHE, OR LOSS OF CONSCIOUSNESS. EMERGENCY AND FIRST AID PROCEDURES IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN. IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. FLUSH SKIN WITH WATER.

SECTION VI - Reactivity Data



STABILITY: STABLE HAZARDOUS POLYMERIZATION; WILL NOT OCCUR CONDITIONS TO AVOID: HEAT, SOURCES OF IGNITION, FLAME INCOMPATIBLES: STRONG OXIDIZING AGENTS

SECTION VII - Spill and Disposal Procedures

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING. SHUT OFF IGNITION SOURCES; NO FLARES, SMOKING OR FLAMES IN AREA. STOP LEA IF YOU CAN DO SO WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. TAKE UP WITH SAND OR OTHER NON-COMBUSTIBLE ABSORBENT MATERIAL AND PLACE INTO CONTAINER FOR LATER DISPOSAL. FLUSH AREA WITH WATER. J. T. BAKER SOLUSORB(R) SOLVENT ADSORBENT IS RECOMMENDED FOR SPILLS OF THIS PRODUCT. DISPOSAL PROCEDURE DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS. EPA HAZARDOUS WASTE NUMBER: U159 (TOXIC WASTE)

SECTION VIII - Protective Equipment

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS. RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS UP TO 1000 PPM, A CHEMICAL CARTRIDGE RESPIRATOR WITH ORGANIC VAPOR CARTRIDGE IS RECOMMENDED. ABOVE THIS LEVEL, A SELF-CONTAINED BREATHING APPARATUS IS RECOMMENDED. EYE/SKIN PROTECTION: SAFETY GLASSES WITH SIDESHIELDS, RUBBER GLOVES ARE RECOMMENDED.

SECTION IX - Storage and Handling Precautions

SAF-T-DATA(TM) STORAGE COLOR CODE: RED SPECIAL PRECAUTIONS BOND AND GROUND CONTAINERS WHEN TRANSFERRING LIQUID. KEEP CONTAINER TIGHTLY CLOSED. STORE IN A COOL, DRY, WELL-VENTILATED, FLAMMABLE LIQUID STORAGE AREA.

SECTION X - Transportation Data and Additional Information

DOMESTIC (D.O.T.) PROPER SHIPPING NAME METHYL ETHYL KETONE HAZARD CLASS FLAMMABLE LIQUID UN/NA UN1193 LABELS FLAMMABLE LIQUID INTERNATIONAL (I.M.O.) PROPER SHIPPING NAME METHYL ETHYL KETONE HAZARD CLASS 3.2 UN/NA UN1193 LABELS FLAMMABLE LIQUID

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Is there anything else you can learn from the MSDS about the use of MEK for this task?

Section IV of the MSDS tells us that “MEK is a dangerous fire hazard and a moderate explosion hazard when exposed to heat or flame.” If you know what happens in a paper machine, you know there is plenty of heat.

You may want to investigate if there are other materials that could do the same job without posing the same kind of health and flammability hazards.

Example 2: Investigating the Slimicide

Recall that several cases of skin rash have come to the attention of the safety committee. The safety committee has further investigated what might be causing the skin rashes.

One member of the committee suggests that you look for any chemical usage that may have changed recently. Your initial investigation leads you to a slimicide that seems to have been introduced in the last couple of months. It is called **Slimetrol RX45**. It is used in number one paper machine and is introduced at the wet end. Since this is the general area where several of the reported cases have worked, it seems worth investigating further.

What does the MSDS for Slimetrol RX45 tell you that is helpful in your investigation?**Ingredients**

Four ingredients are listed in Section 2, one of which is a trade secret. The listed ingredients are:

- *Heavy Aromatic Naptha*
- *B-Bromo-B-Nitrostyrene*
- *Dimethylformamide*

Health Hazard Effects

Section 3 lists a number of health effects of the material as a whole. These include acute effects of severe skin and respiratory irritation, and chronic effects of dermatitis and reproductive system damage.

A good thorough MSDS may be all you need to do your investigation and make decisions about a material's hazards. Is this the case for this MSDS?

You know from the information provided in this MSDS that Slimetrol may cause some of the skin effects you're concerned with. However, the MSDS is somewhat confusing because there are four ingredients and it isn't clear which may be the most hazardous. So this is a case where more information would be helpful.

**BETZDEARBORN MATERIAL
SAFETY DATA SHEET**



EFFECTIVE DATE: 21-MAY-1998
PRINTED DATE: 16-NOV-1999

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1) CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME : SLIME-TROL RX-45

PRODUCT APPLICATION AREA: A BIOCIDES AND/OR SLIME CONTROL AGENT.

COMPANY ADDRESS:

BetzDearborn Inc.
4636 Somerton Road, Trevose, Pa. 19053
Information phone number: (215) - 355-3300

EMERGENCY TELEPHONE (HEALTH/ACCIDENT): (800)-877-1940 (USA)

2) COMPOSITION / INFORMATION ON INGREDIENTS

Information for specific product ingredients as required by the U.S. OSHA HAZARD COMMUNICATION STANDARD is listed. Refer to additional sections of this MSDS for our assessment of the potential hazards of this formulation.

HAZARDOUS INGREDIENTS:

CAS#	CHEMICAL NAME
68-12-2	DIMETHYLFORMAMIDE (DMF) Combustible; possible human carcinogen (IARC=2B); embryotoxic (animals, high doses); potential liver and kidney toxin
64742-94-5	SOLVENT NAPHTHA, PETROLEUM, HEAVY AROMATIC Combustible liquid; irritant (eyes)
95-63-6	1,2,4-TRIMETHYLBENZENE Flammable; irritant (respiratory); CNS depressant
7166-19-0	B-BROMO-B-NITROSTYRENE Corrosive (eyes and skin); highly toxic (by inhalation); toxic (by ingestion) TRADE SECRET INGREDIENT(E019);TSRN 125438 - 5008P Irritant (eyes and skin)
91-20-3	NAPHTHALENE Irritant; absorbed by skin; sensitizer; toxic to liver, kidney, and blood

CONTINUED

PRODUCT NAME : SLIME-TROL RX-45
EFFECTIVE DATE: 21-MAY-1998



3) HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

DANGER

Severe irritant to the skin. Absorbed by skin. Corrosive to the eyes. Vapors, gases, mists and/or aerosols cause irritation to the upper respiratory tract. Prolonged exposure may cause dizziness and headache.

DOT hazard: Combustible liquid
Emergency Response Guide #27
Odor: Hydrocarbon; Appearance: Red-Brown, Liquid

Fire fighters should wear positive pressure self-contained breathing apparatus(full face-piece type). Proper fire-extinguishing media: dry chemical, carbon dioxide, foam or water

POTENTIAL HEALTH EFFECTS

ACUTE SKIN EFFECTS:

Primary route of exposure; Severe irritant to the skin. Absorbed by skin.

ACUTE EYE EFFECTS:

Corrosive to the eyes.

ACUTE RESPIRATORY EFFECTS:

Primary route of exposure; Vapors, gases, mists and/or aerosols cause irritation to the upper respiratory tract. Prolonged exposure may cause dizziness and headache.

INGESTION EFFECTS:

May cause severe gastrointestinal irritation with possible nausea, vomiting, headache, dizziness, unconsciousness and injury to kidneys and liver. Aspiration during ingestion or vomiting may cause lung injury, possibly leading to death.

TARGET ORGANS:

Prolonged or repeated exposures may cause defatting-type dermatitis and/or toxicity to the liver and kidney. Component(s) may cause reproductive toxicity at maternal toxic levels. Limited evidence for increased risk of cancer.

MEDICAL CONDITIONS AGGRAVATED:

Not known.

SYMPTOMS OF EXPOSURE:

Excessive dermal exposure causes defatting and drying of skin. Excessive inhalation of vapors causes dizziness, headache and nausea.

PRODUCT NAME : SLIME-TROL RX-45
EFFECTIVE DATE: 21-MAY-1998

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4) FIRST AID MEASURES

SKIN CONTACT:

Remove clothing. Wash area with large amounts of soap solution or water for 15 min. Immediately contact physician.

EYE CONTACT:

Immediately flush eyes with water for 15 minutes. Immediately contact a physician for additional treatment.

INHALATION:

Remove victim from contaminated area. Apply necessary first aid treatment. Immediately contact a physician.

INGESTION:

Do not feed anything by mouth to an unconscious or convulsive victim. Do not induce vomiting. Immediately contact physician. Dilute contents of stomach using 3-4 glasses milk or water.

5) FIRE FIGHTING MEASURES

FIRE FIGHTING INSTRUCTIONS:

Fire fighters should wear positive pressure self-contained breathing apparatus (full face-piece type).

EXTINGUISHING MEDIA:

dry chemical, carbon dioxide, foam or water

HAZARDOUS DECOMPOSITION PRODUCTS:

Thermal decomposition (destructive fires) yields elemental oxides.

FLASH POINT:

136F 58C SETA(CC)

MISCELLANEOUS:

Combustible liquid
NA1993;Emergency Response Guide #27

6) ACCIDENTAL RELEASE MEASURES

PROTECTION AND SPILL CONTAINMENT:

Ventilate area. Use specified protective equipment. Absorb on paper trim. Recycle paper trim into hydropulper. If other absorbent material is used it should be considered a pesticide, placed in a waste disposal container and disposed of in an approved pesticide landfill. See product label for storage and disposal instructions.

Flush area with water. Spread sand/grit. Neutralize with sodium sulfite.

DISPOSAL INSTRUCTIONS:

Water contaminated with this product may be sent to a sanitary sewer treatment facility, in accordance with any local agreement, a permitted waste treatment facility or discharged under a permit. Product as is - Dispose of in approved pesticide facility or according to label instructions.

PRODUCT NAME : SLIME-TROL RX-45
EFFECTIVE DATE: 21-MAY-1998



7) HANDLING AND STORAGE

HANDLING:

Combustible. Do not use around sparks or flames. Bond containers during filling or discharge when performed at temperatures at or above the product flash point.

STORAGE:

Keep containers closed when not in use. Store in cool ventilated location. Store away from oxidizers.

8) EXPOSURE CONTROLS/PERSONAL PROTECTION

CHEMICAL NAME	EXPOSURE LIMITS
---------------	-----------------

DIMETHYLFORMAMIDE (DMF)	
-------------------------	--

PEL (OSHA): 10 PPM(SKIN)

TLV (ACGIH): 10 PPM(SKIN)

SOLVENT NAPHTHA, PETROLEUM, HEAVY AROMATIC	
--	--

PEL (OSHA): NOT DETERMINED

TLV (ACGIH): NOT DETERMINED

MISC: Note- manufacturer's recommended exposure limit: 100 ppm.

1,2,4-TRIMETHYLBENZENE	
------------------------	--

PEL (OSHA): NOT DETERMINED

TLV (ACGIH): 25 PPM(TRIMETHYLBENZENE MIXED ISOMERS)

B-BROMO-B-NITROSTYRENE	
------------------------	--

PEL (OSHA): NOT DETERMINED

TLV (ACGIH): NOT DETERMINED

TRADE SECRET INGREDIENT(E019);TSRN 125438 - 5008P	
---	--

PEL (OSHA): NOT DETERMINED

TLV (ACGIH): NOT DETERMINED

NAPHTHALENE	
-------------	--

PEL (OSHA): 10 PPM

TLV (ACGIH): 10 PPM

PRODUCT NAME : SLIME-TROL RX-45
EFFECTIVE DATE: 21-MAY-1998



8) EXPOSURE CONTROLS/PERSONAL PROTECTION (continued)

ENGINEERING CONTROLS:

Adequate ventilation to maintain air contaminants below exposure limits.

PERSONAL PROTECTIVE EQUIPMENT:

Use protective equipment in accordance with 29CFR 1910 Subpart I

RESPIRATORY PROTECTION:

A RESPIRATORY PROTECTION PROGRAM THAT MEETS OSHA'S 29 CFR 1910.134 AND ANSI Z88.2 REQUIREMENTS MUST BE FOLLOWED WHENEVER WORKPLACE CONDITIONS WARRANT A RESPIRATOR'S USE.

USE AIR PURIFYING RESPIRATORS WITHIN USE LIMITATIONS ASSOCIATED WITH THE EQUIPMENT OR ELSE USE SUPPLIED AIR-RESPIRATORS.

If air-purifying respirator use is appropriate, use a respirator with organic vapor cartridges and dust/mist prefilters.

SKIN PROTECTION:

gauntlet-type butyl gloves, chemical resistant apron-- Wash off after each use. Replace as necessary.

EYE PROTECTION:

splash proof chemical goggles, face shield

9) PHYSICAL AND CHEMICAL PROPERTIES

Specific Grav. (70F, 21C)	0.948	Vapor Pressure (mmHG)	4.8
Freeze Point (F)	< -30	Vapor Density (air=1)	> 1.00
Freeze Point (C)	< -34		
Viscosity (cps 70F, 21C)	4	% Solubility (water)	0.0
Odor		Hydrocarbon	
Appearance		Red-Brown	
Physical State		Liquid	
Flash Point	SETA(CC)	136F 57C	
pH 50% Extract (approx.)		2.8	
Evaporation Rate (Ether=1)		< 1.00	

NA = not applicable ND = not determined

10) STABILITY AND REACTIVITY

STABILITY:

Stable under normal storage conditions.

HAZARDOUS POLYMERIZATION:

Will not occur.

INCOMPATIBILITIES:

May react with strong oxidizers.

DECOMPOSITION PRODUCTS:

Thermal decomposition (destructive fires) yields elemental oxides.

BETZDEARBORN INTERNAL PUMPOUT/CLEANOUT CATEGORIES:

"B"

PRODUCT NAME : SLIME-TROL RX-45
EFFECTIVE DATE: 21-MAY-1998



11) TOXICOLOGICAL INFORMATION

Oral LD50 RAT:	2,200 mg/kg
Dermal LD50 RABBIT:	5,700 mg/kg
Inhalation LC50 RAT:	>7,700 ppm/hr
Skin Irritation Score RABBIT:	.37
Eye Irritation Score RABBIT:	7.3

NOTE - Reversible; 3 day test, max.ave. score day 1

12) ECOLOGICAL INFORMATION

AQUATIC TOXICOLOGY

Rainbow Trout 96 Hour Static Acute Bioassay

LC50: 1 mg/L
No Effect Level: .75 mg/L

Daphnia magna 48 Hour Static Acute Bioassay

LC50: 1.37 mg/L
No Effect Level: .75 mg/L

Bluegill Sunfish 96 Hour Static Acute Bioassay

LC50: 1.1 mg/L
No Effect Level: .625 mg/L

Mysid Shrimp 96 Hour Static Acute Bioassay

LC50: 2.1 mg/L

Sheepshead Minnow 96 Hour Static Acute Bioassay

LC50: 3 mg/L

BIODEGRADATION

COD (mg/gm): 2429 Calculated
TOC (mg/gm): 669 Calculated
BOD-5 (mg/gm): 29 Calculated
BOD-28 (mg/gm): 131 Calculated

13) DISPOSAL CONSIDERATIONS

If this undiluted product is discarded as a waste, the US RCRA hazardous waste identification number is :
D001=Ignitable.

Please be advised; however, that state and local requirements for waste disposal may be more restrictive or otherwise different from federal regulations. Consult state and local regulations regarding the proper disposal of this material.

PRODUCT NAME : SLIME-TROL RX-45
EFFECTIVE DATE: 21-MAY-1998



14) TRANSPORT INFORMATION

DOT HAZARD: Combustible liquid
UN / NA NUMBER: NA1993
DOT EMERGENCY RESPONSE GUIDE #: 27

15) REGULATORY INFORMATION

TSCA:

This is an EPA registered biocide and is exempt from TSCA inventory requirements.

CERCLA AND/OR SARA REPORTABLE QUANTITY (RQ):

317 gallons due to DIMETHYLFORMAMIDE (DMF);576 gallons due to NAPHTHALENE; Treat as oil spill

FIFRA REGISTRATION NUMBER:

45017-29

FOOD AND DRUG ADMINISTRATION:

21 CFR 176.300 (slimicides for wet end use)
When used in this specified application, all ingredients comprising this product are authorized by FDA for the manufacture of paper and paperboard that may contact aqueous and fatty foods as per 21 CFR 176.170(a)(4).

SARA SECTION 312 HAZARD CLASS:

Immediate(acute);Delayed(Chronic);Fire

SARA SECTION 302 CHEMICALS:

No regulated constituent present at OSHA thresholds

SARA SECTION 313 CHEMICALS:

CAS#	CHEMICAL NAME	RANGE
68-12-2	DIMETHYLFORMAMIDE (DMF)	2.0-5.0%
95-63-6	1,2,4-TRIMETHYLBENZENE	16.0-20.0%
91-20-3	NAPHTHALENE	2.0-5.0%

CALIFORNIA REGULATORY INFORMATION

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65) CHEMICALS PRESENT:

No regulated constituent present at OSHA thresholds

MICHIGAN REGULATORY INFORMATION

CAS#	CHEMICAL NAME
91-20-3	NAPHTHALENE

PRODUCT NAME : SLIME-TROL RX-45
EFFECTIVE DATE: 21-MAY-1998



16) OTHER INFORMATION

NFPA/HMIS

CODE TRANSLATION

Health	2	Moderate Hazard
Fire	2	Moderate Hazard
Reactivity	0	Minimal Hazard
Special	NONE	No special Hazard
(1) Protective Equipment	D	Goggles, Face Shield, Gloves, Apron

(1) refer to section 8 of MSDS for additional protective equipment recommendations.

CHANGE LOG

	EFFECTIVE DATE	REVISIONS TO SECTION:	SUPERCEDES
MSDS status:	22-AUG-1995	REVISED FORMAT	** NEW **
	13-DEC-1995	15;EDIT:8	22-AUG-1995
	17-JAN-1997	2	13-DEC-1995
	01-APR-1997	12	17-JAN-1997
	21-MAY-1998	2	01-APR-1997



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