Chemical Safety in the Laboratory

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All You Need to Know to be Safe in the Laboratory are Found in the Following Three Hazard Control Areas.

Hazard Control Measures

- **Engineering Controls**: The work environment is designed to eliminate hazards or reduce exposure to hazards.

- **Work Practices and Administrative Controls**: Policies or procedures used to reduce employee exposure.

- **Personal Protective Equipment**: Worn by the worker to protect against exposure to chemicals.

Work Practices and Administrative Controls Examples

- Standard operating procedures
- Training requirements
- Chemical Hygiene Plan
- Lab policies and procedures
- Inspections and audits
- Emergency procedures

How HVAC Works In a Typical Lab
Hazardous Work in Laboratories Standard

- MI OSHA Regulation, Jan 1, 1992
- Laboratory Use and Laboratory Scale
- Chemical Hygiene Plan
- Supersedes Right-To-Know and all other substance specific standards

Chemical Hygiene Plan

- Hazards of chemicals
- Appropriate work practices and procedures.
- Controls to protect all workers.
- Basic standard operating procedures (SOPs).

Personal Protective Equipment

Laboratory Fire (9/27/98)
"A safe day in the lab does not happen by accident"

RJC
2011

Safe Research

- Anticipate and Identify the Hazard(s)
- Select the Appropriate Hazard Control and Safety Measures
- Control Hazards and Risks

Who is ultimately responsible for your Health and Safety?

YOU!
Hazards -vs- Risks

- Hazard: physical and chemical properties of materials.
- Risk: probability that a substance will produce harm.
Hazards in the Laboratory Environment

Radioactive Hazard
- Safety Hazard
  - Temperature

Biohazard
- Light

Chemical Hazard
  - Health
  - Physical

Routes of Exposure
- Inhalation
- Skin Contact
- Ingestion
- Injection

Local Effect
Occurs at the point of contact with the skin, eyes, nose, throat and airway.

Systemic Effect
Occurs when a chemical or physical agent gets into the blood and is distributed throughout the body to tissues.

Latent Effect
Delayed effect that may occur one to seventy-two hours after exposure.
ACUTE EXPOSURE AND EFFECT

Single Exposure
Usually High Concentrations

WARNING SIGNS
- Dizziness
- Disorientation
- Rapid Breathing
- Blurred vision
- Heavy Sweating
- Difficulty Breathing
- Chest Pains
- Headache
- Loss of Coordination
- Ringing in Ears
- Skin Irritation
- Nausea

CHRONIC EXPOSURE AND EFFECT

Repeated Exposures
Usually Low Concentrations

Properties and Hazardous
- Physical & Chemical Hazards involve the release of energy in a violent fashion: fires, explosions, violent reactions
- Health Hazards interact directly with the body to cause harm.
Health Hazards
- Carcinogens
- Toxic
- Highly Toxic
- Irritants
- Corrosives
- Sensitizers
- Reproductive Toxin

Dose Response Curve
The effects of exposure to hazardous chemicals vary with the amount of exposure or “dose.”

Goal: Keep exposure at level where no adverse effects occur

Permissible Exposure Limits
Rule 4. For laboratory uses of MI OSHA-regulated substances, an employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in MI OSHA occupational health standards.

Exposure Limits
- Examples of PELs:
  - Permissible Exposure Limit (PEL)
  - Regulatory limits on concentration of a substance in air
  - Based on an 8-hour time weighted average (TWA)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>PEL (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>750</td>
</tr>
<tr>
<td>Ethyl ether</td>
<td>400</td>
</tr>
<tr>
<td>Methanol (skin)</td>
<td>200</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>0.75</td>
</tr>
</tbody>
</table>

If PEL is less than 50 ppm, work in a hood.

Exposure Limits/ TWA
- OSHA PEL 8 Hours Enforceable
- MIOSHA PEL 8 Hours Enforceable
- ACGIH TLV 8 Hours Recommend
- NIOSH REL 10 Hours Recommend

Exposure Limits
- PEL Permissible Exposure Limit
- TLV Threshold Limit Value
- STEL Short Term Exposure Limit
- Ceiling
- IDLH Immediately Dangerous to Life and Health
Carbon Monoxide

- OSHA PEL: 50 ppm
- MIOSHA PEL: 35 ppm
- ACGIH TLV: 25 ppm
- NIOSH REL: 35 ppm
- NIOSH Ceiling: 200 ppm
- NIOSH IDLH: 1,200 ppm

LD$_{50}$

LD$_{50}$: amount to kill 50% of test animals in one dose
Low LD$_{50}$ = High toxicity
LD$_{50}$ says nothing about levels at which other acute toxic, but non-lethal effects might occur

If LD$_{50}$ < 50 mg/kg:
- PPE
- Training
- Label, dispose or decontaminate all equipment
- Handle with care
- Engineering controls: Work inside a hood

Carcinogens

Chemical substances which induce cancer or increase its incidence.
Carcinogens are assigned to one of three hazard categories:
1A - Known Human Carcinogen
1B - Presumed Human Carcinogen
2 - Suspected Carcinogen.
A list of carcinogens can be found in the CHP.

Do not cause harm upon initial exposure, but repeated exposures over many years.
Common lab carcinogens and their uses are:
- Chloroform - laboratory solvent
- Formaldehyde - tissue preservation
- Carbon tetrachloride - laboratory solvent

Working With Carcinogens

- Using engineering controls, such as fume hoods or glove boxes.
- Using PPE such as eye protection, lab coat, and gloves.
- Developing an SOP.
- Keeping quantities to a minimum.
- Labeling bottle and storage area with the words carcinogen or cancer hazard.

Mutagens & Teratogens

Mutagen:
Agent giving rise to an increased occurrence of mutations in populations of cells and/or organisms.
One of two hazard categories, 'known or presumed' and 'suspected'.
Examples:
- Ethidium bromide
- Formaldehyde, nicotine

Reproductive Toxicity:
Adverse effects on sexual function and fertility in adult males and females
- Developmental toxicity in offspring
One of two hazard categories, 'known or presumed' and 'suspected'.
Examples:
- Ethyl alcohol
- Mercury compounds

Sensitizers

Cause an allergic reaction after repeated exposure
Respiratory sensitizer: induces hypersensitivity of the airways
Skin sensitizer: induces an allergic response following skin contact
Abnormally severe allergic responses upon repeated exposure to the chemical.
Examples of sensitizers:
- Formaldehyde/Formalin
- Latex
Irritants

- Reversible, but still painful, inflammation of skin, eyes, nose or respiratory tract.
- Examples:
  - Diluted acids
  - Halogens
  - Alkaline dusts and mists
  - Ozone
  - Hydrogen chloride
  - Arsenic trichloride
  - Diethyl/dimethyl sulfate

Particularly Hazardous Substances

- Select carcinogens, reproductive toxicants and highly toxic chemicals

Special Considerations:
- Establish and label designated work areas.
- Notify ALL lab staff of the work area.
- Label, decontaminate or dispose of contaminated items.