OCCUPATIONAL HYGIENE & HAZARDS

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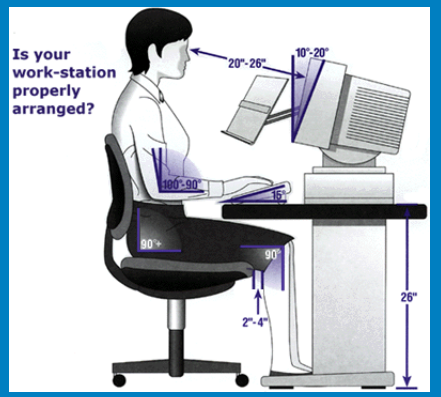
Expected Outcomes from this lecture



- The value of occupational hygiene and the role
- Health hazards
- Hazard recognition techniques

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Expected Outcomes from this lecture

- Sources and potential routes of exposure
- Exposure assessment and the measurement processes
- Methods of control

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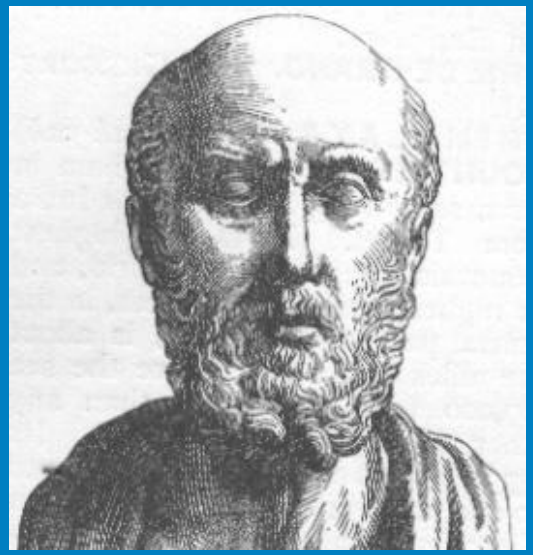
History

Ca 400 BC Hippocrates in ancient Greece first noted illness in mercury sulphide workers.



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History

1858 John Stenhouse introduces a charcoal impregnated mask to control exposure to gases and vapours.

John Stenhouse respirator

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History

1910 Alice Hamilton works in the US as the first Industrial toxicologist pioneering the field of toxicology and occupational hygiene.

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History

- 1917 - During the first world war, the urgency of the work in munitions factories led to poor working conditions.

- The work of the "Health of Munitions Workers Committee" laid the ground for many subsequent practices in ergonomics, psychology, welfare and shift-work regimes.

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- 1920s-30s - Industrial hygiene develops and grows in the USA in both the Public Health Service (PHS) and large private companies.

- 1938/9 - The American Conference of Governmental Industrial Hygiene (ACGIH) and the American Industrial Hygiene Association (AIHA) were formed.

- 1953 - British Occupational Hygiene Society (BOHS) founded.

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- 1970s - Occupational Safety and Health Act in the USA and the Health and Safety at Work Act in the UK lay the path for Risk Assessment / performance based legislation.
- 1980/90s - The practice of occupational hygiene grows widely in the USA, UK,
- 2000s - The societies of 25 different countries are members of the International Occupational Hygiene Association (IOHA).
    - Industrialisation in countries such as China and India increase the need for Occupational hygiene.
    - The development of modelling techniques for assessing exposure.

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That means approximately 228 people have died from work related injury or ill health since we started an hour ago.

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What is Occupational Hygiene?

The International Occupational Hygiene Association (IOHA) defines Occupational Hygiene as:

"The discipline of **anticipating**, **recognizing**, **evaluating** and **controlling** health hazards in the working environment with the objective of protecting worker health and well-being and safeguarding the community at large".

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"The science and art devoted to the anticipation, recognition, evaluation and control of factors and stresses (arising in or from the workplaces), which may cause sickness, impaired health and well being or significant discomfort, and inefficiency among workers or among the citizens of a community" –

"The science devoted to *recognition (or identification), evaluation and control of hazards arising in or from the workplace*, which could impair the health and well being of people at work, while also taking into account the possible impacts on the general environment "-

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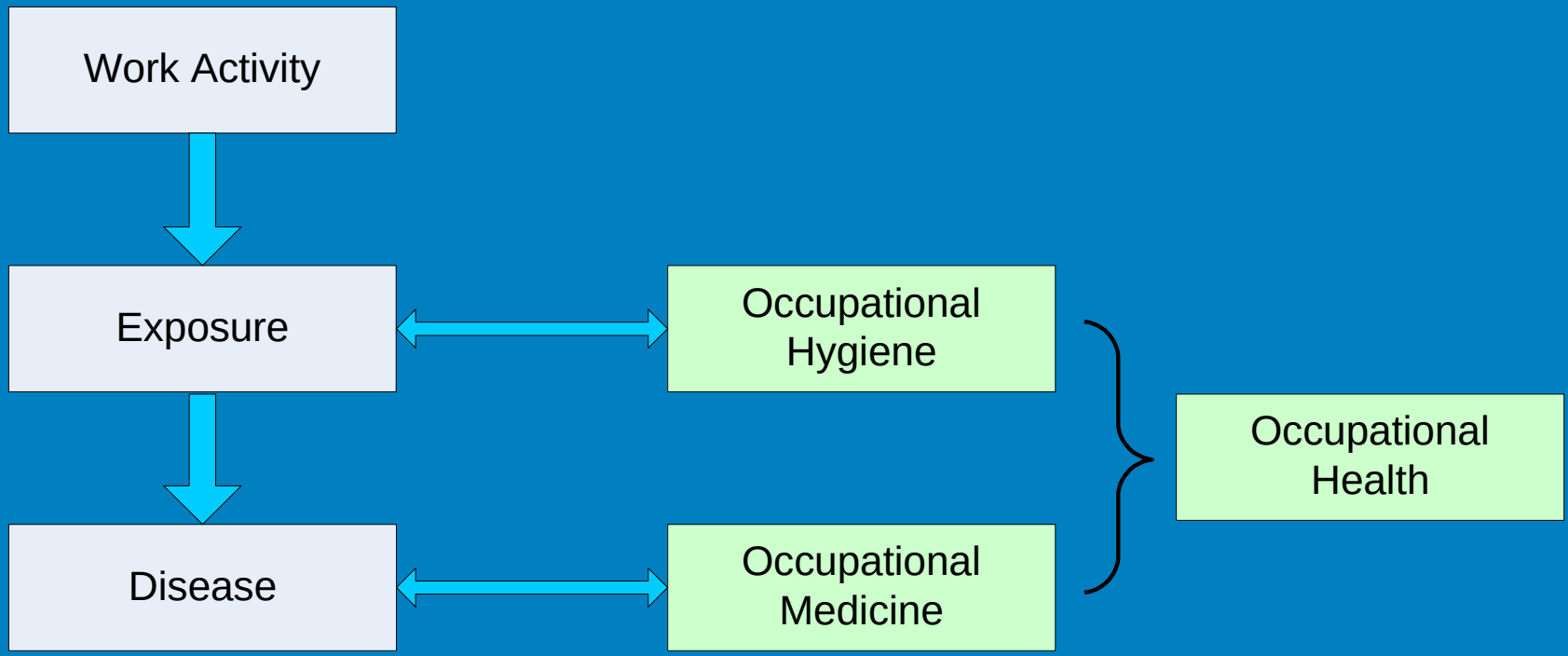
What is Occupational Hygiene?



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Objectives

- To create awareness among employers and workers on the importance of OH practices in industry to preserve and protect the health of workers from being affected by hazards in the working environment.

- To investigate the effect of specific hazard on the health of workers so that the short and long term measures can be taken to control the hazard

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Activities

- Occupational Hygiene Inspection
- Monitoring of occupational hazards
- Biological monitoring

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Activities

- Enforcement
- Investigation of complaints / accidents
- Training

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Scope of OH

- Anticipation
- Recognition
- Evaluation
- Control

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Anticipating and Recognizing

ANTICIPATION – this involves identifying potential hazards in the workplace before they are introduced.

RECOGNITION - this involves identifying the potential hazard that a chemical, physical or biological agent - or an adverse ergonomic situation - poses to health.

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Anticipation

- Design of process, equipment
- Future legislation/regulations
- Research

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Recognition

- Raw materials, by-product, products
- Process and operations
- Records of accidents and diseases
- Walk around – senses, talk to workers, etc
- Grab samples

Evaluation

EVALUATION of the extent of exposure to the chemical hazards, physical or biological agents (or adverse ergonomic situation) in the workplace. This often involves measurement of the personal exposure of a worker to the hazard/agent in the workplace, particularly at the relevant interface between the environment and the body, e.g. breathing zone, hearing zone, and assessment of the data in terms of recommended occupational exposure limits (OELs), where such criteria exist.

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Evaluation

- Purpose
- Sampling technique and strategy
- Instrumentation (Real time & non Rt)
- Standard, regulations etc

Scientific Committee on Occupational Exposure Limits (SCOEL) will give advice on the setting of OELs based on scientific data and where appropriate propose dvalues.

Control

CONTROL of the chemical, physical or biological agent - or adverse ergonomic situation, by procedural, engineering or other means where the evaluation indicates that this is necessary.

LVPEI
So that all may see

Control

- Principle of control measures
- Hierarchy of control measures

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Control

- Improve health and hygiene
- Reduce compensation
- Improve job satisfaction

Control

- Reduce absenteeism
- Improve productivity
- Improve workers' attitude towards management

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Industrial Hygiene Instruments

- Noise level – Dosimeter, SLM
- Lighting – Luxmeter
- Heat – WBGT, Hygrothermometer
- Gas/Vapour/Fumes – Gas detector, Drager pump
- Dust – suction pump

Occupational Hygiene Inspection

What are you going to inspect???

- Refer to the checklist on factory inspection

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Industrial Hygiene Monitoring - occupational hazards

- Chemical
- Biological
- Physical
- Ergonomic/mechanical
- Psychosocial

Biological Monitoring

- Blood – Pb, Hg, Cd etc
- Lung Function Test
- HCP

Result and Action

- Medical surveillance
- Medical examination
- Removal

Result and Action

- Control
- Laws
- Enforcement

Exposure Assessment

- Control exposures
- Compliance determinations
- Program management
    - (i.e. respiratory; hearing/noise; medical surveillance, etc.)

Exposure Assessment

- Epidemiologic studies
- Health complaint investigations
- Risk assessment
- Proposed change evaluations to process

Control Methods

- Engineering – remove the hazard; should be primarily considered.

Control Methods

- Administrative – reduce exposures through scheduling/job rotation; housekeeping; employee training; not generally favored.

Control Methods

- Personal Protective Equipment (PPE) – use should be secondary to design and implementation of engineering controls.

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Engineering Controls

- Substitution
- Change in process
- Source modification
- Isolation
- Enclosure
- Wet methods
- Ventilation

Exposure Assessment

- Determination or estimation of the magnitude, frequency, duration, and route of exposure.
- Determine purpose and scope of survey
- Become familiar with process operations

Exposure Assessment

- Perform the preliminary, qualitative survey
- Conduct workplace monitoring as a quantitative evaluation
- Interpret the sampling results.

Types of Evaluations

- Comprehensive exposure assessment to identify and quantify health hazards
- Assess compliance with regulatory standards and/or technical guidelines
- Review exposures based on complaints +

Types of Evaluations

- Comprehensive exposure assessment to identify and quantify health hazards
- Assess compliance with regulatory standards and/or technical guidelines
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Types of Evaluations

- Exposure assessment for medical and epidemiological studies
- Determine effectiveness of engineering and/or administrative controls

Comprehensive Exposure Assessment

Primary objective is to determine the acceptability of exposures to health hazards for all workers in designated work areas or for specific operations such as batch production, spill response, pilot projects, and maintenance.

Based on identification and quantification/estimation of exposures to workplace stressors, then use of walk-through survey procedures for hazard identification, and subsequently, evaluation techniques to estimate employee exposure levels are employed.

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Process Operations

- Physical facility layout +
- Process description and steps
- Inventory of process stressors/hazards
- Worker job classifications

Process Operations

- Worker health status
- Control measures in place +
- Results from past evaluations
- Other associated process hazards

Process Methodology

Information obtained through interviews, personal/visual observations, technical process information, and record reviews.

A walk-through survey is an important methodology to understand, verify, and/or modify documentation; look for potential sources of health hazards and chemical air contaminants and physical agents. +

Past Evaluations/Identify Potential Hazards

Review of past occupational hygiene or related evaluations. Determine: time elapsed; process changes, identification of significant problems, and/or other indicators.

Personnel interviews and site review. Get workers involved in the familiarization step of a survey to assist with acceptance.

Preliminary assessment - Qualitative

Familiarity with process/operation to qualitatively evaluate magnitude of stressors without benefit of instrumentation.

Visual observations; use of senses (i.e. smell); inspection of control measures implemented and effectiveness; and, PPE.

Work Place monitoring - Quantitative Evaluation

Document exposure levels either by measurement or use of semi-quantitative methods. Strategy developed depends on the reason for evaluation. Purpose is FIRST!

Sampling objectives: EITHER engineering testing, surveillance, or control; OR compliance, health research, or epidemiological purposes.

Stressor Identification/ Concentration Estimation

Hazard information by familiarization and then prioritization (probability/consequence of overexposure) based on significance for monitoring.

Probable range of contaminant concentrations to assist with sampling strategy development and facilitate selection of monitoring methods and/or specific equipment for assessment.

Sampling and Analytical method selection

Use of accurate, sensitive, specific, and reproducible analytical methods and proper calibrated sampling equipment. Knowledge of interferences and detection limits.

Principles – validated methods (OSHA, NIOSH).

Specificity, selectivity, and other considerations for direct-reading instruments.

Limitations - combine workplace observations with measurements for result interpretation.

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Hazard Recognition

- Chemical Hazards: corrosives/irritants, poisons
- Hazard Assessment for Chemicals
- Physical Hazards: compressed gases, laser hazards

Hazard Assessment

What is the *probability* of exposure?

Hazard Assessment: How is the chemical used?

- Large, open reaction vessel
- No engineering controls
- Heated
- > 1 atm or <<< 1 atm

Hazard Control

- Chemical Hazard Information
- Engineering Controls
- Personal Protective Equipment

Toxicity VS. Hazard

- Toxicity is the capacity of a material to produce injury or harm to living tissue when the chemical has reached a sufficient concentration at a certain site in the human body.

- Hazard is the probability that this concentration will occur within the body; affected by many factor/elements generally related to conditions of use.

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Potential Hazard

- Chemical
- Physical
- Biological
- Ergonomic

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Chemical Hazards

- Hydrocarbons
- Solvents
- Oil Mist
- Dust (Total and Respirable)
- Crystalline Silica
- Formaldehyde
- Carbon Monoxide
- Airborne Fibers

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Physical Hazards

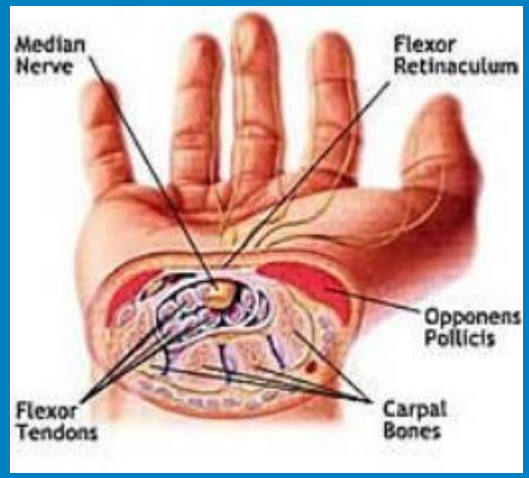
- Noise
- Radiation
  - Ionizing
  - Non-ionizing
- Lighting
- Heat/Cold Stress
- Pressure Extremes

Biological Hazards

- Bioaerosols
- Surface/Bulk Contamination
- Tuberculosis
- Bloodborne Pathogens
- Indoor Air Quality Issues

Ergonomic Hazards

- Musculoskeletal Disorders
- Cumulative Trauma Disorders
- Carpal Tunnel Syndrome
- Material Handling/Lifting
- Workplace Design Considerations



Other Hazards

- Confined Spaces
- Waste Management
- Lab Health and Safety
- Emergency Planning
- Etc. . .

Corrosive Materials

- Chemical substances that, by direct chemical action, are injurious to living tissues or corrosive to metal surfaces
- The degree of hazard associated with a corrosive material is greatly dependent upon its physical state (solid, liquid, gas)
- Minor corrosive injury = irritation

Corrosive Liquids

- Most common cause of corrosive injury

- Corrosive liquids will destroy any living tissue but the most frequently injured organs are the skin and eyes. Corrosive vapors can also escape from some solutions (check out the interior of any acid cabinet). Fuming acids are particularly hazardous

Corrosive Liquids: Bases

- Concentrated alkalies are more damaging to tissues than most strong inorganic acids
- Alkaline solutions gelatinize and saponify tissues, producing deeply penetrating, painful burns
- Even weak alkaline solutions can dissolve skin fats and weaken the epidermis, making the skin more permeable to other agents
- Initial contact may not be painful – poor warning property!

Corrosive Liquids: Acids

- Chemical action of acids is different from that of bases. Acids burn largely due to thermal action with moisture in tissues. When acids come into contact with skin, the acid reacts to form a (very slightly) protective barrier, whereas bases dissolve proteins.

Corrosive Liquids: organic solvents

- A corrosive liquid need not have a very high or low pH to be capable of causing corrosive injury. Many organic solvents can cause severe irritation of skin and mucus membranes by defatting tissues, which paves the way for secondary infections.

Corrosive Liquids: hydrofluoric acid

- HF and gaseous hydrogen fluoride merit special discussion. These are easily the most hazardous corrosive materials encountered in the laboratory

- HF is extremely dangerous not only because it is an acid but because the fluoride ion is capable of traveling through layers of tissue on its way to the bone, producing severe, slow healing burns

- Always store/use HF solutions and hydrogen fluoride gas in a chemical fume hood – never on the lab bench!

Corrosive Gases

- Most seriously hazardous of all corrosive materials! Readily absorbed into the body by dissolution in tissue moisture (e.g. in skin and/or respiratory tract and/or eyes).

- Severity of the corrosive effect and the region o the respiratory tract affected by exposure is greatly dependent upon the **aqueous solubility** of the chemical (see table on next slide).

- Always use/store corrosive gases in a chemical fume hood – never *ever* on the bench!

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Corrosive Gases

Highly water soluble (upper respiratory tract)	**Medium aqueous solubility** (upper respiratory tract and bronchi)	**Low aqueous solubility** (easily reaches alveoli, causing delayed pulmonary edema
Ammonia	Bromine	Phosgene
Hydrogen chloride	Chlorine	Nitrogen dioxide
Hydrogen fluoride	Iodine	Ozone
Formaldehyde	Phosphorus pentachloride	
Sulfonyl chloride	Phosphorus trichloride	
Thionyl chloride	Sulfur dioxide	

Compressed Gas Cylinders

Compressed Gas Cylinders

- Store/use upright and secured
- Cylinder must be hydrostatically tested every 10 years (by the manufacturer)
- Transport cylinders in cylinder carts with protective cap and restraining chain in place

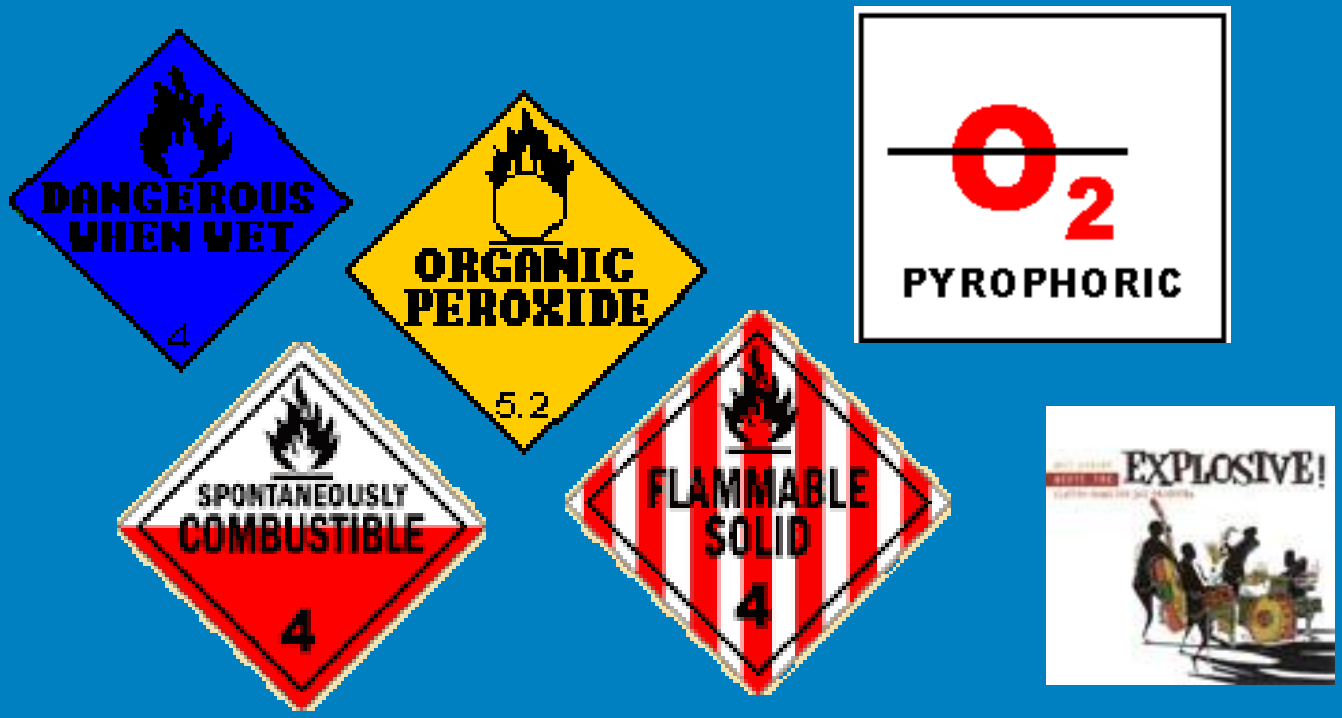
Compressed Gas Cylinders

- Do not use unknown cylinders!
- Open cylinder only after the correct regulator is in place
- Test for leaks with soap solution (e.g. Snoop)

Compressed Gas Cylinders

- Do not force/modify any cylinder valve
- Use O_2 regulators for O_2 only
- Do not empty any cylinder to atmosphere
- Clearly label empty cylinders as such
- Store full cylinders separately from empty

Hazard Assessment: Chemical Reactivity



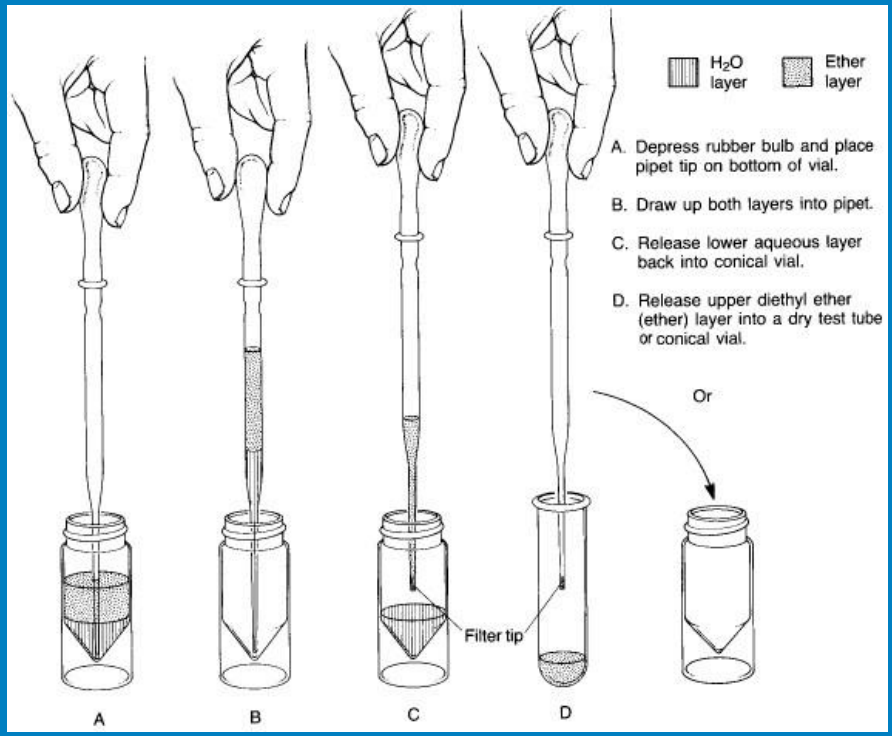
Hazard Assessment: Warning Properties

- Easily detectable warning properties = less hazardous
- Intensely irritating

- Strong odor
- Low odor threshold
- Color

Hazard Assessment: Quantity

large quantities = large hazard



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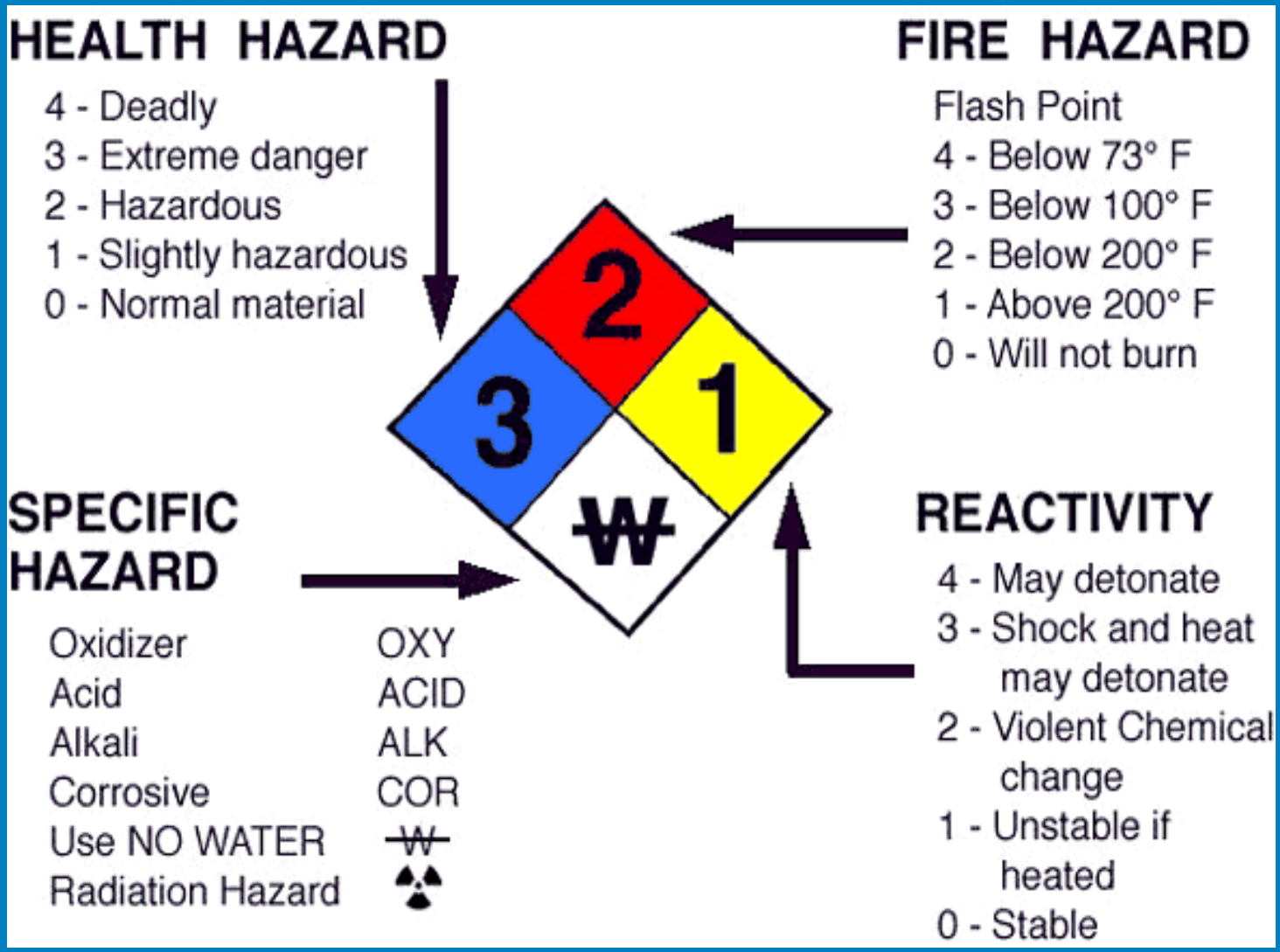

Chemical Hazard Information on the Internet

- Vermont Safety Information Resources, Inc. (Vermont SIRI): http://haz1.siri.org
- Agency for Toxic Substances and Disease Registry (ATSDR) Chemical Fact Sheets (ToxFAQs): www.atsdr.cdc.gov/toxfaq.html
- NIOSH/OSHA/DOE Health Guidelines for Hazardous Chemicals: www.osha-slc.gov/SLTC/healthguidelines/index.html

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Let us know the outcomes from this lecture

- What is the value of occupational hygiene and the role
- What are the potential health hazards
- What are Hazard recognition techniques?

Expected Outcomes from this lecture

- What are the sources and potential routes of exposure?
- Exposure assessment and the measurement processes?
- Methods of control

Thank you!

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