Introduction to Industrial Hygiene

Patrick N. Breysse, PhD, CIH
Peter S.J. Lees, PhD, CIH

Johns Hopkins University
Section A

Definition of Industrial Hygiene
What Is Industrial Hygiene?

♦ Definition

– Science and art devoted to the anticipation, recognition, evaluation, and control of those workplace environmental factors which may cause sickness, impaired health and well-being, or significant discomfort and inefficiency among workers or among citizens of the community
What Is an Industrial Hygienist?

- A person who by study, training, and experience can:
  - Anticipate
  - Recognize
  - Evaluate
  - Control

workplace environmental hazards
Some Occupational Hazards

- Chemical agents
  - Gases, vapors and particulate aerosols
- Physical (energy) agents
  - Noise, ionizing / non-ionizing radiation, heat and cold stress
- Biological agents
  - Infectious agents, allergens
- Psychological stressors
- Ergonomic/safety
Industrial Hygiene Concepts

- Anticipation/recognition of potential or actual hazards through knowledge of:
  - Materials
  - Operations
  - Processes
  - Conditions

- Scope of IH activities encompasses the “cradle-to-grave” concept (research through waste disposal)
Industrial Hygiene Concepts

- Evaluation of environmental factors through:
  - Measurement of exposure intensity
  - Determination of exposure frequency, and duration
  - Comparison with regulatory, professional, and internal standards
  - Judgement: weigh all factors
Control of Exposures

- Employ methods to eliminate or reduce exposure resulting in elimination or reduction of the occurrence of occupational disease through:
  - Engineering (including process) interventions
  - Administrative/programmatic measures
  - Personal protective equipment
Opportunities for Control
Section B

Environmental/Occupational Health Paradigm
Environmental/Occupational Health Paradigm

Source → External Exposure → Internal Exposure → Early Biological Effect → Health Effect

Grinding, Chipping, Milling, Sawing, Sweeping, Heating, Welding

Exposure Assessment, Biomarkers, Biomarkers Clinical Manifestation, Disease Death

Health Effect
IH in the Exposure-Response Paradigm

Response (individual or population) vs. Exposure
Exposure Definitions and Concepts

- Contact between outer boundary of the human body (skin, nose, lungs, GI tract) and a pollutant or mixture of pollutants
- Requires the presence of a pollutant and the contact between the person and that medium (vs. potential exposure)
- Quantified by concentration of the contaminant and the time of contact
Exposure Assessment

- **Route of exposure:** Inhalation, ingestion, dermal, injection
- **Magnitude of exposure:** Concentration in media (ppm, mg/m³, f/cm³)
- **Duration of exposure:** Minutes, hours, days, lifetime
- **Frequency of exposure:** Daily, weekly, seasonally
Section C

The Industrial Hygiene Profession
Education of an Industrial Hygienist

- Usually requires advanced education in engineering and the biological sciences
- A combination of education and experience is necessary in order to take the American Board of Industrial Hygiene (ABIH) exam for certification in industrial hygiene (CIH)
Who Is an Industrial Hygienist?

- Education
  - Undergraduate degree in sciences or engineering (28%)
  - Graduate level (68%)

Source: Taken from AIHA membership survey, 2000
Who Is an Industrial Hygienist?

- Employed by
  - Industry (47%)
  - Consulting (23%)
  - Government (14%)
  - Academia (5%)
  - Insurance (3%)
  - Labor (1%)

Source: Taken from AIHA membership survey, 2000
American Board of Industrial Hygiene

- Established to improve the practice and educational standards of the profession
- Primary influence through certification
  - CIH by written exam and five years practice
  - Not required for practice (no licensing)
  - Five-year recertification cycle
  - Approximately 9,000 in United States
Professional Organizations

- American Industrial Hygiene Association (AIHA)
  - Founded 1939
  - Nonprofit professional society for IH professionals
  - Exists to promote the field
  - 12,500 members in 2000

Continued
Professional Organizations

- American Conference of Governmental Industrial Hygienists (ACGIH)
  - Founded 1938
  - Free exchange of ideas and promotion of standards and techniques in industrial health
Professional Organizations

- **ACGIH**
  - Approximately 5,000 members
  - Full members government and academic IHs only
  - Increased role for associate members
  - Publish threshold limit values (TLVs) and Biological Exposure Indices (BEIs)
Section D

Risk Assessment and Industrial Hygiene
Risk Assessment

- *Risk assessment* is usually considered to be an environmental term, but it is an essential part of the industrial hygiene profession.
- Broadly defined as the methodology that predicts the likelihood of unwanted events (explosions, injuries, natural catastrophes, diseases, death).
## Risk Assessment

### Comparison of Terminology

<table>
<thead>
<tr>
<th>Industrial Hygiene</th>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anticipation and Recognition</td>
<td>Hazard identification</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Exposure and toxicity assessment and Risk characterization</td>
</tr>
<tr>
<td>Control</td>
<td>Risk management</td>
</tr>
<tr>
<td>Hazard communication</td>
<td>Risk communication</td>
</tr>
</tbody>
</table>
Risk Assessment

- The act of comparing exposure measurements with exposure limits (TLVs, PELs, etc.) is a fundamental aspect of risk characterization which is the final step in the risk assessment process.
Risk Assessment

- Risk assessment Equation 1:

\[
\text{Risk} = \left( \frac{\text{Prob. of Health Effect}}{\text{Unit of Exposure}} \right) \times (\text{Level of Exposure})
\]
Risk Assessment

- Another form of Equation 1:

\[
\text{Risk} = \left( \frac{\text{Prob. of Health Effect}}{\text{Absorbed Dose}} \right) \times (\text{Absorbed Dose})
\]
Risk Assessment

- Equation 1: Determining the probability of a negative health effect by combining the dose-response and exposure assessment over some relevant period of time
- Exposure is an approximation for dose
- Absorbed dose is the relative or specific amount of material that gets into the body and therefore can do harm
### Estimated Asbestos Related Cancer Mortality per 100,000 by Number of Years Exposed and Exposure Level

<table>
<thead>
<tr>
<th>Asbestos fiber concentration (f/ml)</th>
<th>Cancer mortality /100,000 exposed</th>
<th>45 years exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lung</td>
<td>Mesothe-lioma</td>
</tr>
<tr>
<td>0.1</td>
<td>231</td>
<td>82</td>
</tr>
<tr>
<td>0.2</td>
<td>460</td>
<td>164</td>
</tr>
<tr>
<td>0.5</td>
<td>1143</td>
<td>407</td>
</tr>
<tr>
<td>2.0</td>
<td>4416</td>
<td>1554</td>
</tr>
<tr>
<td>4.0</td>
<td>8441</td>
<td>2924</td>
</tr>
<tr>
<td>5.0</td>
<td>10318</td>
<td>3547</td>
</tr>
<tr>
<td>10.0</td>
<td>18515</td>
<td>6141</td>
</tr>
</tbody>
</table>


² Estimated as 10% of lung cancer risk rather than calculated using dose-response information.

Source: The Federal Register, 2 August 1986