Evaluating Worker Exposures – The Future Is Arriving

The Risk Assessment & Control Landscape – Measuring Up to the Task, Defining the Future

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Practice Line Leader – Industrial Hygiene
The World of Occupational Health Risk Evaluation

- Environment factors, air quality, climate change
- Work-life balance, physical activity, diet, age
- Nanoparticles, new chemicals, biohazards
- Traditional IH practice

Environmental Human Health

Occupational Health Protection & Health Promotion

Occ. Exposure Assessment w/o OEL and/or S&A methods

Occ. Exposure Assessment to authoritative OEL

Ex: BMW production line retrofit, Obayashi “exoskeleton”

ADCs, advanced materials, flavorings
The IH Decision-making Framework and Process

- Anticipate and Recognize
- Evaluate
- Control and Confirm Protection

Constant communication, continuous improvement

Risk Assessment

**Hazard Assessment**
- Identify and define dose-response relationships and "Hazard Criteria"
- Occupational Exposure Limits
- Skin Notations, ...
- Hazard Bands

**Exposure Assessment**
- Collect all "relevant and reliable" exposure information for assessment against and refinement of the "Hazard Criteria"

**Risk Characterization**
- Characterize risks associated with "realistic" combinations of hazards and exposures

Risk Management
- Use the Hierarchy of Controls to apply "appropriate" controls and programs and confirm protection

How will I include all of this in my IH practice?
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**Occ. Health Protection & Health Promotion**

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Management Systems Approach

Establish OSH policy
 Allocate resources
Identify hazards. OEBs and/or exposure limits
Assess potential risk from exposure

Plan       Do

Act            Check

Plan → Do → Act → Check → Plan
Plan

► Establish policy

- Policy addresses chemical agents without authoritative OELs

“...to protect laboratory workers from adverse health effect ...regardless of what hazardous substances are used.”

► Allocate resources

- OEB Tier 1; IH
- OEB Tier 2; IH with specialized expertise, occupational toxicologist

► Identify hazards and exposure limits or bands

- Ex. NIOSH OEB Guidance Document (pending) and AIHA BoK

► Assess potential risk from exposure
Assessing Potential Exposure Risks

No Authoritative OEL or OEB
Sampling and Analytical Methods Available

Authoritative OEL
Sampling and Analytical Methods to Detect < 0.1 x OEL

No OEL
No OEB
No Sampling Method
No Analytical Method

Authoritative OEL or OEB
No Analytical Method to Quantify Exposures to < 50% of the OEL
Semi-quantitative or Surrogate Methods Available

Ability to Assess Exposures

Knowledge of Occupational Health Hazard

Current IH Exposure Assessment Body of Knowledge
Qualitative Example: dimethyl dicarbonate (CAS 4525-33-1)

Signal word: Danger

Acute toxicity via inhalation (Acute Toxicity 2)

Corrosive to skin (Skin Corr. 1B)

OEB: Band D/E

No authoritative OEL

No sampling or analytical method

No sensor technology

Well within our IH capabilities!

- Consider substitution
- Closed transfers
- Ventilation known to control exposures to < 1 PPM
- Skin and eye protection, RPE
- Access to safety shower and eyewash
- Life cycle assessment; from receipt to ultimate disposal
Management Systems Approach

Establish OSH policy
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Plan

Do

Act

Check

Eliminate and substitute hazards
Control residual exposures
Equipment retrofit
Equipment procurement
Hierarchy of Controls

- **Elimination**: Physically remove the hazard
- **Substitution**: Replace the hazard
- **Engineering Controls**: Isolate people from the hazard
- **Administrative Controls**: Change the way people work
- **PPE**: Protect the worker with Personal Protective Equipment

Courtesy of NIOSH
http://www.cdc.gov/niosh/topics/noisecontrol/
► Eliminate and substitute hazards

- Tier 1 provides a rapid and defensible method
- GHS Hazard Categories that prompt “D” and “E” OEBs indicate the potential for irreversible health effects at relatively low doses

<table>
<thead>
<tr>
<th>Hazard Class</th>
<th>Hazard Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Toxicity</td>
<td>1</td>
</tr>
<tr>
<td>Skin Corrosion/Irritation</td>
<td>1A</td>
</tr>
<tr>
<td>Serious Eye Damage/ Eye Irritation</td>
<td>1</td>
</tr>
<tr>
<td>Respiratory or Skin Sensitization</td>
<td>1</td>
</tr>
<tr>
<td>Germ Cell Mutagenicity</td>
<td>1A</td>
</tr>
<tr>
<td>Carcinogenicity</td>
<td>1A</td>
</tr>
<tr>
<td>Reproductive Toxicity</td>
<td>1A</td>
</tr>
<tr>
<td>Specific Target Organ Toxicity</td>
<td>1</td>
</tr>
<tr>
<td>(STOT) – Repeated Exposure</td>
<td>1</td>
</tr>
</tbody>
</table>

- OEBs: D, E
  - GHS Hazard Categories: 1A, 1B, 1C, 2A, 2B, 2
  - Tier 1 provides rapid and defensible method.
Selecting the Appropriate Controls

**GHS Hazard Statements**
- mild / reversible
- severe / irreversible

**Physical Form**
- slurry/suspension → agglomerated → highly disperse

**Task**
- 8 hours

**Duration**
- 15 minutes

**Quantity**
- kilograms
- milligrams

**Engineered local exhaust ventilation**

**Closed Systems**

**Exposure Risk**
## Including ALL Chemical Hazards into the Design Process

<table>
<thead>
<tr>
<th>Stage</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptual Design</td>
<td>Establish IH goals, identify IH hazards and associated regulations and standards. Identify relevant OELs and/or agents of concern.</td>
</tr>
<tr>
<td>Preliminary Design</td>
<td>Eliminate hazards, if possible. Substitute less hazardous agents / processes, and establish risk minimization targets for remaining hazards (OELs and OEBs). Qualitative exposure assessment; develop control alternatives.</td>
</tr>
<tr>
<td>Procurement</td>
<td>Develop specifications and include in procurements. Develop test protocols for factory acceptance testing and commissioning.</td>
</tr>
<tr>
<td>Construction</td>
<td>Construction site safety and contractor safety.</td>
</tr>
<tr>
<td>Commissioning</td>
<td>Factory acceptance and operational qualification testing. SOPs. Exposure assessments. Mgmt. of residual risks.</td>
</tr>
<tr>
<td>Start Up and Occupancy</td>
<td>Education. Management of change. Modification of SOPs.</td>
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</tbody>
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Assess potential risk from exposure

Eliminate and substitute hazards
Control residual exposures
Equipment retrofit
Equipment procurement

Plan

Do

Act

Check

Exposure control verification
Develop SOPs
Train workers
Health surveillance

Plan

Do

Act

Check
Exposure control verification

- Historical data
- Modeling
- Surrogates must consider
  - Physical Form
  - Morphology
  - Limit of Detection
  - Particle Size
  - Hygroscopy
  - Flowability

Exposure control verification using surrogates must replicate the work environment, including work practices and PPE, that the workers will use.
Management Systems Approach

Plan
- Establish OSH policy
- Allocate resources
- Identify hazards and exposure limits
- Assess potential risk from exposure

Do
- Eliminate and substitute hazards
- Control residual exposures
- Equipment retrofit
- Equipment procurement

Act
- Assess ongoing effectiveness
- Supplement controls
- Make appropriate changes based on new hazard info

Check
- Exposure control verification
- Develop SOPs
- Train workers
- Health surveillance
Act

► Make appropriate changes based on new hazard info

► Recent examples
  - Pesticides
  - Fumigants
  - Carbon nanotubes and nanofibers
  - Nano silver
  - Beryllium
  - Silica
  - Flavorings
Business Value of Worker Health

► Estimated costs of $250B*/year
  - The medical costs associated with occupational disease and injury: $67B
  - Productivity costs $183B, including current and future lost earnings and fringe benefits


► An Integrated Health and Safety Index has been proposed
  - Translates the impact of employer health and safety programs into business value for the investment community

Ultimately, the value of a company can be seen as the health of its workforce

Dr. Robert McLellan, co-author of Integrated Health and Safety model
Integrated Health and Safety Index

Economic
- Leadership + Management
- Absence + Disability Management
- Integrated Health + Productivity

Environmental
- Healthy Workers
- Healthy Environment

Social
- Engagement in Prevention + Wellness
- Value-based Benefits
- Corporate Social Responsibility

Source: 2015 American College of Occupational and Environmental Medicine
AIHA Strategic Direction and Content Priorities

► **Vision:** Elimination of Workplace Illnesses

► **Mission:** Creating Knowledge to Protect Worker Health

► **Content Priorities:**

- Exposure Banding/OEL Process
- Sensor Technologies
- Emerging Markets/Global IH/OH Standard of Care
- IH Value Strategy/Business Case Development
- Changing Workforce Demographics/Environment
- Big Data/Data Management and Interpretation

Protecting Worker Health
Move Forward with Confidence