THE MANY ASPECTS OF OCCUPATIONAL RISK ASSESSMENT: UNDERSTANDING DIFFERING APPROACHES AND GOALS

August 25, 2022
1:00 p.m.-3:00 p.m. EST
MODERATOR INTRODUCTION

- Andrew Maier, MS, PhD, CIH, DABT
  - Director of the WEEL Committee
  - Principal Health Scientist at ChemRisk (Stantec)
  - Former IH in petrochemical industry, associate professor at University of Cincinnati, NIOSH Fellow
WORKSHOP OVERVIEW

• Overall goal is information sharing

• Highlight the key differences in terminology, objectives, and methods

• Describe assessments from different contexts
  − TSCA occupational risk evaluations, health and safety compliance, research, and product stewardship programs.

• Provide comparison of approaches and extrapolating from one domain to another

• Identify common data gaps and opportunities for data sharing
# ROADMAP (AGENDA)

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Presenters</th>
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<tr>
<td>1:00-1:10</td>
<td>AIHA opening remarks, moderator introduction</td>
<td>Larry Sloan (AIHA), Andy Maier (OARS)</td>
</tr>
<tr>
<td>1:10 - 1:55</td>
<td>Speaker presentations</td>
<td>Majd El-Zoobi, Chris Whittaker, Bill Perry</td>
</tr>
<tr>
<td>1:55 - 2:00</td>
<td>Break</td>
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<tr>
<td>2:00 – 2:15</td>
<td>Speaker presentation</td>
<td>Fred Boelter</td>
</tr>
<tr>
<td>2:15 – 2:55</td>
<td>Discussion and Audience polls</td>
<td>Facilitated Panel</td>
</tr>
<tr>
<td>2:55 – 3:00</td>
<td>Next Steps</td>
<td>AIHA Staff</td>
</tr>
</tbody>
</table>
SPEAKERS AND DISCUSSANTS

Speakers

• Fred Boelter, CIH, PE, BCEE, FAIHA
• Majd El-Zoobi, PE
• William Perry, CIH
• Christine Whittaker, PhD

Discussants

• Brenda Finter, CIH, CSP, CHMM
• John Henshaw, CIH, FAIHA
• MaryAnn Hoff, CIH
• Steve Jahn, CIH, FAIHA
• Silvia Maberti, PhD
• Paul Price, PhD
• Rebecca Reindel, CIH
GOALS OF OCCUPATIONAL RA

• Overall goal is protecting worker health
• Fit-for-purpose
• Domains of occupational risk assessment
  – Facility/site based (exposure control)
  – Research-oriented (NIOSH, academic)
  – Compliance-based (OSHA)
  – Chemical registration and evaluation (REACH, TSCA)
RISK ASSESSMENT PROCESSES VARY

**AIHA framework**

**EPA Risk Evaluation Process for Existing Chemicals**

- **Prioritization**
  - Chemical designated Low-Priority
  - Chemical designated High-Priority for Risk Evaluation

- **Risk Evaluation**
  - EPA determination of No Unreasonable Risk
  - EPA determination of Unreasonable Risk

- **Risk Management**
  - Impose restrictions to Eliminate the Unreasonable Risk

---

**Risk Assessment**

1. **Anticipate and Recognize**
2. **Evaluate**
3. **Control and Confirm Protection**

**Risk Characterization**

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

**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"

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**Risk Management**

- Use the Hierarchy of Controls to apply “appropriate” controls and programs and confirm protection
A SHARED FOUNDATION

- Problem formulation
- Exposure assessment
- Dose-response
- Risk characterization
- Risk management
- Risk communication

PHASE I: PROBLEM FORMULATION AND SCOPING

- Identify existing environmental problems
- Options for altering conditions
- Identify needed assessments & risk management options

PHASE II: PLANNING AND CONDUCT OF RISK ASSESSMENT

Stage 1: Planning
- Necessary attributes of assessments
- Appropriate uncertainty and variability

Stage 2: Risk Assessment
- Hazard Characterization
- Dose-Response Assessment
- Exposure Assessment

- Risk Characterization

Stage 3: Confirmation of Utility
- Consistent with planning?
- Discriminate among risk management options
- Review

PHASE III: RISK MANAGEMENT

- Benefits of options
- Impact of other factors
- Communication
- Justification for decision
- Decision effectiveness

FORMAL PROVISIONS FOR INTERNAL AND EXTERNAL STAKEHOLDER INVOLVEMENT AT ALL STAGES

Input should not compromise technical assessment of risk (Adapted from NRC, 2009)

MEET THE SPEAKER

Majd El-Zoobi, PE,
Chemical Engineer, U.S. EPA OCSPP,
Existing Chemicals Risk Assessment Division

• 18 years at EPA as a Chemical Engineer in the Office of Chemical Safety and Pollution Prevention (OCSPP)
• Prior to joining EPA, he worked as a project, process design, and production engineer in the chemical industry
• Expertise in exposure assessment
Occupational Exposure Assessments in TSCA Risk Evaluations

Majd El-Zoobi, M.S., P.E.

Many Paths, One Goal – Protecting Worker Health: An AIHA Workshop Series on Occupational Risk Assessment

August 2022 Workshop: The Many Aspects of Occupational Risk Assessment - Understanding Differing Approaches and Goals

August 25, 2022
Outline

Introduction

- Background
- TSCA Provisions and EPA Work Process

Occupational Exposure Assessment

- Goals
- Elements
- Data Sources and Assessment Approach
- Opportunities for Improvement
Background

EPA evaluates the risk of adverse human health and environmental effects caused by chemical substances

- The Toxic Substances Control Act (TSCA) - 1976
- In commerce (“existing”) and not in commerce (“new”) chemical substances
- TSCA Inventory: ~ 87,000 chemical substances
  - ~ 42,000 chemical substances potentially active in commerce
Identification of Candidate Chemicals for Prioritization

Prioritization

- Low-Priority designation
- High-Priority designation

Risk Evaluation

- No Unreasonable Risk Determination
- Unreasonable Risk Determination

Risk Management

- e.g., 1-Docosanol
- e.g., 1-Eicosanol

- e.g., 1-Docosanol
- e.g., 1-Eicosanol

- e.g., Formaldehyde
- 1,1-Dichloroethane

- e.g., 1,1-Dichloroethane
- 1-Bromopropane
- Methylene Chloride
**Approach:** Occupational Exposure Assessment as Part of the Overall Process

- Prioritization
- Risk Management
- Scoping
- Risk Determination
- Occupational Exposure Assessment as Part of the Risk Evaluation
- Risk Characterization
Conditions of Use (COU)

**Chemical Data Reporting (CDR) Program**

**Public Comments**

**Other Sources**

<table>
<thead>
<tr>
<th>Life-Cycle Stage</th>
<th>Category</th>
<th>Subcategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Processing</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Distribution in commerce</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Industrial use</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Commercial use</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Disposal</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**COU Example**

<table>
<thead>
<tr>
<th>Risk Evaluation</th>
<th>Life Cycle</th>
<th>Category</th>
<th>Subcategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-BP</td>
<td>Industrial/Commercial Use</td>
<td>Solvent (for Cleaning or Degreasing)</td>
<td>Batch Vapor Degreaser (e.g., Open-Top, Closed-Loop)</td>
</tr>
</tbody>
</table>
Conditions of Use (COU) and Occupational Exposure Scenarios (OES)

• OES are environmental release and occupational exposure scenarios associated with the COU and are determined during risk evaluation

• A COU may be associated with one or more OES:
  • Example: the 1-BP COU of batch vapor degreasing
  2 OES: open-top and closed-loop degreasing

• Multiple COUs may be associated with a single OES:
  • Example: the methylene chloride COU of aerosol degreaser, interior car care spot remover, and spray lubricant
  1 OES: commercial aerosol products
Goal of the Occupational Exposure Assessment

To assess worker and occupational non-user (ONU) exposure and to enable risk calculation for each OES of the risk evaluation

Example of non-cancer risk calculation:

\[ \text{MOE} = \frac{\text{non-cancer hazard value}}{\text{worker or ONU exposure}} \]
Goal of the Occupational Exposure Assessment

An example calculation of worker or ONU exposure:

\[ \text{ADD} = \frac{C \times b \times ED \times EF \times WY}{BW \times AT} \]

- ADD = average daily dose used for chronic non-cancer risk calculations (mg/kg-day)
- C = inhalation exposure mass concentration (mg/m³)
- b = breathing rate (m³/hr)
- ED = exposure duration (hr/day)
- EF = exposure frequency (days/yr)
- WY = the number of years of a worker or ONU’s lifetime during which exposure to the chemical occurs (yr)
- BW = body weight (kg)
- AT = averaging time, non-cancer risks (days)
Goal of the Occupational Exposure Assessment

For each occupational exposure scenario, the following is assessed:

• Central tendency and high-end worker exposures
• Central tendency and high-end ONU exposures

Depending on the available hazard data, each of the assessed exposures may include the following:

• Chronic (cancer and non-cancer), subchronic, and acute exposures
## Elements of Occupational Exposure Assessment

### Facility Information
- Process Description (including concentration)
- Operations Information
  - Production volume for the life cycle stage
  - Days of operation per year
  - Worker activities
  - Number of sites
- Industrial Hygiene Information
  - Physical form
  - Exposure routes
  - Exposure duration
  - Exposure frequency
  - Engineering controls
  - Administrative controls
  - PPE
  - Number of potentially exposed workers

### Monitoring Information
- Inhalation Exposure Mass Concentration
- Worker and ONU
- Personal and area concentrations
- TWA, short-term and peak values
- Central tendency and high-end values
- OES-specific or surrogate data
- Exposure durations
- Dermal Applied Dose
- Dermal Percent Absorption

### Modeling Information
- Throughput of the Chemical
- Use Rate of the Chemical
- Emissions Rate
- Duration of Operation or Worker Activity
- Ventilation Rate
  - Exchange rate
  - Workspace volume
- Dermal Applied Dose and Percent Absorption
Occupational Exposure Assessment Data Sources and Approach

• Data Sources:
  • Gray literature (e.g., NIOSH and OSHA data)
  • Peer reviewed literature
  • Test orders
  • Public comments

• Assessment Approaches:
  • Systematic review (data identification, quality evaluation and integration)
  • Hierarchy of data types (e.g., monitoring data of adequate quality are preferable to modeling data)
  • Risk evaluation review: internal government review, public comments, and peer review
Occupational Exposure Assessment
Hierarchy of Data Types

**Monitoring Data**
- Personal and directly applicable
- Area and directly applicable
- Personal and potentially applicable or similar
- Area and potentially applicable or similar

**Modeling Approaches**
- Surrogate monitoring data
- Fundamental modeling approaches
- Statistical regression modeling approaches

**Occupational Exposure Limits**
- OSHA Permissible Exposure Limits (PELs)
- Company-specific OELs (for site-specific exposure assessments)
- Voluntary limits: ACGIH TLV, NIOSH REL, Occupational Alliance for Risk Science (OARS), Workplace Environmental Exposure Level (WEEL) [formerly by AIHA]
Opportunities for Improvement: Number of Conditions of Use and Exposure Scenarios and Availability of Worker Inhalation Monitoring Data

<table>
<thead>
<tr>
<th>Risk Evaluation</th>
<th>Number of Conditions of Use</th>
<th>Number of Occupational Exposure Scenarios</th>
<th>Number of OES Assessed Based on Worker Inhalation Monitoring Data that is Chemical and Exposure Scenario-Specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos Part 1</td>
<td>7</td>
<td>8</td>
<td>6 (or ~75%)</td>
</tr>
<tr>
<td>1-Bromopropane</td>
<td>26</td>
<td>15</td>
<td>8 (or ~53%)</td>
</tr>
<tr>
<td>HBCD</td>
<td>9</td>
<td>14</td>
<td>1 (or ~7%)</td>
</tr>
</tbody>
</table>
Opportunities for Improvement: Select Public Comments on the Draft Risk Evaluations

Comments by Industry & NGOs

• Use of NMP in semiconductors should be separated from the other electronics uses
• Certain conditions of use of 1-BP are oversimplified, leading to missing considerations
• EPA lumps together a highly diverse set of 1,4-Dioxane uses as “industrial uses” and asserts that all such operations “are expected” to be similar. Support for this assumption should be provided.
THANK YOU
MEET THE SPEAKER

Christine Whittaker, PhD
Director, Division of Science Integration, NIOSH/CDC

• Director of the Division of Science Integration (DSI) at the National Institute for Occupational Safety and Health (NIOSH)
• DSI researches and develops NIOSH recommendations and communication products
• Previously served as Chief of the Risk Evaluation Branch within DSI
Occupational Risk Assessment at NIOSH

Christine Whittaker, Ph.D.
Director, Division of Science Integration

AIHA Workshop on Occupational Risk Assessment

August 25, 2022
Occupational Risk and Exposure Assessment

- **Fit for purpose**
  - Answers specific questions such as:
    - What are risks faced by workers exposed to a chemical?
    - What occupational exposure concentration corresponds to a target risk level?
    - How do specific engineering controls reduce exposures and risks?

https://www.cdc.gov/niosh/programs/exap/description.html
Several Purposes

- Support NIOSH recommendations to protect workers from workplace exposures to chemicals
  - Many types of workplace exposures
- Support NIOSH evaluations for individual facilities
  - Targeted workplace exposures
- Support NIOSH research in epidemiology and engineering control technology
  - Answer specific research questions
Occupational Risk and Exposure Assessment at NIOSH

- NIOSH Risk and Exposure Assessments
  - NIOSH Recommendations
    - Recommended Exposure Limits (REL)
    - Risk Management Limits for Carcinogens (RML-CA)
    - Immediately Dangerous to Life or Health values (IDLH)
    - Skin Notations (Sk)
  - NIOSH Occupational Exposure Banding
  - Site assessments as part of Health Hazard Evaluations
  - Evaluation of engineering controls
  - Epidemiological investigations
Recommended Exposure Limits and Risk Management Levels for Carcinogens

- **NIOSH Risk Assessment**
  - Designed to protect workers from occupational exposure even if exposed every day for a working lifetime (45 years)
  - Used for chronic adverse health outcomes, like cancer and respiratory disease
  - Assume cumulative risk, working lifetime exposure to constant concentration, lower 95% confidence limit on
  - Uses human epidemiology or animal toxicology data to predict the exposure level at a target risk – not necessarily current exposures.

https://www.cdc.gov/niosh/topics/riskassessment/how.html
Recommended Exposure Limits and Risk Management Levels for Carcinogens

- NIOSH Exposure Assessments
  - to characterize current exposures to understand scope of problem
  - to evaluate potential engineering controls
  - to recommend appropriate respiratory protection

https://www.cdc.gov/niosh/docs/2020-106/default.html
Immediately Dangerous to Life or Health Values

- **NIOSH Risk Assessments**
  - Aim: To protect workers from acute over-exposure to hazardous chemicals – up to 30 minutes to allow escape
  - Used for acute adverse health outcomes and escape-impairing effects
  - Health effects: eye and respiratory irritation, neurotoxicity and other acute toxicity or toxicity related to escape impairment
  - Use human acute studies or animal toxicology data to predict the exposure level at a target risk. [No exposure assessment]

https://www.cdc.gov/niosh/docs/2014-100/
NIOSH Skin Notations

- **NIOSH Hazard Identification**
  - **Aim:** To protect workers from dermal exposure to hazardous chemicals
  - Assigned notations for systemic, direct and sensitizing effects due to skin exposure
  - Notations for potential lethal exposures, skin irritation and corrosion
  - Notations based on physicochemical properties, human exposures and health effects, animal and in vitro testing, computational modeling techniques. [No exposure assessment]

    [Link](https://www.cdc.gov/niosh/topics/skin/skin-notation_profiles.html)
NIOSH Occupational Exposure Banding

- NIOSH Semi-Quantitative Risk Assessment
  - Aim: To provide a tool to develop guidance for chemicals with no occupational exposure limits
  - Based on health effects data from authoritative sources
  - Tool provides occupational exposure bands based on toxicity [No exposure assessment]
  - NIOSH does not provide authoritative occupational exposure bands

https://www.cdc.gov/niosh/topics/oeb/default.html
Other Exposure Assessments at NIOSH

- **Health Hazard Evaluations (HHE)**
  - Investigating health hazards by request of employees, union officials, or employers
  - Evaluating exposures and/or health effects

- **Epidemiological Evaluations**
  - Rigorous evaluation of exposures and health effects in various industrial settings

- **Evaluation of Engineering Controls**
  - As part of an HHE or research study, or to provide technical assistance

[https://www.cdc.gov/niosh/hhe/default.html](https://www.cdc.gov/niosh/hhe/default.html)
Exposure Assessment Data Sources

- NIOSH epidemiology research
- NIOSH Health Hazard Evaluations
- NIOSH exposure assessment, engineering control, and field study research
- OSHA database
- Scientific literature
- Data submitted by stakeholders in industries of interest
- Occupational exposure modeling
- Other sources as appropriate
Characteristics of Useful Chemical Exposure Data

Comprised of many elements, including a clear description of:

- Time/date/duration of collection
- Personal or area monitoring
- Task-based or shift-based and work being undertaken
- Chemical being monitored
- Who was monitored, their occupation and who/how many they represent
- Equipment used for collection, as well as flow rate (if appropriate), sampling time, other parameters, etc.
- Method of analysis
- And more . . .


https://doi.org/10.1080/1047322X.1996.10389417
Occupational Risk Assessment

- Fit for purpose
  - Characterizing existing exposures versus characterizing exposures at target risk
- Relies on exposure and health data from a variety of sources
  - Good exposure information helps prioritize and inform occupational risk assessments
Thanks you!

For more information, contact CDC
1-800-CDC-INFO (232-4636)

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.
MEET THE SPEAKER

William Perry, CIH, retired
Former Directorate of
Standards and Guidance at
OSHA

- Former Director of the Directorate of
  Standards and Guidance at the U.S.
  Occupational Safety and Health
  Administration (OSHA)
- Also served as Deputy Director and as
  an Office Director in DSG.
- Oversaw regulatory and guidance
  development on a wide range of
  topics
OSHA Risk Assessment

William Perry, CIH (Retired, 1990-2022)
Contractor
Occupational Safety and Health Administration
To promulgate health standards under the OSH Act, OSHA must make the following findings:

- That a significant risk to health exists from exposure to a hazardous substance (based on dose-response analysis, not on baseline or prevailing exposures among workers);
- That the new or revised standard is technologically and economically feasible; and
- That the standard is cost-effective.

Although OSHA cannot base its regulatory decisions on cost-benefit analysis, it must fairly assess costs and benefits in accordance with Executive Orders 12866 and 13563.
Technological & Economic Feasibility Analysis

- Technological feasibility, cost, and benefits evaluation:
  - Analyses of prevailing exposures among workers by industry and operation (exposure characterization);
  - Combines that with the dose-response analysis to characterize baseline risks to workers, and to estimate potential reductions in fatalities and illnesses attributable to regulation (risk characterization);
  - These analyses make use of a wide variety of existing occupational exposure data
Exposure Data

- Sources of exposure data include:
  - OSHA air sampling data from enforcement activities (OSHA’s Information System, compliance case files);
  - Site visits conducted by OSHA (and its contractors);
  - NIOSH reports (HHE’s, control technology assessments, others);
  - Published studies; and
  - Unpublished data provided by employers, trade associations, labor organizations

- Typically relies on personal air samples taken over nearly a full work shift
Risk Assessment Goal

- Goal is to estimate the number of workers exposed within various ranges of exposure, for each industry sector and operation.
- May combine data representing a single operation across many industries (application groups).
- Important to obtain information that explains why some exposures are low and others higher.
  - (Intrinsic to operation? Differences between facilities or processes? Use of or lack of exposure controls/work practices?)
Handling Missing Data

- Where data for an industry/operation are missing or sparse, OSHA has used data from other similar operations where materials and exposure routes are similar:
  - Example (Hex Chrome rulemaking) – OSHA relied on data describing exposures to hexavalent chromium during packing/bagging of chrome pigments to represent exposures during packing/bagging of plastic colorants.
  - Example (Crystalline silica rulemaking) – OSHA lacked specific data describing exposures during operation of small drivable milling machines, and used data from operation of large drivable milling machines to supplement, providing a credible upper bound exposure for smaller machines not equipped with dust control.
Examples of Exposure Profiles

Shows distribution of exposure data obtained for electroplating operations – data from OSHA enforcement activities and OSHA and NIOSH site visits.

Table III-3. Distribution of Full-Shift Personal Exposures (8-hour TWA) for Hexavalent Chromium in the Electroplating Industry\textsuperscript{ab}

<table>
<thead>
<tr>
<th>Job Category</th>
<th>Total No. of Data Points</th>
<th>Below LOD\textsuperscript{d}</th>
<th>0.25 to &lt;0.5</th>
<th>0.5 to &lt;1.0</th>
<th>1.0 to &lt;5.0</th>
<th>5.0 to &lt;10.0</th>
<th>10.0 to &lt;20.0</th>
<th>\geq20.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Chrome (No IMIS)</td>
<td>84</td>
<td>NA\textsuperscript{a}</td>
<td>5</td>
<td>8</td>
<td>4</td>
<td>47</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>Decorative Chrome Plater</td>
<td>28</td>
<td>NA</td>
<td>7</td>
<td>29</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Job Shop Chrome Plater</td>
<td>50</td>
<td>NA</td>
<td>14</td>
<td>14</td>
<td>9</td>
<td>6</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Captive Shop Chrome Plater</td>
<td>33</td>
<td>NA</td>
<td>3</td>
<td>10</td>
<td>14</td>
<td>4</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Job Shop Plater</td>
<td>219</td>
<td>NA</td>
<td>49</td>
<td>25</td>
<td>93</td>
<td>7</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>Captive Shop Plater</td>
<td>99</td>
<td>NA</td>
<td>19</td>
<td>16</td>
<td>51</td>
<td>5</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Anodizer</td>
<td>26</td>
<td>NA</td>
<td>12</td>
<td>41</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Operator</td>
<td>86</td>
<td>NA</td>
<td>13</td>
<td>19</td>
<td>32</td>
<td>5</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>Helper/Other</td>
<td>128</td>
<td>NA</td>
<td>18</td>
<td>15</td>
<td>57</td>
<td>0</td>
<td>31</td>
<td>16</td>
</tr>
<tr>
<td>CC Coater</td>
<td>21</td>
<td>NA</td>
<td>9</td>
<td>15</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>774</td>
<td>NA (0%)</td>
<td>149</td>
<td>58</td>
<td>299</td>
<td>29</td>
<td>144</td>
<td>85</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Percentages are based on the number of facilities tested. Based on Combined IMIS, NIOSH, and OSHA Site Visit Full-Shift Occupational Exposure Data.

\textsuperscript{b} Values may be affected by rounding.

\textsuperscript{c} \text{\textmu}g/m\textsuperscript{3} = micrograms per cubic meter.

\textsuperscript{d} LOD = Limit of Detection

\textsuperscript{e} NA = Not applicable. The Limit of Detection samples were assumed to be at the specified limit of detection in the report.

Source: Shaw, 2006
Examples of Exposure Profiles

Shows how OSHA uses distribution of exposure data to estimate numbers of workers in each job category exposed to various ranges of exposure.

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Table III-4. Personal Exposure Profile in the Electroplating Industry (full-shift TWA)\textsuperscript{a,b}

<table>
<thead>
<tr>
<th>Job Category\textsuperscript{a}</th>
<th>Total No. of Workers\textsuperscript{b}</th>
<th>Distribution ((\mu g/m^3))\textsuperscript{c}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Below LOD\textsuperscript{d}</td>
<td>0.25 to &lt;0.5</td>
</tr>
<tr>
<td>Hard Chrome</td>
<td>2,590</td>
<td>NA</td>
</tr>
<tr>
<td>Decorative Chrome</td>
<td>1,850</td>
<td>NA</td>
</tr>
<tr>
<td>Job Shop Chrome Plater</td>
<td>3,339</td>
<td>NA</td>
</tr>
<tr>
<td>Captive Shop Chrome Plater</td>
<td>2,683</td>
<td>NA</td>
</tr>
<tr>
<td>Job Shop Plater</td>
<td>15,600</td>
<td>NA</td>
</tr>
<tr>
<td>Captive Shop Plater</td>
<td>7,494</td>
<td>NA</td>
</tr>
<tr>
<td>Anodizer</td>
<td>1,943</td>
<td>NA</td>
</tr>
<tr>
<td>Operator</td>
<td>5,180</td>
<td>NA</td>
</tr>
<tr>
<td>Helper/Other</td>
<td>6,938</td>
<td>NA</td>
</tr>
<tr>
<td>CC Coater</td>
<td>21,247</td>
<td>NA</td>
</tr>
<tr>
<td>Total</td>
<td>66,857</td>
<td>NA (0%)</td>
</tr>
</tbody>
</table>

\textsuperscript{a} For electroplaters, \textquotedblleft Total No. of Workers\textquotedblright includes plating and coating machine setters, operators, and tenders (metal and plastics).

\textsuperscript{b} Percentages are based on the number of facilities sampled. Values may be affected by rounding.

\textsuperscript{c} \(\mu g/m^3\) = micrograms per cubic meter.

\textsuperscript{d} LOD = Limit of Detection.

\textsuperscript{e} For electroplaters, job shops are all establishments in NAICS 332813 (20,610 employees) and captive shops are all other NAICS codes (23,000 employees). For CC coaters, job shops are all establishments in NAICS 332813 (9,827 employees) and captive shops are all other NAICS codes (11,421 employees).

Source: Shae, 2006
Examples of Exposure Profiles

From the silica rulemaking, an exposure profile for a general industry sector and a construction operation. Note the distinctions made on the construction profile in environmental conditions and dust controls.

### Table IV.A.1-8

Personal Respirable Crystalline Silica Exposure Range and Distribution of Results for Workers in the Pottery Industry (NAICS 327111, 327112, 327113)

<table>
<thead>
<tr>
<th>Pottery Industry</th>
<th>Exposure Profile</th>
<th>Exposure Range</th>
<th>Exposures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean (µg/m³)</td>
<td>Median (µg/m³)</td>
</tr>
<tr>
<td>Material Handler</td>
<td>11</td>
<td>149 (41)</td>
<td>20 (1,101)</td>
</tr>
<tr>
<td>Finishing Line Operator</td>
<td>35</td>
<td>42 (51)</td>
<td>3 (235)</td>
</tr>
<tr>
<td>Coatings Preparer</td>
<td>10</td>
<td>26 (21)</td>
<td>5 (55)</td>
</tr>
<tr>
<td>Coatings Operator</td>
<td>12</td>
<td>8 (82)</td>
<td>1 (693)</td>
</tr>
<tr>
<td>Pottery Industry Total</td>
<td>37</td>
<td>56 (40)</td>
<td>6 (1,101)</td>
</tr>
</tbody>
</table>

*Note: All samples are personal breathing zone (PBZ) results representing 8-hour time-weighted average exposures. Job categories are intended to represent job functions; actual job titles might differ, and responsibilities might be allocated differently, depending on the facility. Percentages may not add to 100 percent due to rounding.*

**Sources:** Document ID: 1720; 3046; 2021; 0168; 0163; 0178; 0181; 2211; 1136.

### Table IV.5.5-8

Personal Respirable Crystalline Silica Exposure Range and Distribution of Results for Construction Workers: Demolition Workers Using Jackhammers and Other Powered Handheld Chipping Tools

<table>
<thead>
<tr>
<th>Demolition Workers Using Jackhammers and Handheld Power Chipping Tools</th>
<th>Exposure Profile</th>
<th>Exposure Summary</th>
<th>Exposure Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean (µg/m³)</td>
<td>Median (µg/m³)</td>
</tr>
<tr>
<td>Outdoor - baseline</td>
<td>36</td>
<td>184 (168)</td>
<td>12 (604)</td>
</tr>
<tr>
<td>Outdoor with water applied</td>
<td>5</td>
<td>226 (140)</td>
<td>12 (320)</td>
</tr>
<tr>
<td>Indoor - baseline</td>
<td>32</td>
<td>424 (111)</td>
<td>12 (2,300)</td>
</tr>
<tr>
<td>Indoor with water applied</td>
<td>11</td>
<td>328 (260)</td>
<td>12 (880)</td>
</tr>
<tr>
<td>Other</td>
<td>29</td>
<td>102 (13)</td>
<td>12 (1,144)</td>
</tr>
<tr>
<td>Demolition Workers Using Jackhammers and Handheld Power Chipping Tools total</td>
<td>134</td>
<td>350 (126)</td>
<td>12 (2,380)</td>
</tr>
</tbody>
</table>

*Notes: All samples are personal breathing zone (PBZ) results representing 8-hour time-weighted average exposures. Job categories are intended to represent job functions; actual job titles might differ, and responsibilities might be allocated differently, depending on the site. Percentages may not add to 100 percent due to rounding.*

**Sources:** Document ID: 1720; 3046; 2021; 0168; 0163; 0178; 0181; 2211; 1136.
Examples of Exposure Profiles

Estimates of exposed workers drawn from the exposure profiles for pottery operations and jackhammering operations.
BREAK
MEET THE SPEAKER

Fred Boelter, CIH, PE, BCEE, FAIHA
Boelter Risk Sciences and Engineering LLC

- Industrial hygiene and environmental engineering professional since 1973
- Consults with clients throughout the United States, the UK, Europe and beyond
- Expertise in risk characterization, risk communication, and risk management in occupational and public health
The Many Aspects of Occupational Risk Assessment: Understanding Differing Approaches and Goals

Employer, Employee, Place of Work, Occupied Spaces, Natural World

AIHA Webinar
Thursday, August 25, 2022

Fred W Boelter, CIH, PE, BCEE, FAIHA
Boelter Risk Sciences and Engineering LLC
Chicago, Illinois, USA
boelterinc@gmail.com, 312-560-9113
Judging Data
Hazard ≠ Risk

Example: TCE Criteria in Indoor Air (μg/m³)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSHA PEL (8-hr TWA)</td>
<td>535,000</td>
</tr>
<tr>
<td>CAL/OSHA PEL</td>
<td>135,000</td>
</tr>
<tr>
<td>ACGIH TLV (8-hr TWA)</td>
<td>54,000</td>
</tr>
<tr>
<td>Cal OEHHA RSL¹</td>
<td>600</td>
</tr>
<tr>
<td>EPA Region 4 RSL²</td>
<td>3</td>
</tr>
<tr>
<td>EPA Region 4 RSL³</td>
<td>0.5</td>
</tr>
<tr>
<td>EPA TSCA 6(b)(4) (July 2022)⁴</td>
<td>$10^{-x}$</td>
</tr>
</tbody>
</table>

¹ California Office of Environ Health Hazard Assess Ref Exposure Level for air (non-cancer endpoints)
² EPA Regional Screening Level for industrial air (cancer endpoint)
³ EPA Regional Screening Level for residential air (cancer endpoint)
⁴ Existing Chemical Exposure Limit (ECEL)
Risk, Safe, Compliant - Context Matters

Is Risk Real? And, to Whom?

“Risk does not exist out there, independent of our minds and culture, waiting to be measured. Human beings have invented the concept of risk to help them understand and cope with the dangers and uncertainties of life. Although these dangers are real, there is no such thing as real risk or objective risk.”

Paul Slovic
Luminary and trailblazer in risk science
Safe = Not Unacceptable Risk

- "Unsafe" Unacceptable Risk
- Acceptable Risk
- "Safe" Not Unacceptable Risk
- Zero Risk

Risk Level:
- Characterized Risk w/o Controls
- Target Risk Objectives w/o Safety Factors
- Risk Objectives w/ Controls
- Zero Risk

Necessary Risk Reduction
Actual Risk Reduction
Residual Risk
AIHA Risk Committee
Five Buckets of Risk

AIHA Webinar – Occ Risk 25Aug 2022 - FW Boelter
DMMR Genesis

Patty’s Industrial Hygiene, 7th Edition

Decision Making in Managing Risk

April 2021

Co-authors – Charles Redinger, Fred Boelter, John Howard, Mary O’Reilly, and Glenn Barbi

First time DMMR is in Patty’s
Hazard, Compliance, Exposure, Dose, Risk, Safe

\[ D_{\text{pot}} = \int C(t) \, IR(t) \, dt \]

Can be transformed to the following general formula:

\[ D_{\text{pot}} = C \cdot IR \cdot ED \]

Where:

- \( D_{\text{pot}} \) = Dose Potential outside the body
- \( C \) = Average concentration (8-hr TWA over working year)
- \( IR \) = Average intake rate (breathing rate)
- \( ED \) = Exposure duration (years)

Inhalation route of entry, reduces to:

\[ E_{\text{Total}} = C \times ED \propto D_{\text{pot}} \]

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POLL – Rank These Five Scenarios

<table>
<thead>
<tr>
<th>PHOTO</th>
<th>DESCRIPTION</th>
<th>RISK RANK (1-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Non-Ferrous Foundry</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Welding</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Neon Bulb Manufacturing</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Butter Flavoring</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Spray Painting</td>
<td></td>
</tr>
</tbody>
</table>

Non-Ferrous Foundry  Welding  Neon Bulb Manufacturing  Butter Flavoring  Spray Painting
Classic Hierarchy of Controls Applied to NIOSH TWH

Eliminate:
- Eliminate working conditions that threaten safety, health, and well-being

Substitute:
- Substitute health-enhancing policies, programs, and practices

Redesign:
- Redesign the work environment for safety, health, and well-being

Educate:
- Educate for safety and health

Encourage:
- Encourage personal change

Transfer:
- Transfer exposed employees

Reduce:
- Reduce the hazard

Administrative controls:
- Isolate people from the hazard

Engineering controls:
- Change the way people work

PPE:
- Protect the worker with Personal Protective Equipment

Safe:
- Physically remove the hazard

Well-Being:
- Practically reduce the hazard

Risk Management Continuum:
- Physically reduce the hazard

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In Summary

• There are reasons for differences:
  • EPA, NIOSH, OSHA have defined missions and purposes
  • But, also overlapping and intersecting interests

• Context matters:
  • Tools are designed for specific jobs and tasks

• Have clarity on why you do what you do:
  • Philosophical, tactical, applicable
Occupational health?  
Protecting self?  
Acute risk?  
Clinical treatment?  
Personal choice?  

Public health?  
Protecting others?  
Chronic risk?  
Precautionary Principle?  
Social responsibility?  

The Many Aspects of Occupational Risk Assessment: Understanding Differing Approaches and Goals

Thank you
Fred Boelter, CIH, PE, BCEE, FAIHA
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Chicago, Illinois, USA
boelterinc@gmail.com
312-560-9113

Sans respirator

Sans hardhat

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DISCUSSANT PANEL

• Brenda Finter (OSHA and IH expertise)
• John Henshaw (former OSHA and risk assessment management)
• MaryAnn Hoff (chemical industry IH expertise)
• Steve Jahn (DoE experience and AIHA EASC)
• Silvia Maberti (Chemical industry and REACH experience)
• Paul Price (Former EPA and exposure and risk expertise)
• Rebecca Reindel (IH expert and organized labor experience)
POLL QUESTION #1

• How often do you consult risk assessment documents from other domains before engaging in risk assessment activities for your scenario?
  – For example: When starting an exposure assessment, do you search for existing data from any/all of these sources: OSHA, NIOSH, and EPA?
    – Always
    – Usually
    – Rarely
DISCUSSION QUESTION #1

- How do the different risk assessment methods the speakers described enable the use of inputs/outputs across domains?
  - What characteristics of these approaches enable uses for other purposes?
  - How do the varying “purposes” of different methods limit the uses of such data?
  - What are some examples of extrapolating data collected for one purpose/type to another?
POLL QUESTION #2

• When you’ve sought out data from other sources, how often have you encountered barriers in obtaining or using that data or information?
  – For example, you identified existing inhalation exposure data, but the annotation was not sufficiently detailed to determine its applicability for your specific use.
    – Rarely
    – Sometimes
    – Often
DISCUSSION QUESTION #2

• What are the most effective ways to share information and data among stakeholders?
  – Are there current avenues in place?
  – What are the barriers to effective information transfer?
  – How can we avoid misapplication or misinterpretation of the outcomes of specific risk assessment processes?
DISCUSSION QUESTION #3

• As we look to the future, how do we envision the evolution of occupational risk assessment?
  – How are the drivers of different risk assessment domains shifting?
  – What are the barriers to incorporating these changes into existing risk assessment processes?
  – What are the highest priorities for enhancing occupational risk assessment methods?

• For participants: Please consider submitting your thoughts to the Workshop Evaluation
NEXT STEPS

• Complete your evaluation (will automatically come up when zoom ends)

• Consider joining us for one of the other planned workshop topics (date/time TBA)
  - Data Quality and Integrity: Methods and Practices
  - OEHS Data Identification and Analytics and Similar Exposure Groups
  - Occupational Exposure Models: Options and Opportunities
  - Dermal Exposure Assessment Methods and Data Gaps
  - Risk Characterization, Communication, and Management Strategies
THANK YOU