Beryllium Aerosol Exposure Characterization During Precision Stamping of Copper Beryllium Alloy

Jeffrey R. Miller, CIH, CSP
Exposure Assessment Study

• Four Plants
  – Representative of the industry
  – Plants contacted through Brush Wellman Product Stewardship Department
  – Eastern U.S.

• Study Population
  – ≈ 1265 admin. & production workers
  – 50 to 675 workers per plant
  – 192 workers in mechanical & material handling processes

• Scope of this paper is mechanical & material handling processes at these plants
Copper Beryllium (CuBe) Alloy

- ≈ 2% Be by weight
- Sold as strip, rod, bar or wire
- Easily formed into complex shapes
Precision Stamping of CuBe Alloy

• CuBe Alloy
  – ↑ electrical & thermal conductivity
  – ↑ tensile strength
  – ↑ spring properties

• Electrical Components
  – Connectors, switches, relays, springs, sockets, RF shielding

• Telecom, Computer, Automotive Industries
Methods

• Project Team
  – Certified Industrial Hygienists
  – Certified Technicians
  – One week at each plant

• Sampling & Analysis Plan
  – Data Quality Objectives
  – Standardized Methods
  – AIHA Accredited Laboratories

• Air Sampling
  – Total Airborne Beryllium (8-hour TWA)
  – Particle Size Sampling
  – Limited diagnostic sampling
**Methods (continued)**

- **A Strategy for Assessing and Managing Occupational Exposures, 2nd & 3rd Editions**
- **Similar Exposure Groups Formed**
  - Groups of workers that have the same general exposure profile for the agent being studied because of the similarity and frequency of the tasks they perform, the materials and processes with which they work, and the similarity of the way they perform the tasks
- **Five SEGs**
  - Press Operators
  - Tool Makers
  - Assembly Operators
  - Shipping Technicians
  - Inspectors
Methods (continued)

- The goal of the statistical analysis was to accurately estimate the distribution parameters of the exposure data and to test the hypothesis that the true 95\textsuperscript{th} percentile exposure is less than the PEL.
- Most helpful statistical methods resources:
  - Hewett, AIHA Appendix VIII: Analysis of Censored Data
  - Finkelstein and Verma: Exposure Estimation in the Presence of Nondetectable Values: Another Look
  - Gilbert: Statistical Methods for Environmental Pollution Monitoring
Results

• Nothing close to the PEL
• Severely censored data set
  – 90% <LOD
• Two SEGs with 100% <LOD
• Particle size sampling 100% <LOD
  – Stopped after first plant
## Beryllium Data Summary

<table>
<thead>
<tr>
<th>Similar Exposure Group</th>
<th>Number of People in SEG</th>
<th>Number of Samples</th>
<th>Number of Samples &gt;LOQ</th>
<th>Percent of Samples &gt;LOQ</th>
<th>Range of Results (g/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Press Operator</td>
<td>69</td>
<td>46</td>
<td>8</td>
<td>17</td>
<td>&lt;0.0048 - 0.017</td>
</tr>
<tr>
<td>Tool Makers</td>
<td>63</td>
<td>29</td>
<td>1</td>
<td>3</td>
<td>&lt;0.0049 - 0.0066</td>
</tr>
<tr>
<td>Assembly Operator</td>
<td>23</td>
<td>14</td>
<td>2</td>
<td>15</td>
<td>&lt;0.0048 - 0.12</td>
</tr>
<tr>
<td>Shipping Technician</td>
<td>22</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Inspectors</td>
<td>15</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>&lt;0.0047 - &lt;0.02</td>
</tr>
<tr>
<td>Total</td>
<td>192</td>
<td>115</td>
<td>11</td>
<td>10</td>
<td>&lt;0.0047 - 0.12</td>
</tr>
</tbody>
</table>
**Statistical Analysis of Airborne Beryllium Exposure Data**

<table>
<thead>
<tr>
<th>Statistic</th>
<th>All Data</th>
<th>Press Operators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Likelihood Estimate - Mean</td>
<td>0.002</td>
<td>0.005</td>
</tr>
<tr>
<td>Maximum Likelihood Estimate - Standard Deviation</td>
<td>0.029</td>
<td>0.02</td>
</tr>
<tr>
<td>Estimate of the 95\textsuperscript{th} Percentile</td>
<td>0.045</td>
<td>0.017</td>
</tr>
<tr>
<td>Upper Tolerance Limit (95% \times 95%)</td>
<td>0.124</td>
<td>0.03</td>
</tr>
<tr>
<td>Exceedance Fraction (Cal OSHA PEL - 0.2 (g/m^3))</td>
<td>2.2</td>
<td>(&lt;0.05)</td>
</tr>
<tr>
<td>Exceedance Fraction (Federal OSHA PEL - 2.0 (g/m^3))</td>
<td>(&lt;0.0001)</td>
<td>(&lt;0.05)</td>
</tr>
</tbody>
</table>
Conclusion

Based on the results of this study, it is concluded that more than 97% of the time the airborne beryllium exposure levels of workers performing mechanical and material handling processes associated with precision stamping of copper beryllium alloy are less than the most stringent regulatory limit, the California OSHA PEL of 0.2 µg/m³.
Contributors

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