Introduction

• Formaldehyde has been confirmed as a human carcinogen and is
designated by the American Conference of Governmental Industrial
Hygienists (ACGIH) as both a respiratory and dermal sensitizer.
• ACGIH established Threshold Limit Values (TLVs) for formaldehyde, a
Short-Term Exposure Limit (STEL) of 0.3 ppm and a Time-Weighted
Average (TWA) of 0.1 ppm. OSHA Permissible Exposure Limits (PELs) include
a STEL of 0.2 ppm and a TWA of 0.75 ppm.
• A standard control implemented in many laboratories is the use of
dilution ventilation to regulate the formaldehyde concentration within
the room; ACGIH suggests that air changes per hour (ACH) are not an
appropriate method for designing contaminant control systems.
• This study was conducted to evaluate personal formaldehyde
exposures among instructors in an anatomy laboratory during a
dissection class and compare those with OSHA and ACGIH
occupational exposure limits.

Objectives

• Measure airborne formaldehyde during dissection class and compare
monitoring results with occupational exposure limits.
• Perform flow rate measurements to assess if the ventilation system in
the laboratory meets the best practices recommendations to control exposure to formaldehyde.

Methods

• Nine personal samples of 15 minutes were taken using air sampling
pumps (GillAir-5) and XAD-2 tubes. The samples were collected
during the dissection class while the instructors were standing near
the cadavers.
• Bureau Veritas followed OSHA 52 method and analyzed the samples
by gas chromatography using a nitrogen selective detector.
• The flow rate and room dimension measurements were taken with a
TNI Air velocity meter to calculate the air changes per hour.
• A smoke tube was used to test the air movement direction and if the
room was under pressure.
• Exposure statistics were calculated using the American Industrial
Hygiene Association (AIHA) IHSTAT (Excel spreadsheet), and the
AIHA Exposure Categorization Scheme was used to interpret the results.
• An 8-hr TWA was estimated by combining information from the
highest STEL sample near the cadavers and the STEL sample far from
the dissection area during the three-hour class period.
• The dilution ventilation (air change per hour) needed to lower the
formaldehyde concentration within the room to 50% of the TLV was
computed assuming a steady state concentration.

Results

• From the nine personal short term exposure samples taken during the class, which ranged from 0.13 to 1.3 ppm, all the samples were below OSHA STEL of 2 ppm; however, 7 of the 9 samples were above the TLV-
STEL. The data were lognormally distributed with a GM of 0.39 ppm and GSD of 1.8. The GM exceeds the
TLV-STEL of 0.3 ppm.
• Analyses indicated that 67% of the exposures exceeded the TLV-STEL, which suggests that exposures were
poorly controlled and instructors are often exposed to high or very high concentrations.
• The estimated 8-hr-TWA was 0.45 ppm, which is below the OSHA PEL-TWA of 0.75 ppm but above the ACGIH
TLV-TWA of 0.1 ppm.
• On the day of sampling the laboratory ventilation system had 15 air changes per hour, and during the smoke
test, no circulation or movement of air inside the laboratory was observed.
• With a concentration of formaldehyde in the room between 0.39 and 1.3 ppm, the dilution ventilation required
to keep the concentration of formaldehyde at 0.15 ppm (50% of TLV) must range between 40 and 133 ACH.

Table 1. STEL sampling results

<table>
<thead>
<tr>
<th>Instructor</th>
<th>STEL (ppm)</th>
<th>STEL-OSHA (ppm)</th>
<th>STEL-TLV-STEL (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruct 1</td>
<td>0.13</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Instruct 1</td>
<td>0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruct 2</td>
<td>0.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruct 2</td>
<td>0.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruct 2</td>
<td>0.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruct 3</td>
<td>0.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruct 3</td>
<td>0.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruct 3</td>
<td>1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruct 3</td>
<td>0.46</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Compliance statistics

<table>
<thead>
<tr>
<th>Substance</th>
<th>Lognormal Distribution</th>
<th>OEL</th>
<th>N</th>
<th>% &gt; OEL</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>OSHA STEL</td>
<td>2</td>
<td>9</td>
<td>0.4</td>
<td>11</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>TWA STEL</td>
<td>0.3</td>
<td>9</td>
<td>67</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Acknowledgements

I would like to thank the instructors who participated in this project; Dennis Terpin and Scott Dubick from the UIC Environmental, Health & Safety Office. This work was partially funded by NIOSH Education and Research Training Grant Number: T42OH008672.

References


Conclusion

• Instructors’ exposure complied with the limits established by OSHA but
were above ACGIH-TLV recommended limits. Employers must comply
with OSHA Standards; however, the formaldehyde PELs have not been
updated since 1987. Therefore companies are expected to follow best
practices, such as the limits proposed by ACGIH.
• Formaldehyde does not meet the criteria for dilution ventilation given
that its toxicity is significant, workers are close to the source where
exposures are above the occupational exposure limits and the amount of
dilution air required to reduce instructors exposures below the limits is
impractical.
• Dissecting tables along with a good design dilution ventilation system
are an effective solution to control formaldehyde exposure. As an example:

Photo: University of Arizona

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