Reduction of Silica Exposure among Bricklayers with use of Engineering Controls for Cutting & Grinding

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The Center to Protect Workers’ Rights (CPWR)

- Research arm of the Building & Construction Trades Council, AFL-CIO
- Conducts research aimed at improving quality of life for construction workers
- Engaged in cooperative agreement with the National Institute for Occupational Safety and Health (NIOSH) since 1990
Tool & Programs for Improving Occupational Health in Construction (TAPs Project)

- 5 year project (Jan 2005 – June 2009)

- Focus is on:
  - verifying the effectiveness of engineering controls (tools) for reducing exposure to:
    - Welding fumes (manganese & hexavalent chromium)
    - Silica (masonry work)
  - developing strategies & programs that get industry to use those controls.
TAPs Project Participants

- CPWR
- Hunter College
- Harvard
- International Masonry Institute
- Ohio Building & Construction Trades
- United Association of Plumbers & Pipe-fitters
- I.U. of Bricklayers and Allied Crafts
Proportionate Mortality Ratios in Construction: Silicosis

Robinson et al. 1995

- painters (abrasive blasting)
  - 7 full-shift samples range between 0.5 – 26.2 mg/m³
  - 3 to 524 times the NIOSH REL
- bricklayers (grinding/cutting masonry & concrete)
  - 5 full-shift samples range between 0.1 – 1.2 mg/m³
  - 2 to 24 times the NIOSH REL
- Operators and laborers (road milling)
  - 22 full-shift samples ranging from 0.01 - 0.62 mg/m³
  - 0.2 to 12 times the NIOSH REL
Industrial hygiene involves protecting workers through control of the environment;

OSHA standards require use of engineering controls as primary means of control;

however, engineering controls in construction are still rare
OSHA Fine

• OSHA Fines Wilmington, Mass., Contractor $60,000 for Silica Hazards at St. John's Prep School
• Contractor failed to protect workers from potentially deadly silica hazards during brick repointing
• Respirators were being worn, but not enough
• OSHA requires that effective engineering controls, such as wet cutting saws, vacuum grinders or other types of local exhaust ventilation first be used to reduce dust levels below permissible exposure limits.
First step: evaluate dust controls under “laboratory conditions”

- All work done in controlled setting
- Journeymen bricklayers performed work
- Multiple, random trials for each control were compared to same task with no controls
Controls investigated

- Stationary wet saw for cutting brick & block
- Portable wet saw for cutting
- Local exhaust ventilation for grinding & cutting
Water Systems
Cutting block dry v. wet
Port-a-Wet Saw used to cut Brick
Cutting brick with Bosch cut-off saw and Bronco water pack
Manufacturer stopped distributing
Portable masonry saw with LEV
### Table 1: Cutting Block

<table>
<thead>
<tr>
<th></th>
<th>Mean mg/m³ (range)</th>
<th>Percent Reduction</th>
<th>Hazard Ratio (mean/REL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felker Stationary Wet Saw</td>
<td>0.26 (0.09-0.61)</td>
<td>90.7</td>
<td>5.27</td>
</tr>
<tr>
<td>Bosch with Vacuum</td>
<td>0.11 (&lt;0.049-0.17)</td>
<td>96.2</td>
<td>2.13</td>
</tr>
<tr>
<td>Bosch with Bronco</td>
<td>0.26 (&lt;0.047-0.52)</td>
<td>90.9</td>
<td>5.16</td>
</tr>
<tr>
<td>Bosch with no Control</td>
<td>2.83 (1.02-4.04)</td>
<td></td>
<td>56.6</td>
</tr>
</tbody>
</table>

NIOSH REL = 0.05 mg/m³
Table 2: Cutting Brick

<table>
<thead>
<tr>
<th></th>
<th>Mean mg/m³ (range)</th>
<th>Percent Reduction</th>
<th>Hazard Ratio (mean/REL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Stationary Wet Saw</td>
<td>0.088 (&lt;0.048-0.14)</td>
<td>90.6</td>
<td>1.8</td>
</tr>
<tr>
<td>Bosch with Vacuum</td>
<td>0.083 (&lt;0.05-0.15)</td>
<td>91.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Bosch with Bronco</td>
<td>0.180 (0.13-0.23)</td>
<td>80.8</td>
<td>3.6</td>
</tr>
<tr>
<td>Bosch with no Control</td>
<td>0.940 (0.45-1.58)</td>
<td></td>
<td>18.8</td>
</tr>
</tbody>
</table>

NIOSH REL = 0.05 mg/m³
Tuck-pointing shrouded grinders & vacuums
Grinding without controls
Grinding with Metabo/with Dust Director and new ICS Vacuum
Bosch grinder and vacuum
Bosch grinder & vacuum
Grinding with Metabo/with Dust
Director and new ICS Vacuum
### Table 3: Grinding Mortar

<table>
<thead>
<tr>
<th></th>
<th>Mean mg/m³ (range)</th>
<th>Percent Reduction</th>
<th>Hazard Ratio (mean/REL)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bosch with Vacuum</strong></td>
<td>0.467 (0.28-0.85)</td>
<td>90.6</td>
<td>9.3</td>
</tr>
<tr>
<td><strong>Bosch with no Control</strong></td>
<td>4.990 (3.06-7.24)</td>
<td>NA</td>
<td>99.8</td>
</tr>
<tr>
<td><strong>Metabo with Dust Director</strong></td>
<td>0.327 (0.19-0.50)</td>
<td>93.4</td>
<td>6.5</td>
</tr>
<tr>
<td><strong>Metabo with no Control</strong></td>
<td>10.879 (5.25-25.76)</td>
<td></td>
<td>217.6</td>
</tr>
</tbody>
</table>

NIOSH REL = 0.05 mg/m³
Static pressure tap used to measure vacuum performance during dust loading
Vacuum system flow rates

- Coefficient of entry was derived in the lab for each shroud/hood using a pitot tube and electronic manometer
- \[ Q = C_e \times (4005) \times (\text{Area of duct}) \times (\text{hood static pressure})^{1/2} \]
- Given this relationship, given HSP and area of duct, flow can be measured in the field
### Average flow rates

<table>
<thead>
<tr>
<th>System</th>
<th>Avg. flow rate (CFM)</th>
<th>Percentage of optimum flow <em>(est. at 125 cfm)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosch vac w/ saw</td>
<td>65.45</td>
<td></td>
</tr>
<tr>
<td>Bosch vac w/ grinder</td>
<td>57.59</td>
<td>46%</td>
</tr>
<tr>
<td>ICS Dust Collector</td>
<td>76.71</td>
<td>62%</td>
</tr>
</tbody>
</table>

*based on Heitbrink & Bennett, JOEH (2006) and ACGIH vent. manual*
## Dust Collection Rates

<table>
<thead>
<tr>
<th>Tool/control</th>
<th>Average Dust Collection Rate (lb/min)</th>
<th>Collection Period (mins.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosch cut-off saw/Bosch vacuum</td>
<td>0.187</td>
<td>28</td>
</tr>
<tr>
<td>Bosch grinder/Bosch vacuum</td>
<td>0.721</td>
<td>31</td>
</tr>
<tr>
<td>Metabo grinder with ICS Dust Director &amp; Dust Control vacuum</td>
<td>0.723</td>
<td>73</td>
</tr>
</tbody>
</table>
Masonry Controls Evaluation
Conclusions & Recommendations

- All tested controls worked in “field laboratory” (Local 5 training center) according to criteria used (at least 50% reduction)
- All need to be tested on actual job sites
- Electrical power requirements, vacuum bag change-out, durability and other issues need to be considered for implementation
- Need to evaluate cyclone vacuum systems to eliminate bag problem
The Next Step - Getting Controls in Use on the Job

- Perception of masonry controls are that they impede productivity, but mostly among those who haven’t used the equipment.
- Access to collect field data difficult.
- Regulatory impetus to use engineering controls is weak.
- Health outcomes generally don’t have an economic impact on employer limiting demand for controls.
"It is of great importance that the general public be given the opportunity to experience, consciously and intelligently, the efforts and results of scientific research.

It is not sufficient that each result be taken up, elaborated, and applied by few specialists in the field."

- Albert Einstein
Acknowledgements

- Mike Cooper
- Chris Cole
- Bricklayers of Local 5 in Southern NJ
- Barry Cardwell, BAC Local 1
- Bill Heitbrink