Quantifying the efficiency of exposure controls – part 3

Exposure Control and Containment II

Day 2, Workshop
13th October 2016

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Quantifying the efficiency of exposure controls, or “Another fine Mess...”
The story so far...

- Part 1 - IOHA London workshop, April 2015
- Part 2 - Glasgow workshop, April 2016
- Part 3 - Today...

- Large differences in estimates of efficiency by groups of experienced practitioners and published efficiency data
- Many factors affect efficiency – technical, organisational, behavioural.
- Efficiency varies widely and cannot use one number to summarise
- Lack of good quality data on efficiency; need evidence rather than guesswork!
Workshop Agenda

1. “Hygiene without Numbers”
2. Workshop Objectives
3. WORKGROUP SESSION:
   - 3 specific case study scenarios with measured exposure data before controls
   - Groups to estimate likely exposure reduction after controls applied
   - Compare estimates with actual measured data
4. Feedback and Open Forum
5. BOHS Control Efficiency Working Group
“Hygiene without Numbers”

“Applying simple rules with unrealistic protection factors (e.g. a factor of 10 for LEV to a factor of 100 for full enclosures and containment) will hardly ever be met in practice.... Simple guidance for control measures can be either insufficient (leading to unnecessary health risks for workers) or too extreme (resulting in sky-high operational costs for employers).”

Commentary, Hans Kromhout
Workshop objectives

- Use case studies to compare “professional judgement” estimates of control efficiencies to actual measured data
- Gain a consensus view on how best to describe efficiency in a simple way that users of control measures can easily understand
- Explore elements of a User Database of efficiency of common engineering control measures
Defining “efficiency”

- **RMM effectiveness**: the % reduction in exposure concentration...produced by application of the risk management measure
  (ECHA Guidance on information requirements and chemical safety assessment, chapter R13, v.1.2, page 20)

- **RMM efficacy value**: the proportional reduction in personal exposure levels of a given RMM in a specific (workplace) situation, expressed as a factor (e.g. reduction of 90% = efficacy value of 0.1)
  (ECEL database)

- **Modifying Factor (MF) scores**: an Assigned Typical Value of effectiveness of exposure reduction
  (ART mechanistic model, TNO report V9009, v.1.5, January 2013)

- **Exposure reduction**: the % reduction in exposure when using control measures compared to the uncontrolled situation
  (HSE RR926, On-tool controls to reduce exposure to respirable dusts in the construction industry – a review, HSL, 2012)
Sources of information

- ECEL database
  - Data from 67 peer-reviewed papers
  - 414 entries of technical RMM efficiencies

- CEFIC RMM Library
  - Excel spreadsheet developed for REACH
  - Lists “default” and “max. achievable” efficiency values for some RMMs
  - Current CEFIC LRI B15 project to update tool

- Exposure assessment models
  - ART
  - Stoffenmanager
  - ECETOC-TRA

- Published literature, “grey” literature, YOU
Workshop scenarios

- 3 scenarios to work through in small groups:
  - Tile cutting – silica dust
  - Hand soldering – colophony fume
  - Food manufacture – flour dust

- For each scenario:
  1. Estimate likely % reduction in exposure
  2. Identify the key factors which will determine exposure and “best practice”
Scenario 1: tile cutting “Before”

Before controls
Concrete tiles cut to size using clipper saw before roof installation
Dry cutting

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Duration (mins)</th>
<th>Dust Conc (mg/m³)</th>
<th>Inhal</th>
<th>Resp</th>
<th>RCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>10</td>
<td>1240</td>
<td>288</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>10</td>
<td>912</td>
<td>192</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Scenario 1 – tile cutting “After”

Application of water

1. Estimate % reduction in exposure when water suppression applied
2. List the key factors that are needed for “best practice” in this scenario
Scenario 1 – tile cutting “After”

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Duration (mins)</th>
<th>Dust Conc (mg/m³)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Inhal</td>
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<tr>
<td>Dry Cutting</td>
<td></td>
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<tr>
<td>S</td>
<td>10</td>
<td>912</td>
<td>192</td>
<td></td>
</tr>
<tr>
<td>Wet Cutting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>10</td>
<td>23.3</td>
<td>15.2</td>
<td>7.4</td>
</tr>
<tr>
<td>S</td>
<td>10</td>
<td>27.3</td>
<td>9.1</td>
<td></td>
</tr>
</tbody>
</table>

- % reduction in personal exposure:
  - Total inhalable dust = 98%
  - Respirable dust = 95%
  - RCS = 94%

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ART – wet suppression at point of release</td>
<td>0.1 (90%)</td>
</tr>
<tr>
<td>ECEL database</td>
<td>0.1 – 0.53 (47-90%)</td>
</tr>
</tbody>
</table>
Scenario 2 – hand soldering “Before”

- PCB manufacture in medium sized company
- Customer Returns dept. where boards de-soldered and re-soldered to rectify faults
- Hand soldering, flux-cored solder wire, tip extraction

Scenario “Before”:
Initial exposure monitoring when controls not functioning effectively – workstation layout poor, tip extraction system overloaded, tip positioning poor.

<table>
<thead>
<tr>
<th>Control</th>
<th>No. samples</th>
<th>TRA conc. (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min.</td>
</tr>
<tr>
<td>Tip extraction</td>
<td>6</td>
<td>&lt;6</td>
</tr>
</tbody>
</table>
Scenario 2 – hand soldering; controls

Scenario “After”:
monitoring repeated after maintenance work to improve LEV:

- LEV enhanced
- workstation layout improved
- tip extraction system expanded (new fan/filter units) and re-distributed better
- staff training on correct use and maintenance of LEV.

1. Estimate % reduction in exposure when tip extraction system was improved
2. List the key factors that are needed for “best practice” in this scenario
Scenario 2 – hand soldering “After”

Results “Before” and “After”

<table>
<thead>
<tr>
<th>Control</th>
<th>Condition</th>
<th>No. samples</th>
<th>TRA conc. (µg/m³)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tip extraction</td>
<td>“before”</td>
<td>6</td>
<td>&lt;6</td>
<td>2929</td>
</tr>
<tr>
<td></td>
<td>“after”</td>
<td>3</td>
<td>4.7</td>
<td>120</td>
</tr>
</tbody>
</table>

Typical default values for on-tool extraction:
- ART (TNO report) = 90% reduction (ATV = 0.1)
- ECEL database = 99%+ to negative value! (efficacy values range from 0.002 – 1.31)
- HSE RR926 = 90% reduction

95% reduction in personal exposure
Scenario 3 – Flour Dust “Before”

- Food manufacture in medium sized company
- Operator occasionally loads flour into ‘sprinkler’
- Exposure monitoring showed elevated dust exposure.

<table>
<thead>
<tr>
<th></th>
<th>Inhalable Dust Exposure mg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Control</td>
<td>6.2</td>
</tr>
</tbody>
</table>
Scenario 3 – Flour Dust “After”

**LEV flexible hood applied as shown**

1. Estimate % reduction in exposure when water suppression applied
2. List the key factors that are needed for “best practice” in this scenario
## Scenario 3 – Flour Dust “After”

<table>
<thead>
<tr>
<th>Condition</th>
<th>Inhalable Dust mg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Before”</td>
<td>6.2</td>
</tr>
<tr>
<td>“After”</td>
<td>3.1</td>
</tr>
</tbody>
</table>

50% reduction in personal exposure

Typical default values for moveable capture hoods:
- ART (TNO report) = 50% reduction (ATV = 0.5)
- ECEL database = 7 – 80% (efficacy values range from 0.21 – 0.93)
Open Forum discussion

Some questions to ponder:

1. Is it necessary to quantify efficiency of exposure controls?
2. Is it feasible to assign numerical efficiency values to all types of exposure controls?
3. How can we describe the variability in efficiencies in a simple and meaningful way?
Workshop objectives

- Use case studies to compare “professional judgement” estimates of control efficiencies to actual measured data
- Gain a consensus view on how best to describe efficiency in a simple way that users of control measures can easily understand
- Explore elements of a User Database of efficiency of common engineering control measures
Preferred definition

- % REDUCTION IN EXPOSURE
- EFFICACY VALUE
- ASSIGNED TYPICAL VALUE
- ???
BOHS Control Efficiency User Database:

BOHS Council at their September meeting approved setting up a Control Efficiency Working Group to develop a User Database of quantified efficiencies of common exposure control measures.

- WG chaired by Alvin Woolley and Andy Gillies
- Scope and objectives to be defined and 2017 work plan to be agreed
- Fraunhofer ITEM Institute in Hannover have offered their co-operation
- A small group of Members volunteered to help at the Glasgow Conference.

We’re looking for more help – please let Alvin or Andy know if you’re interested
Key elements of a User Database

Taking on-tool extraction as an example:

- Who is the audience for a User Database?
- What information should be included in the Database?
- What format is best?
THANK-YOU FOR YOUR PARTICIPATION