Diesel Particulate Matter - Limits of Exposure and Exposure Data

Control Measures in Mining Session

Lung Cancer and Prevention in Mining Symposium
July 10th – 11th, 2017
Sudbury, Ontario

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Outline

- Background information
- Exposure limits
- Exposure data
- What’s next?
Controlling Exposure Requires Monitoring

Exposure Sampling and Analysis
- Enables assessment of impact of control measures
- Is a legislated requirement
Health Concern

- Nose and throat remove particles greater than 10 µm
- Trachea and upper bronchi remove particles 2.5 µm to 10 µm
- Particles between 0.1 µm and 2.5 µm are deposited in bronchioles and alveoli
- Particles less than 0.1 µm (diesel) reach all areas of lung and to some degree diffuse into body tissue
The Case of Claude Fortin

- Fortin was a Québec U/G gold miner (25 years service)
- A physically active non-smoker
- Diagnosed with lung cancer, passes away December 25th, 2009
- 2103 Québec superior court upholds the regulators assertion that this represents an occupational disease (diesel exposure)

Source: Le Devoir, January 25th 2013
Exposure Limits
Current North American Exposure Limits

- 1992 – MSHA (USA) begins developing dpm rule
- Canadian Diesel ad hoc Committee proposes 1.5 mg/m$^3$ dpm exposure limit - Adopted in 1992 by B.C. and Ontario
- 2003 - MSHA adopts 0.4 mg/m$^3$ exposure limit – becomes 0.16 mg/m$^3$ in 2008 *
- Québec - 0.6 mg/m$^3$ (Spring 2003) **
- Ontario - 0.4 mg/m$^3$ (January 2012) *

* dpm measured as Total Carbon (TC) – NIOSH 5040 method
** since revised down to 0.4 mg/m$^3$
Exposure Data
Number of U/G Mine Samples - Diesel Particulate - NIOSH 5040 TC

* CanmetMINING Analytical Laboratory data
Diesel Particulate Exposure - Frequency Distribution - 2013

- U.S. 0.16 mg/m³
- Ontario 0.40 mg/m³
- Québec 0.60 mg/m³
- Canada 1.50 mg/m³

* CanmetMINING Analytical Laboratory data
Percentage of Samples in Excess of Various Exposure Limits – 2013 Canadian Underground Mine Data (1000+ samples)

<table>
<thead>
<tr>
<th>Exposure limit (mg/m³)</th>
<th>% of samples in excess of limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 (Canada)</td>
<td>0</td>
</tr>
<tr>
<td>0.6 (2003 Québec)</td>
<td>1.5</td>
</tr>
<tr>
<td>0.4 (Ontario)</td>
<td>3</td>
</tr>
<tr>
<td>0.16 (USA – MSHA)</td>
<td>26</td>
</tr>
</tbody>
</table>

* CanmetMINING Analytical Laboratory data
Year by Year Percentage of Samples in Excess of USA Limit

Percentage of DPM Samples in Excess of 0.16 mg/m³

* CanmetMINING Analytical Laboratory data
Diesel Equipment in Mines
Clean Modern Engines

Source: Diesel Technology Forum
Ventilation Rate per Brake Power

Source: CanmetMINING – Diesel Certification data
Diesel U/G for the Foreseeable Future??

- Next 5 years likely business as usual
- Electric vehicles set to make a breakthrough?
- Several manufacturers of electrical Light-duty Vehicles
- Goldcorp’s Borden mine all electric by 2019
Industrial Fabrication Inc. - MINECAT

General Electric

Prairie Machine and Parts

RDH Mining Equipment
Impact on U/G Mining and H&S

- Ventilating for dpm control has been the golden rule in mining
- Control diesel concentrations and often every other substance or physical agent is ok
- Question: as diesel engines get cleaner or alternative energies take over...
- How will we manage ventilation engineering in the future?
- Are we ready to safely adopt various forms of alternative energy (hydrogen fuel cells, Li-ion batteries, etc.)?
Thank you...

Merci!
DPM personal sample

- no violation: **DONE**
- TC ≥ 191
  - yes: **DONE**
  - no: EC ≥ 176
    - yes: violation: **DONE**
    - no: analyze area sample

- determine TC:EC ratio of area sample

- multiply EC from personal sample by TC:EC ratio from area sample, defined as TC_{adj}

- TC_{adj} ≥ 202*
  - yes: are controls feasible?
    - yes: respiratory protection in use per §57.5060(d)
    - no: no violation: **DONE**
  - no: no violation: **DONE**

* Enforceable limit (PEL x EF) for TC_{adj} depends on number of area samples taken. Above example for 1 area sample. For more than 1 area sample, see table.