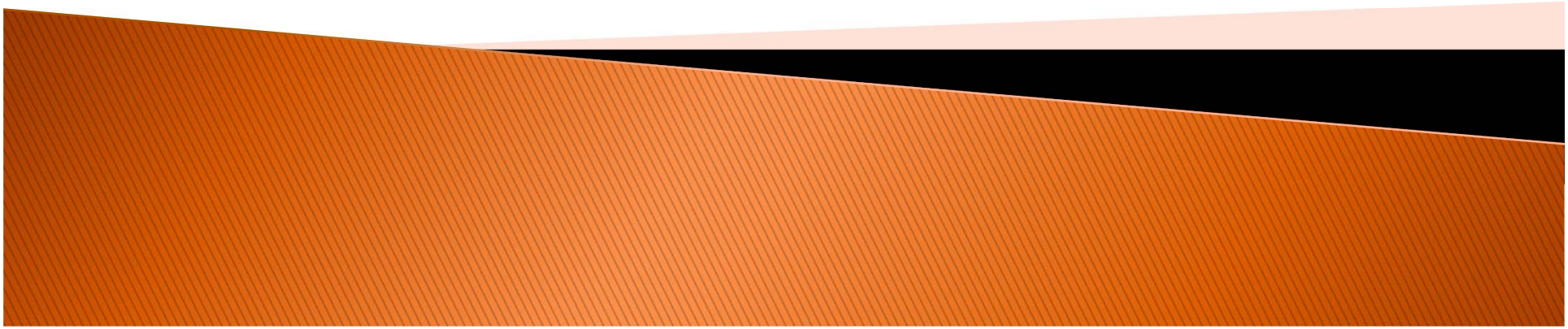
ASSESSMENT OF CUT-OFF SAW CONTROL METHODS FOR RESPIRABLE PARTICULATE AND CRYSTALLINE SILICA DURING HIGHWAY CONSTRUCTION APPLICATIONS

B. Hubbard, B. Middaugh, N. Zimmerman
and J. McGlothlin

Grant Title: "Development and Evaluation of a Personal, Respirable Silica Scavenging System for Highway Construction Cut-Off Saws"



Hand Held Cut-off Saws

- Gas-powered saw
  - Abrasive cutting blade (diamond)
- Used to cut:
  - Concrete
  - Asphalt
  - Metals

Cut-off Saw

Traditional Dry Cut-off Sawing

Current Work Practices

- In roadway construction, proper respiratory protection programs are rare.
- Dust control technology is not readily available or tested for many work processes.
- Traditional uncontrolled practices allow high overexposures.

After Asphalt Cut-off Sawing

Research Objectives

Research objectives:

1) Develop exposure baseline for three saw methods of concrete curb cutting
   - Dry sawing method (DSM)
   - Wet sawing method (WSM)
   - Local exhaust ventilation sawing method (LSM)
2) Determine if current local exhaust ventilation sawing technology is comparable to wet sawing methods
3) Characterize the effect of additional factors that may improve dust control design in construction

General Research Methods

- All three saw methods evaluated during the sawing of concrete curb expansion joints
- Concrete curb was selected because of the irregular cutting surfaces
- All methods used the same 14 inch diamond cutting blade

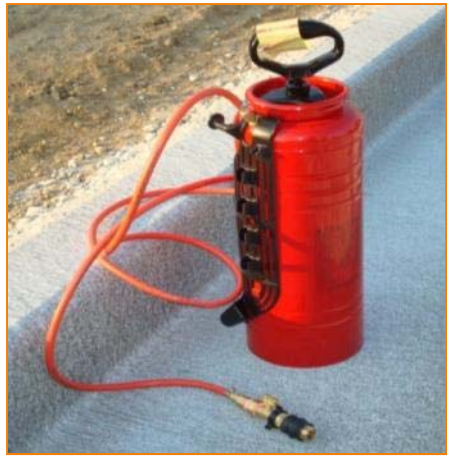
Curb Expansion Joint

DSM (Dry Sawing Method)

- Dust production not modified
- Control for experimental methods (LSM and WSM)

WSM (Wet Sawing Method)

- Saw coupled to a pressurized water tank located on a two wheel cart
- Mean water flow to the saw was estimated at 0.85 LPM



LSM (Local Exhaust Ventilation Sawing Method)

- Saw designed with dust collection system was used
- Consists of spring-loaded, movable guard
- Diverts dust into belt driven impellor exhaust system
- LSM has fewer operational issues than WSM

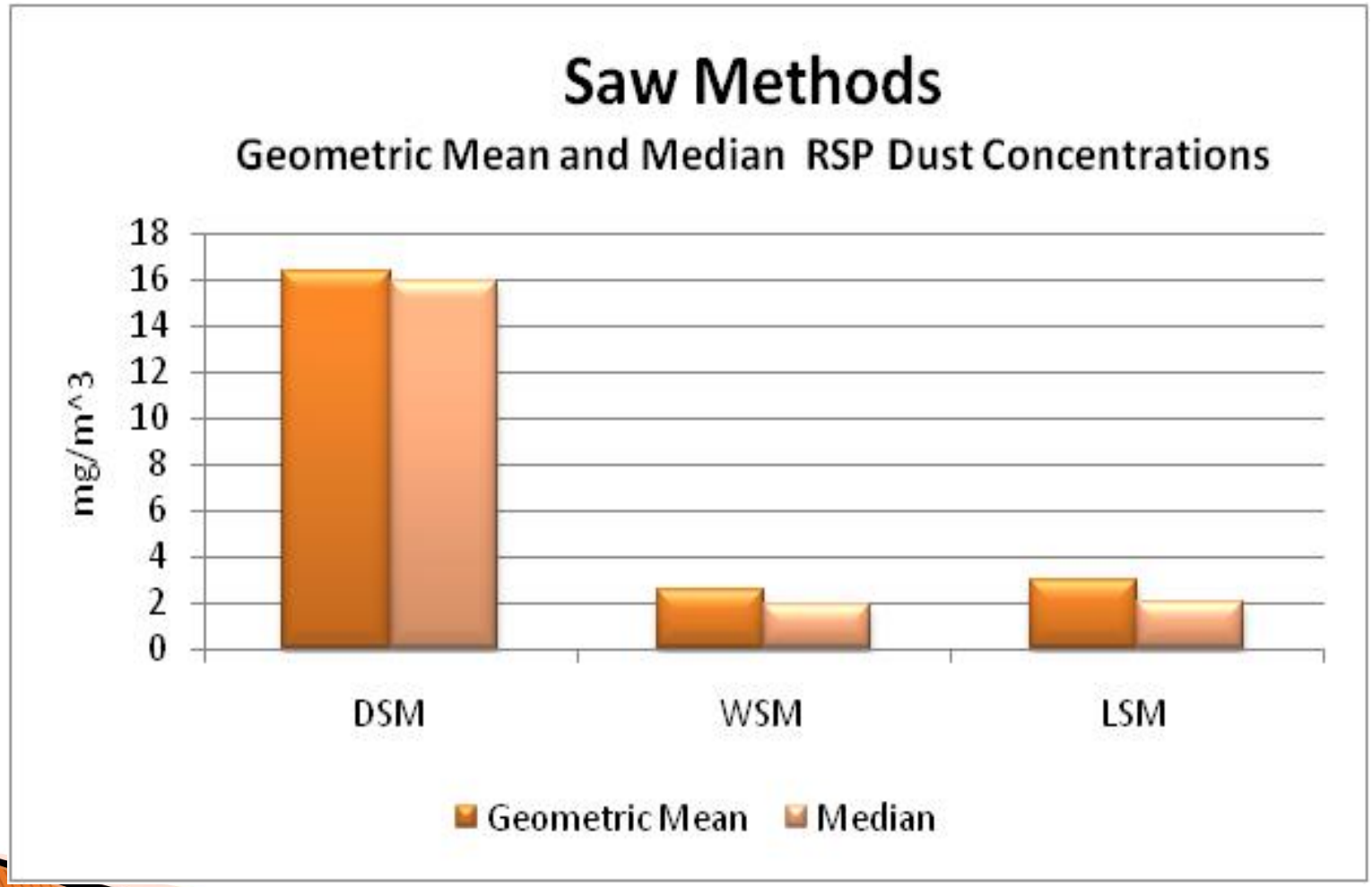
Field Data Collection

- Respirable dust and quartz air filter samples
  - Cyclone placed on worker's left lapel
  - Dust was collected on a pre-weighed PVC filter
- Concrete displacement measurements (Productivity)
- Bulk material samples

Field Data Collection

- Video Exposure Monitoring
- DustTrak Real-time RSP Dust Samples
- Real-time weather conditions
  - Temperature
  - Relative humidity
  - Wind speed
  - Worker orientation relative to wind direction

Time Weighted Average Respirable Dust Concentrations



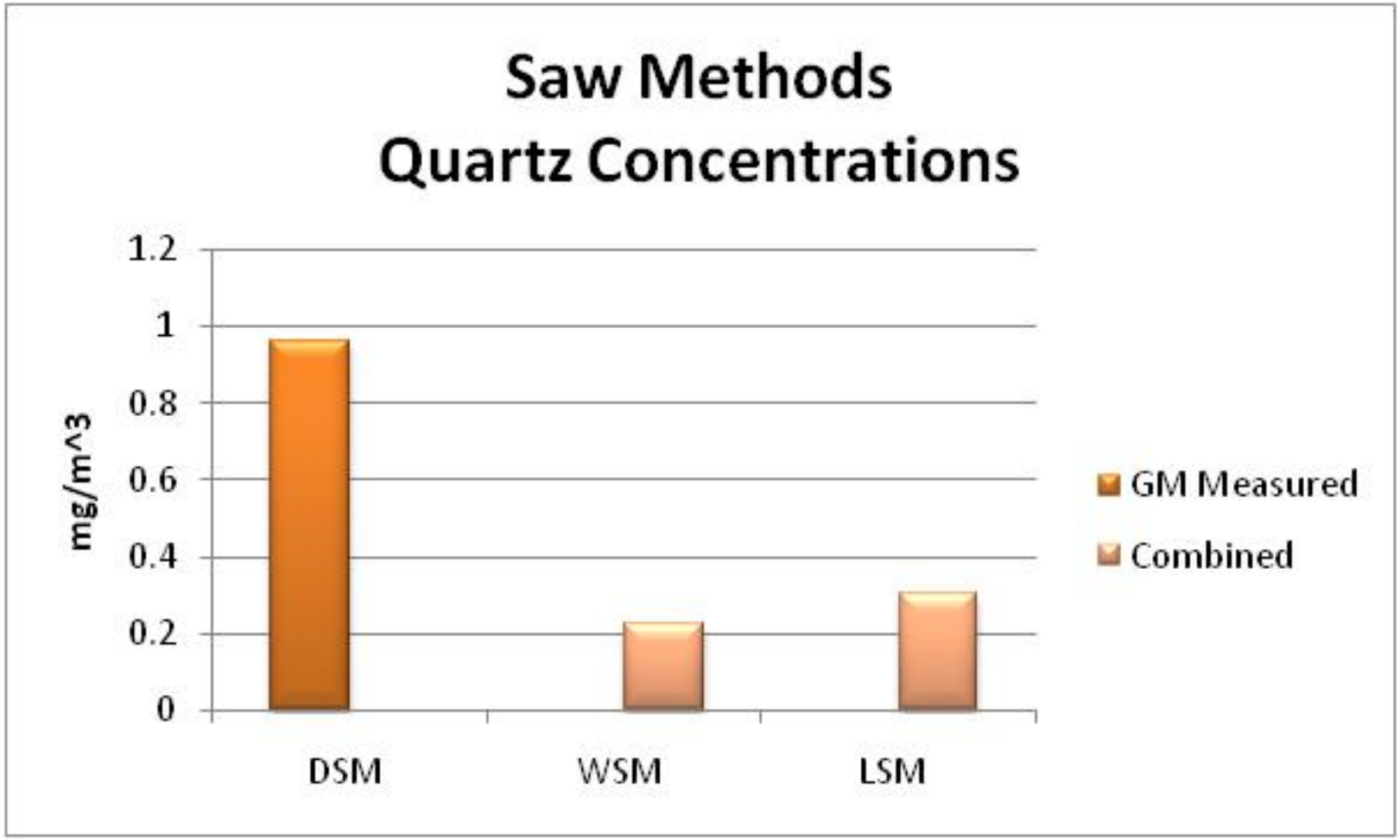
WSM 84.5% Decrease

LSM 81.9% Decrease

RSP Dust Statistical Comparisons

- Statistically significant difference between the DSM and both the WSM ($p<0.001$) and LSM ($p<0.001$)
- There was no significant difference seen between the WSM and the LSM ($p=0.118$)
- Differences between the WSM and LSM may have been masked by the large number of samples below the Level of Detection (LOD)

Quartz Concentrations



Severity Ratio of Time Weighted Average Quartz Concentrations

Method	Severity Ratio PEL	REL
Individual DSM Filters	9.6	19
Combined WSM Filters	1.5	3.0
Combined LSM Filters	2.2	4.4

Notes:

Severity ratio = concentration/exposure limit

PEL = OSHA general industry Permissible Exposure Limits (PEL) = 0.1 mg/m^3

NIOSH Recommended Exposure Limit (REL) 0.05 mg/m^3

Concrete Displacement (Productivity)

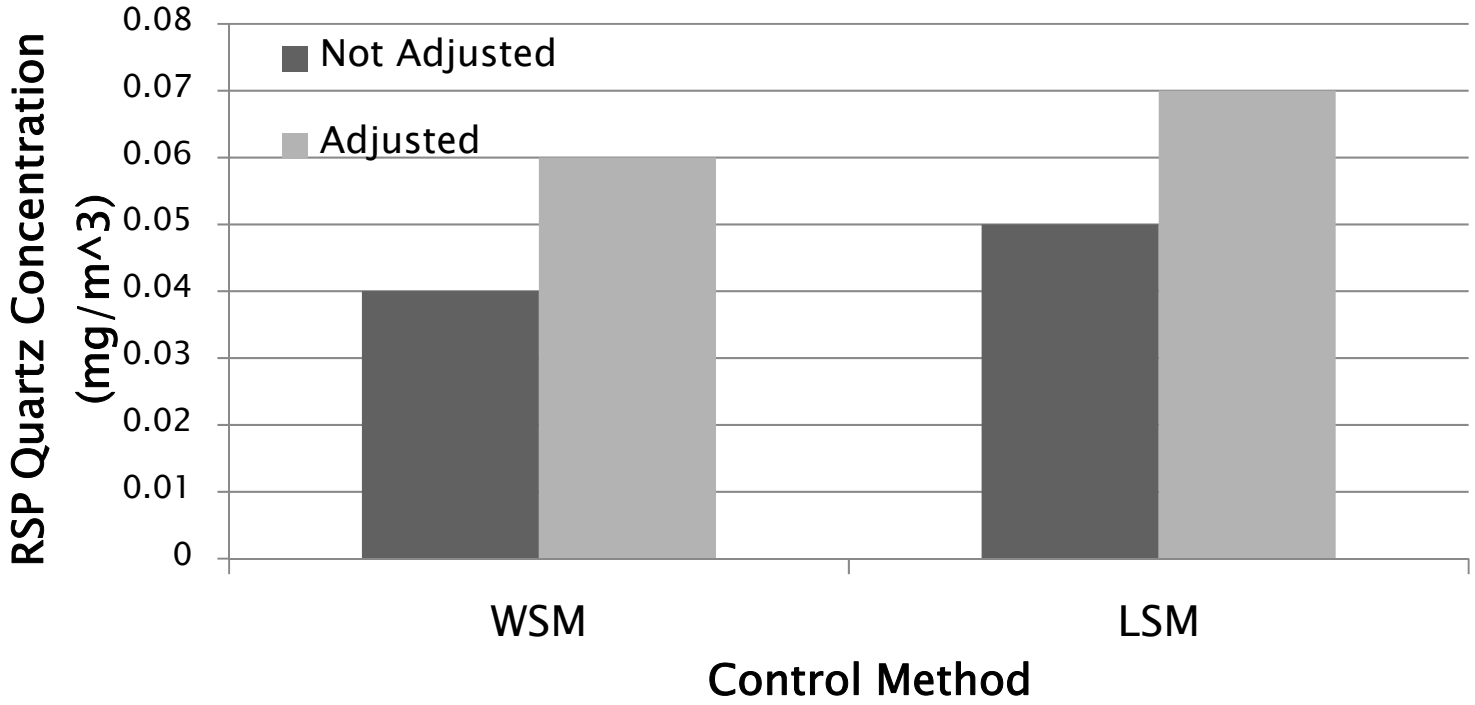
Concrete Displacement Rates for Saw Methods

Control Method	N	Concrete Displacement Rate (in^3/min) Mean (Std dev)
DSM	17	14.2 (2.51)
WSM	14	6.6 (3.15)
LSM	12	8.5 (1.62)

Productivity and Exposure

- Both the WSM and LSM method require the saw operator to work longer to accomplish the same amount of work relative to DSM
- Differences can be attributed to:
  - Time needed to move the equipment
  - Time needed to make cuts
  - Tasks necessary to keep equipment operational (e.g. hand pumping water container).
- Implications
  - Reduced productivity among engineering controls
  - May extend the exposure time of an individual using the engineering controls.

8-hour Time Weighted Average Quartz Concentrations before and after Adjustment



Notes:

8-h time weighted average for work shift assumes silica exposure for equivalent to 2 hour saw period using dry method

33% increase in exposure for the WSM after adjustment.

29% increase in exposure for the LSM after adjustment.

Real-Time Overview (DustTrak)

- Percent grand mean respirable dust reduction
  - WSM: 80.9%
  - LSM: 78.6%
  - Similar to reductions seen during gravimetric analysis
- Median peak concentration
  - WSM: reduced by 70.0%
  - LSM: reduced by 54.6%
- Although the grand mean reduction was very similar for the WSM and LSM, the WSM was more effective in reducing peak RSP dust concentrations

Conclusions

- Both the WSM and LSM are comparable in their respirable dust reduction capabilities
  - Neither control method would be effective in protecting workers below regulatory standards for a full 8 hours of sawing
- WSM is more effective and consistent at reducing peak concentrations of respirable dust
  - Improvement of the saw hood and vacuum system would reduce escaping dust
- Decreases in productivity were shown to be an important factor when assessing exposure reduction

Conclusions (Cont'd)

- The gas-powered local exhaust ventilation design (LSM) appears to overcome many of the drawbacks associated with water
  - Wet and caustic conditions
  - Slipping hazards
  - Workers can be protected year round during winter months
  - Electrical hazards
- Based on these findings, the LSM is an appropriate solution for roadway construction
- However, current local exhaust ventilation methods may still need to be accompanied by respiratory protection

Potential Future Directions

- Continue development and testing based on research findings
  - Portable multi-purpose LEV collection system for outdoor applications.
  - More effective collection hood for cut-off saws
- Design and evaluate dust controls for other road construction operations

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Questions?

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