

Investigation of Coal Dust Mitigation Strategies

KY Professional Engineers in Mining Seminar

September 5, 2014

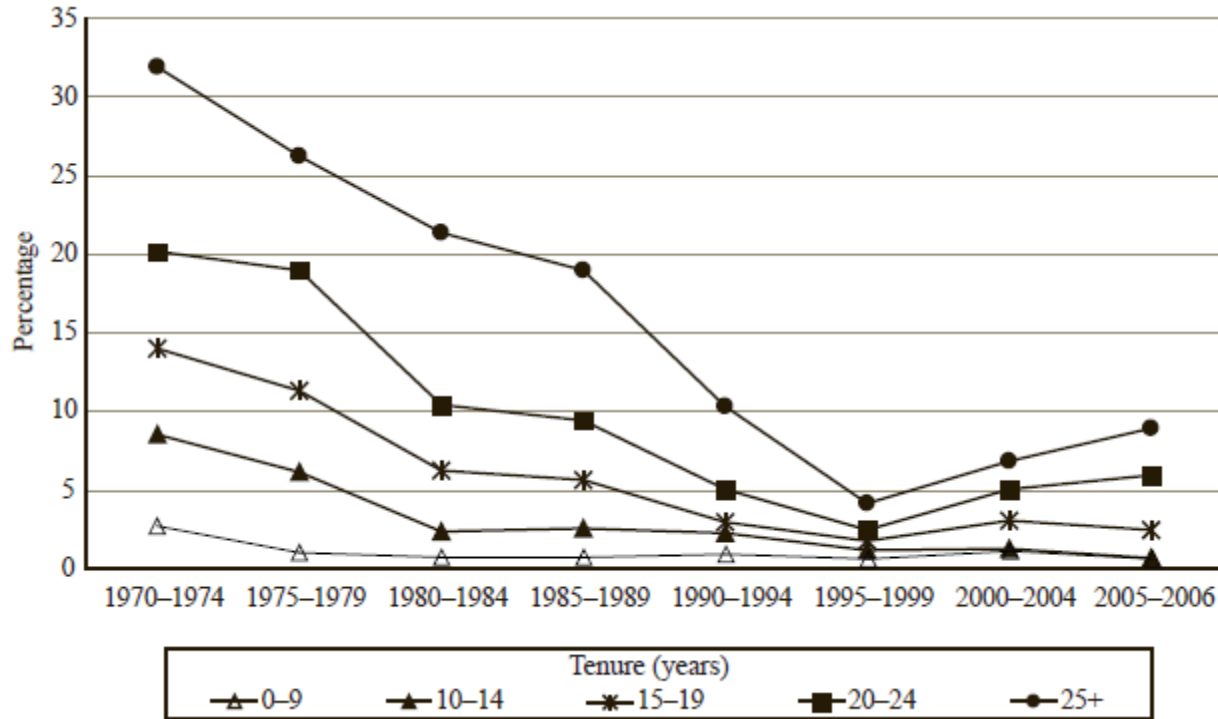
Chad Wedding



Overview

- Importance of Coal Dust Mitigation
 - Changes to the coal dust regulations
- Dust mitigation technologies
 - Passive ‘Wing’ Regulator
 - Flooded Bed Scrubber for Longwall Shearer
 - Novel Vortecone Scrubber technology transfer
- Summary
- Acknowledgements

Trend in CWP through 2006



Percentage of examine miners with coal worker's pneumoconiosis (category 1/0+) by tenure in mining, 1970 – 2006 (NIOSH, 2008)

Changes to the Dust Regulations

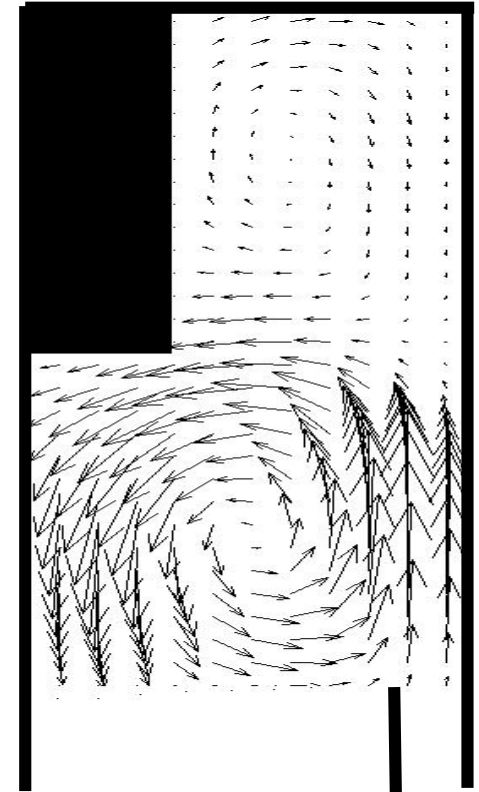
1. Lowers the existing concentration limits for respirable dust in coal mines.
2. Mandatory use of a Continuous Personal Dust Monitor (CPDM).
3. Redefines the term “Normal Production Shift.”
4. Requires full shift sampling.
5. Change to the averaging method for compliance.
6. MSHA inspectors may use single, full-shift samples to gauge compliance.

Passive Wing Regulator

- Significant enhancement for blowing curtain face ventilation systems
 - Improved penetration of fresh air to the face
 - Improved dilution performance to lower dust exposure levels
 - Improved dilution performance to lower methane levels
- Recent invention from UK colleagues
 - US Provisional Patent Application No 61/818,112.

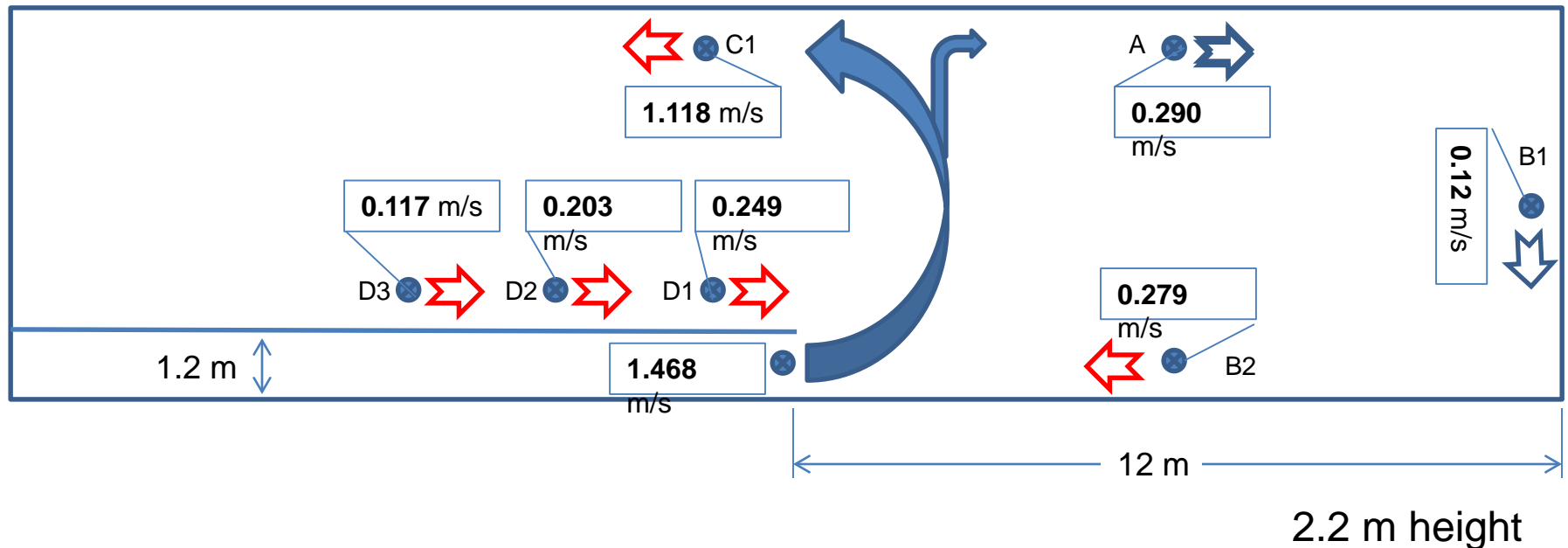
Flow Separation Phenomenon

- Only ~20% of the intake air makes it to the face for dust and methane dilution (Wala, 2001, 2004)
- Observed in both full scale, reduced scale models, and active mines



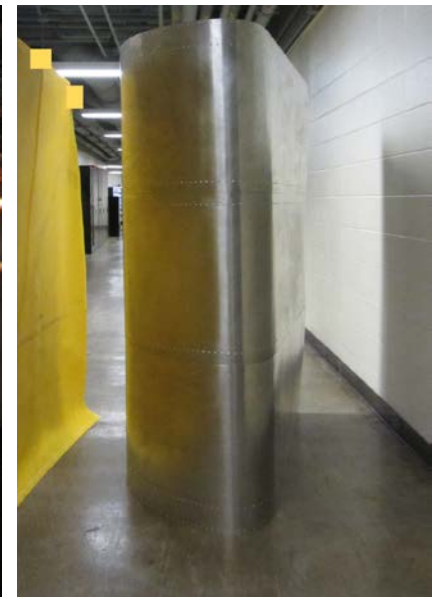
Flow Separation cont.

- Velocity readings at a typical blowing curtain face ventilation arrangement



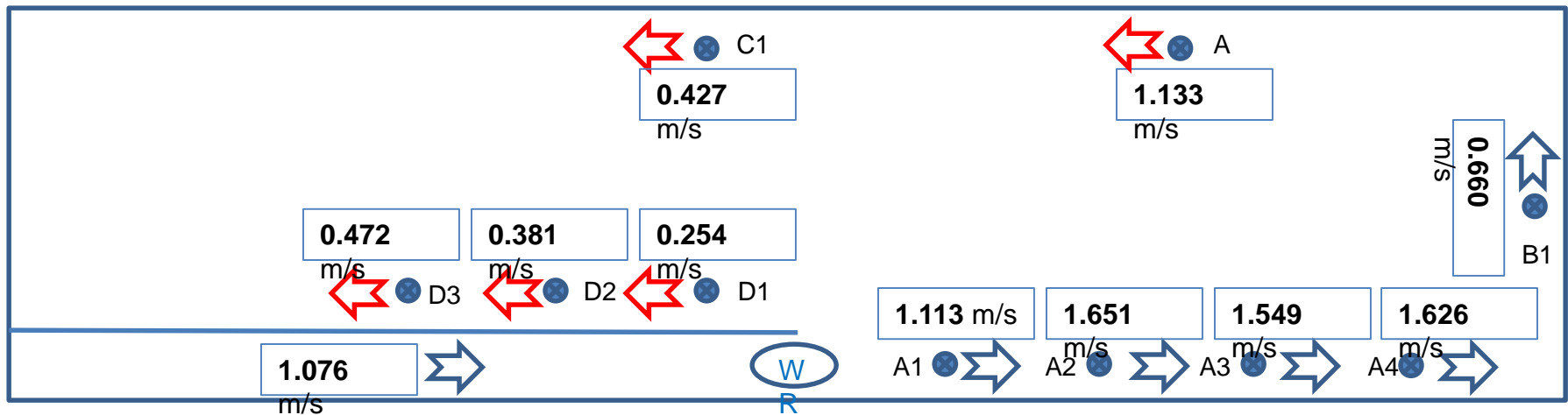
Passive 'Wing' Regulator

Solution to flow separation from concept to prototype



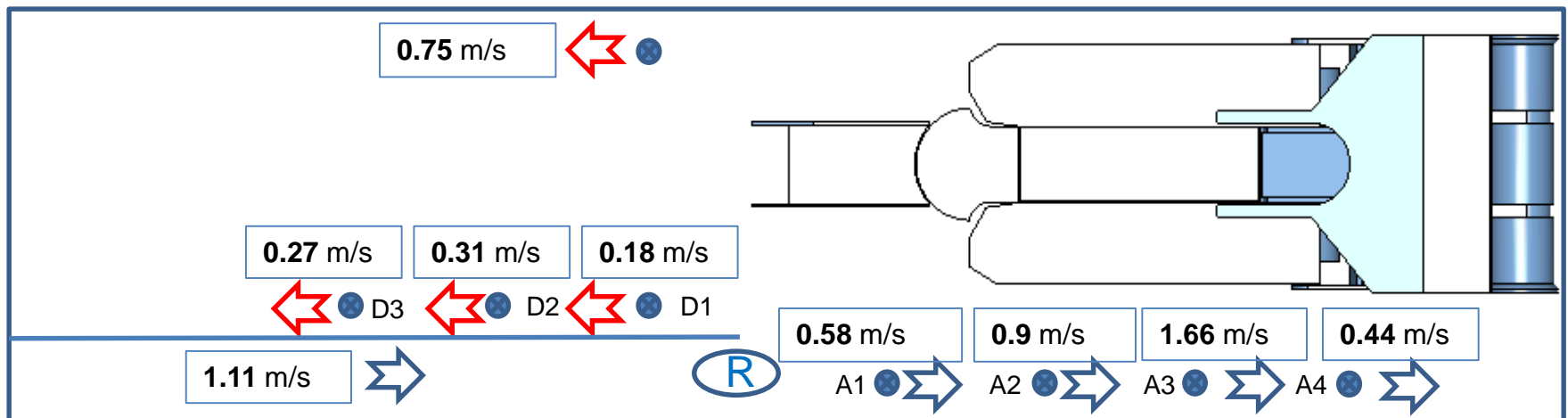
Jet Penetration Enhanced due to Wing Regulator

- Velocity readings with the wing regular applied to same blowing curtain face ventilation arrangement

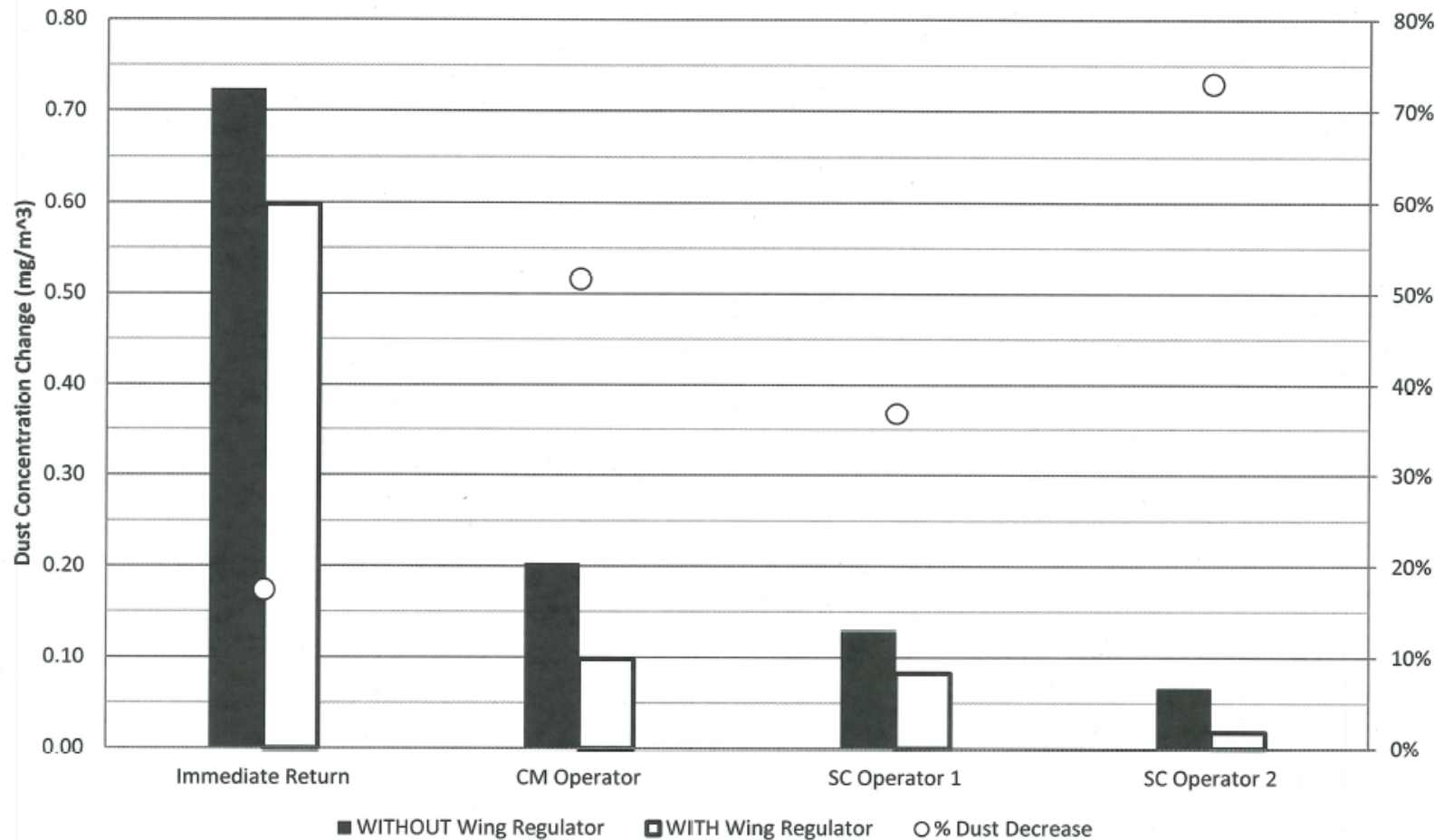


Jet Penetration Enhanced due to Wing Regulator cont.

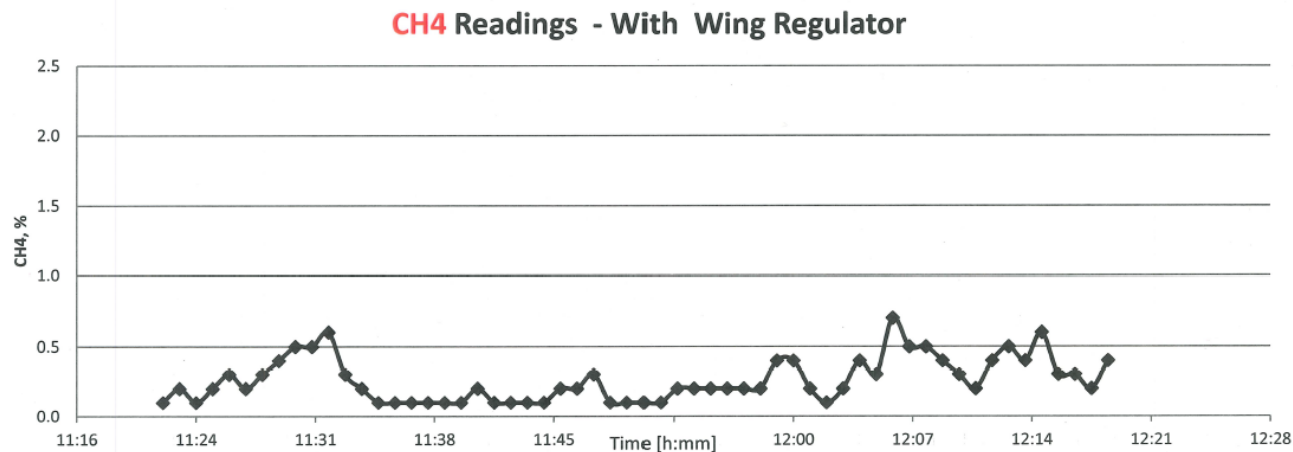
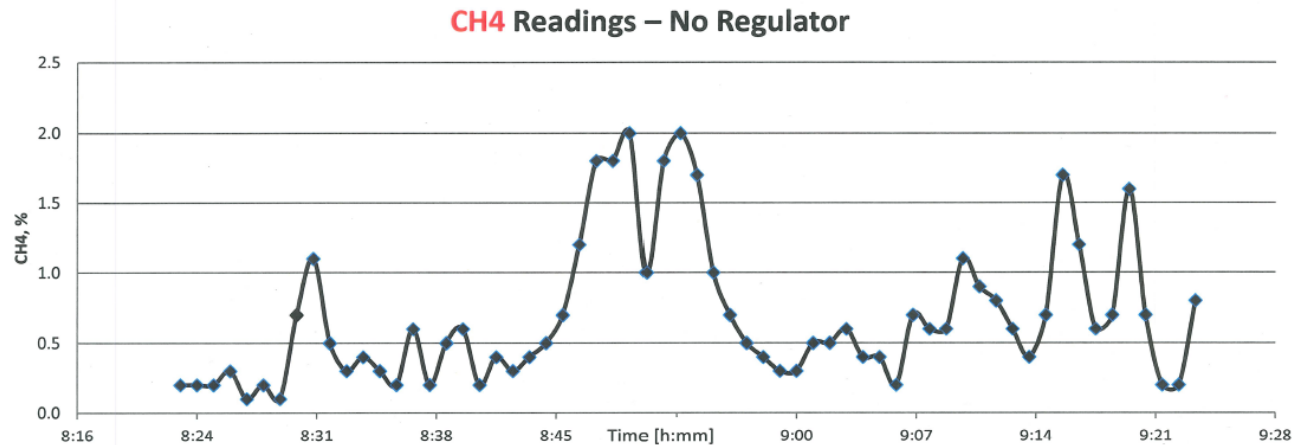
- Enhanced performance present with equipment at the face



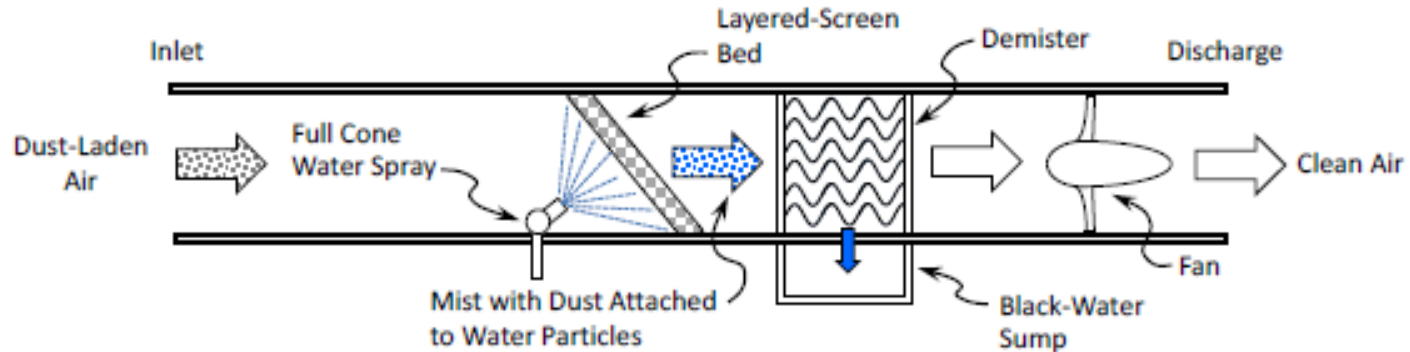
Improved Dust Dilution with Wing Regulator



Improved Methane Dilution with Wing Regulator



Flooded Bed Scrubber for Longwall Shearer



- Along dilution and water sprays, common dust capture technology for continuous miner units
- Needs to be adapted for longwall shearer

ACARP Project

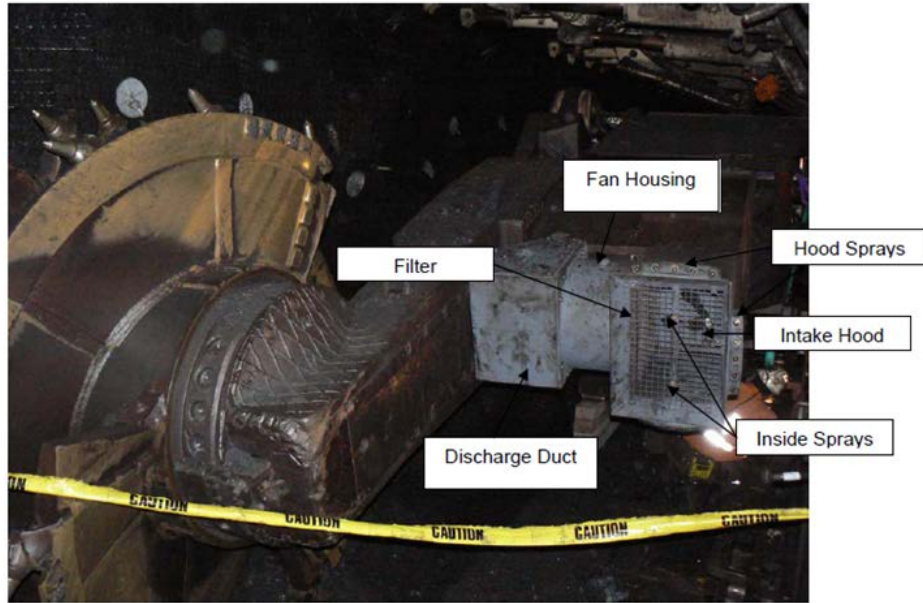


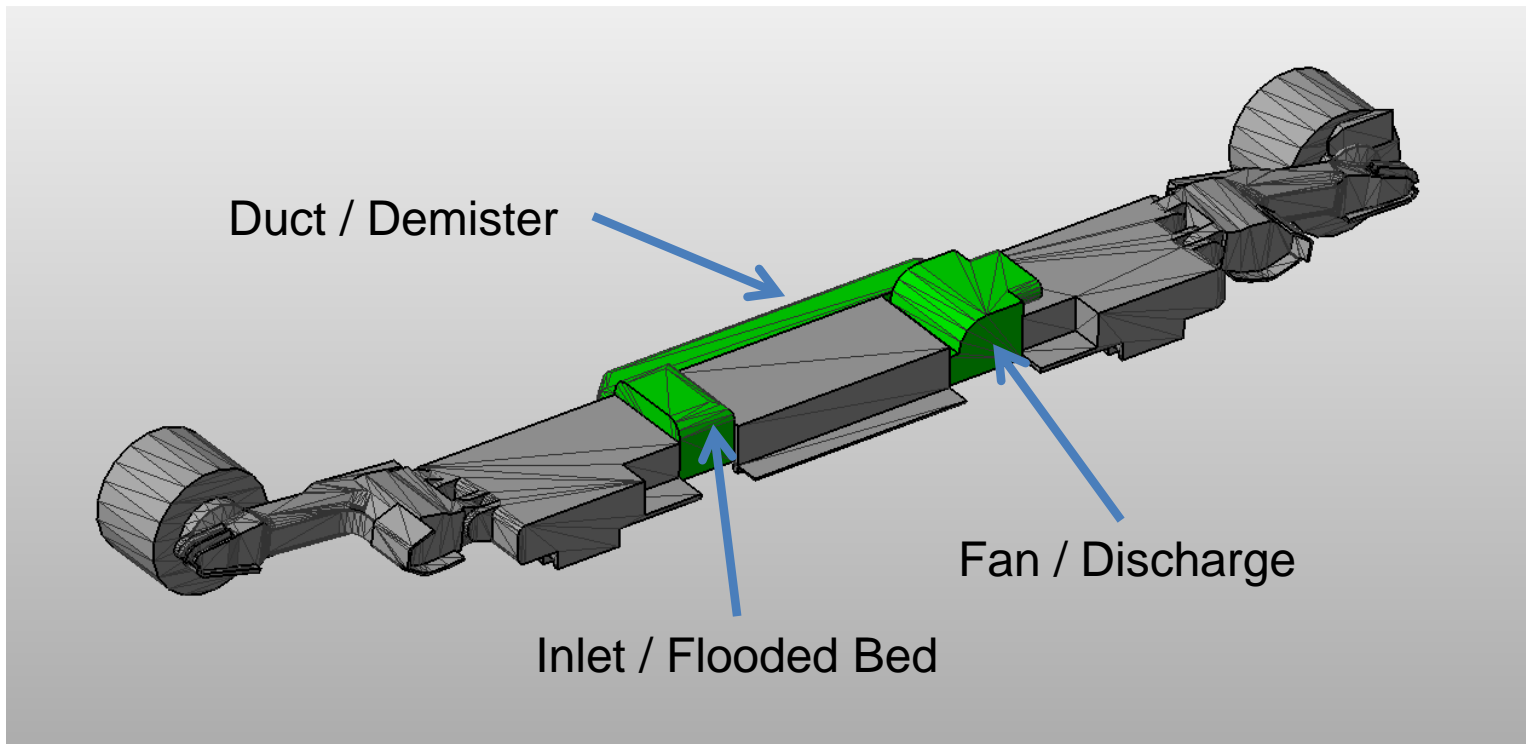
Figure 7. The installation of the final scrubber design

- Following on from an Australian Project ending in 2009
- Compact modular scrubber added to the ranging arm
- Reduction in dust concentration from 14% to 56% measured outby from shearer operator

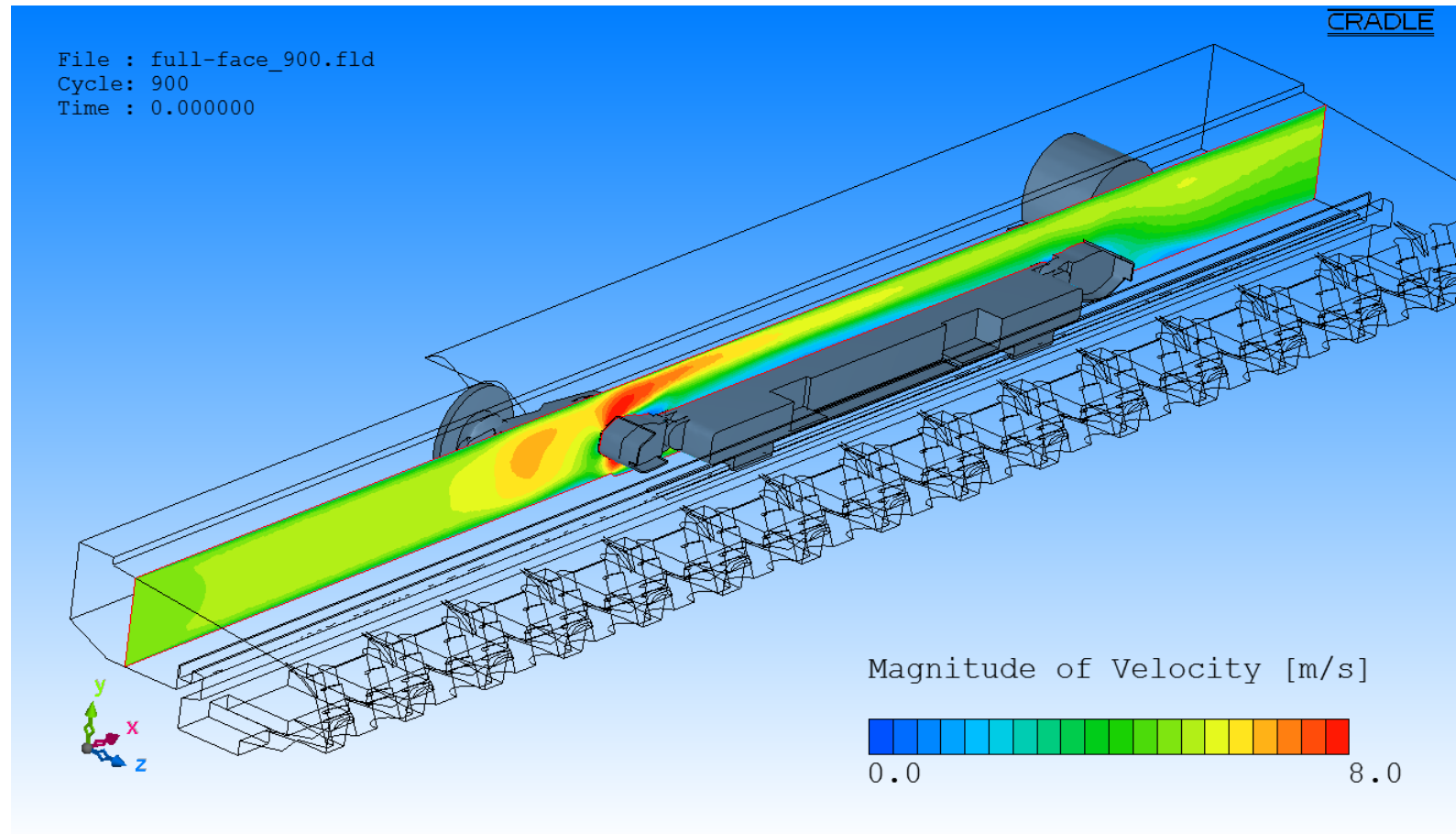
Field Trials



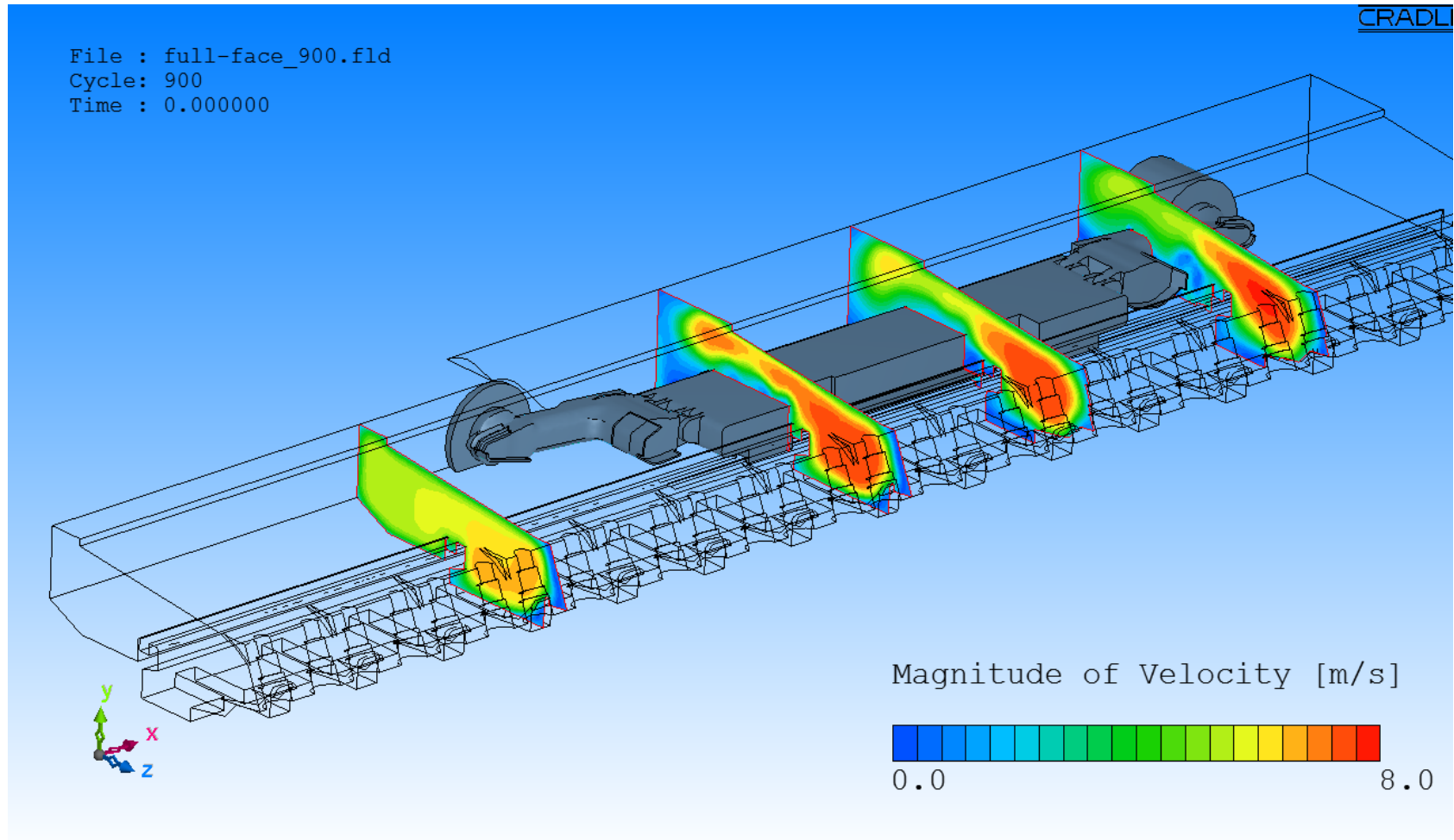
Conceptual Layout



Preliminary Velocity Contours



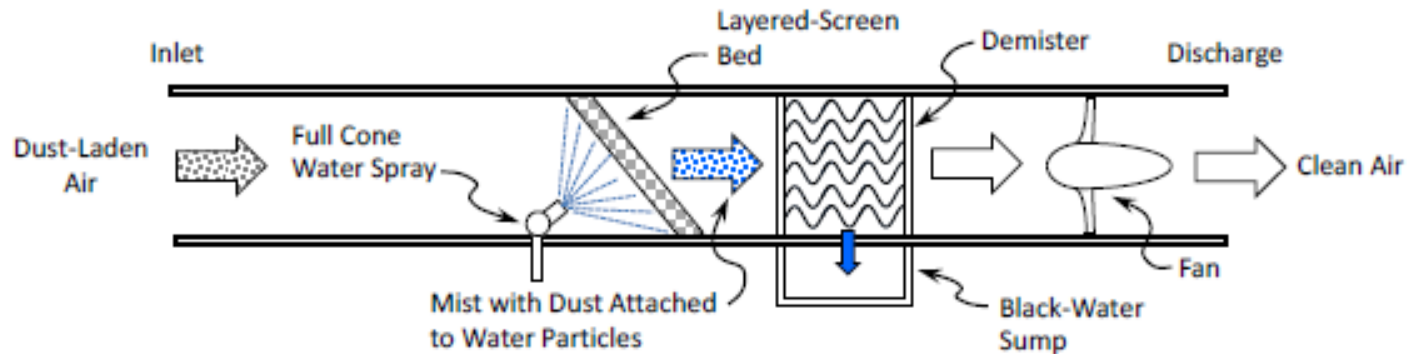
Preliminary Velocity Contours cont.



Novel Vortecone Scrubber Technology Transfer

- Technology Transfer of a novel scrubber design
- NIOSH Funded Research
 - Recently awarded project – August 29
 - Five year research project

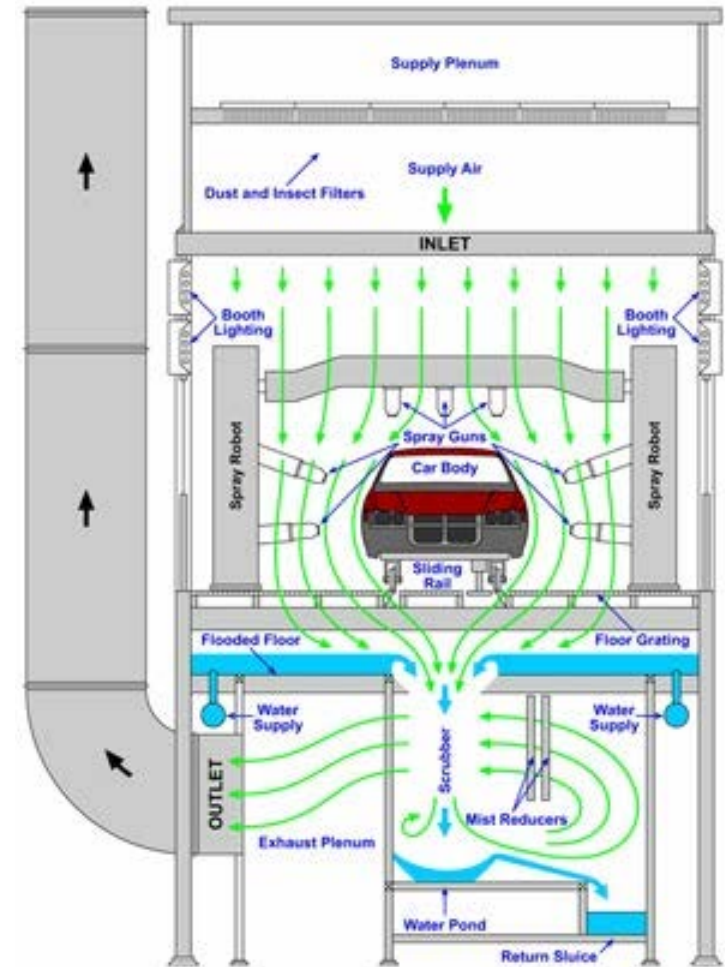
Conventional Scrubbers



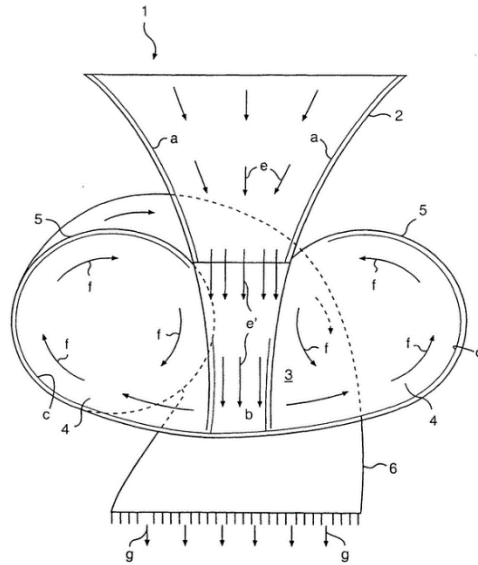
- Cleaning efficiencies between 60% and 90% (NIOSH 1997)(USBM, 1990)
- Requires frequent maintenance to maintain performance

Paint Dust Challenge at Toyota

- Automotive manufacturers must scrub paint dust from the air
 - Paint application efficiency is between 50% and 60%, with particles from 1 to ~300 microns
 - OSHA requires a uniform downdraft velocity of at least 0.5 m/s within the painting area, (500 kcfm in total)
- The painting line consumes nearly 40% of the energy required to assemble an automobile



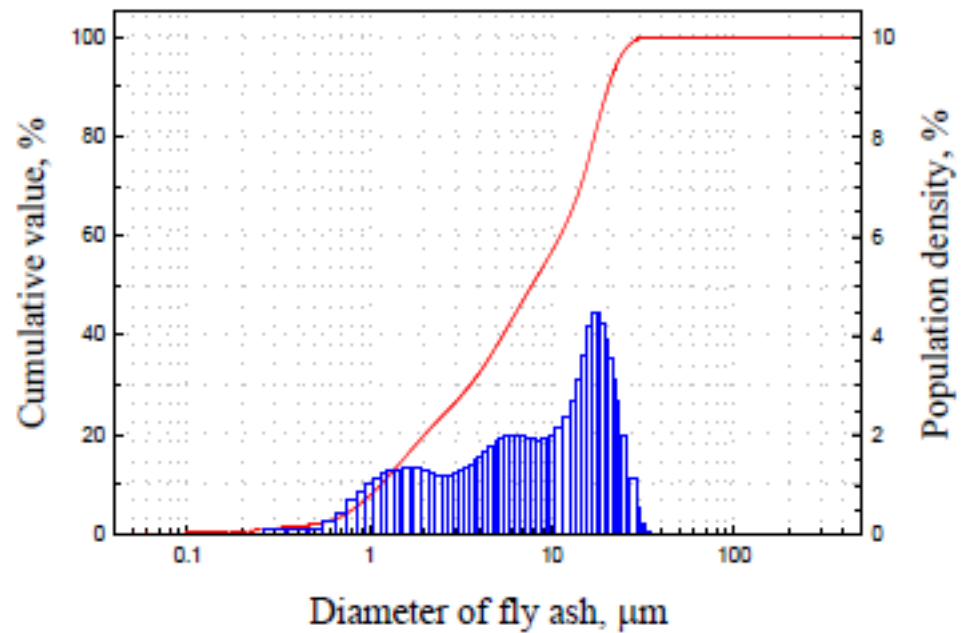
Vortecone Scrubber



- Currently operating in seven of Toyota's plants to capture paint over-spray
- Cleaning efficiency of 99.6%
- 30% reduction in operating costs
- Greater system availability due to reduced maintenance frequency

Application to Fly Ash

- Feasibility study for capturing fly ash from flue gas from coal-fired power plants,
 - emphasis on the 2.5 micron size and smaller fraction
- Shawnee Power Plant fly ash, mean of 9.6 μm and a D_{50} of 7.7 μm
- 99.8% cleaning efficiency



Vortecone Scrubber for Mining

- Applicable for respirable size fraction
- High cleaning efficiency
- Minimal maintenance
- Scalable in match air requirements
 - From 200 cfm lab models to 60,000 cfm at Toyota



Summary

- Several new dust mitigation strategies under exploration at the University of Kentucky
 - For improved dust dilution
 - Potential for improved dust capture
- For follow ups
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 - Email: Chad.Wedding@uky.edu

Acknowledgement

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