Public Comments on NPRM—Lowering Miners' Exposure to Respirable Coal Mine Dust, Including Continuous Personal Dust Monitors

An Industrial Hygiene Viewpoint

Mike Cooper, MS, MPH, CIH
mcooper@exponent.com
Sheila McCarthy, MHS, CIH
Exponent

8 February 2011
Washington, PA

Mike Cooper, MS, MPH, CIH

Sr. Managing Scientist, Exponent- mcooper@exponent.com

- Graduate work in Chemistry and Public Health.
- Certified Industrial Hygienist, comprehensive practice.
- 20 years industry experience directing Environmental Health and Safety (EHS) organizations for aerospace, semiconductor, and medical device manufacturers.
- Conducted airborne contaminant exposure assessments for various industries including military bases in the middle East.
- Member, California State Health Expert Advisory Committee; committee sets health-based permissible exposure limits for airborne contaminants for consideration by Cal OSHA.
- University of California instructor in EHS Management and Program Development.

Disclaimer

- Mike Cooper and Sheila McCarthy with Exponent were asked to independently review the proposed MSHA Rule related to continuous personal dust monitor (CPDM) use and maintenance, exposure monitoring, and other industrial hygiene issues.
- Exponent received funding from Murray Energy Corporation (MEC) to conduct this independent industrial hygiene (IH) review.
- The opinions and comments presented herein reflect the independent scientific assessment of Mr. Cooper and Ms. McCarthy.

Methodology

- Reviewed proposed rule from an industrial hygiene viewpoint
- Reviewed National Institute of Safety and Health (NIOSH) CPDM studies, and Quantitative Risk Assessment (QRA) literature.
- Reviewed conditions in two underground bituminous MEC coal mines.
- Reviewed all collected continuous personal dust monitor (CPDM) data for five underground mines.
- Interviewed dust managers, miners, and safety and health professionals.

Areas of Agreement with Proposed MSHA Rule

- Appreciate the process that allows the public to comment on the Agency's approach to reduce risks to miners from respirable coal dust.
- Use of the CPDM unit has the potential to improve the timeliness and knowledge of dust levels in the mine, assuming high reliability of CPDM and feasibility of its usage
- Objectives of 2009 End Black Lung Initiative
  - Rulemaking – need for collaborative participation
  - Enhanced enforcement – goal should be consistent enforcement
  - Collaborative outreach – this approach can be highly effective
  - Education and training – this approach can be highly effective

Areas of Concern

- Reliability of the one MSHA-approved CPDM unit is a concern. Miners report frustration with the unit based, in part, on the high fault rate, weight, and potential for distraction.
- The proposed rule calls for a large increase in the number of mixed coal mine dust samples. However, factors such as mine size, coal type, mine region, silica, and miner age are not monitored by increasing the number of CPDM samples.
- Large scale CPDM data collection is an inefficient way to improve our understanding of dose-response trends and factors influencing CWP incidence. A smaller, focused data set of higher quality would be more useful and efficient.

Areas of Concern (cont'd)

- The proposed rule may result in unintended health & safety risks:
  - Wearing the CPDM unit may increase worker distraction and decrease the ability of a miner to work safely - the CPDM has no audible or vibrational alarm and the display is difficult to read.
  - Increase risk for musculoskeletal disorders (MSD) due to weight, and an unbalanced load when wearing the unit.
- Citations in the proposed rule change from averages to single shift data *at the same time* that:
  - Significantly more samples are required
  - A new instrument is required that lacks sufficient testing under the full range of mine conditions
  - The new instrument appears to have a high fault rate, and
  - The PEL is lowered.

Topics to be discussed

- Provide data regarding
  - Miner experience with CPDM sampling
  - CPDM maintenance problems
  - NIOSH 2006 CPDM testing & error rates
  - Five mine experience with CPDM testing and error rates
- Feasibility and rationale for lowering of PEL
- Practical considerations

Mine Experience with CPDM Sampling

Miner concerns

- Frustrated that the unit has a high fault rate (29% invalid samples in this review)
- CPDM is too bulky for seats in equipment compartments; faults occur due to pinched hoses at start of shift
- No alarms: audible, light, or vibrational to alert miner
- Difficult to read display using cap lamp
- Hose to cap lamp is too long, catches on equipment
- Connections to remote units are hard to make in the mine, connectors are not as easy as those on the standard cap lamp battery
- CPDM does not fit workers' pouches or belt

Mine Experience with CPDM Sampling (cont.)

Certified Dust Manager concerns

- Long start time (35 minutes) have routinely meant portal-to-portal shift sampling was thwarted
- CPDM unit is more complicated to maintain than the gravimetric sampler
- Maintenance of the CPDM is specialized and requires practiced skill to maintain
- Four of five CPDM units needed to be sent back to factory 6 times in 18 months (two sere sent twice)
- Significant time required to return units to company for repairs (2 weeks)
- Concern that one of five units experienced a failed pump prior to one year of operation
- Very little experience with KO, cyclone cleaning, flow rate
- Only one MSHA-approved CPDM unit on market at this point

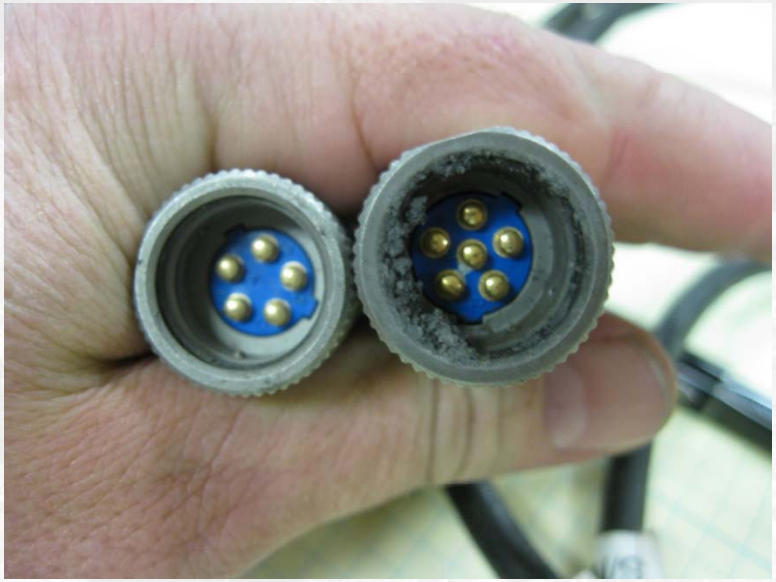
Mine Experience with CPDM Sampling (cont.)

Safety and Health Personnel concerns

- Wearing the CPDM unit may cause unintended worker distraction and decrease the ability for miners to work safely
- Wearing the CPDM may increase the risk for musculoskeletal disorders due to weight added to belt and unbalanced load
- Mis-conception that CPDM is a real-time device
- PDM does not provide instantaneous readings to the miner – the unit provides the miner with 30 minute averages and end-of-shift values averages, other data can be downloaded on the dust card
- While this is an improvement over the gravimetric unit, the ability to implement rapid changes to miner work practices (<30 minute) is missing.

Connectors for Remote Continuous Mining Equipment

- Two connector types have to be connected in the mine
- Preference for connector used on current cap lamp battery

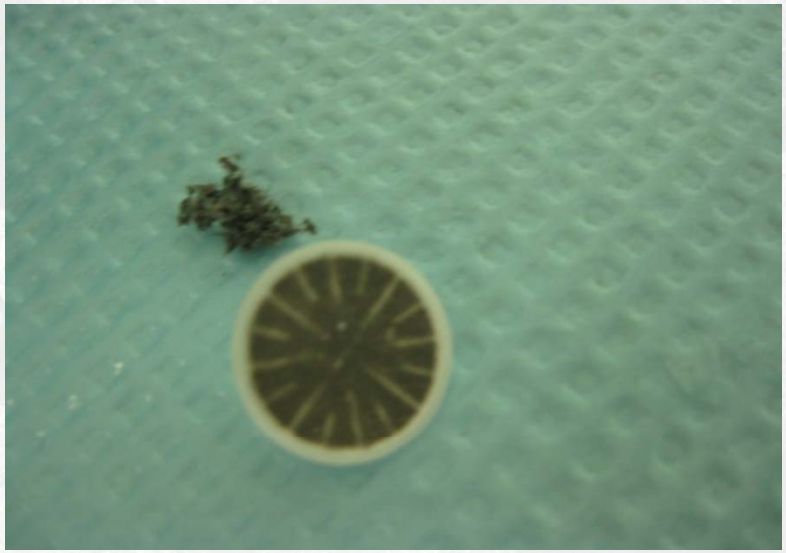


CPDM Maintenance Issues

- One CPDM unit (S/N 0509055) was provided to Exponent for several weeks of sampling and to review the maintenance procedures
- Unit repeatedly passed diagnostics but reported end of shift (EOS) results of 1-2 mg/m^3 in an office setting
- KO test failed once and then subsequently passed
- Other concerns
  - No data concerning mean time between failure (MTBF) of critical parts
  - No useful life of the unit defined
  - Unclear how long it would take to approve upgrades (hardware, software) for the CPDMs

Example of an Unusual Failure

- Symptoms
  - Unit (S/N 0509055) passed diagnostics
  - Readings of 1-2 mg/m^3 in a clean office environment (very high)
  - Unit cleaned, passed diagnostics again and passed a KO audit
  - Odd fibrous carbon material (95% carbon) found adjacent to filter after unit faulted multiple times during mine data collection



CPDM Maintenance Reported by NIOSH

- NIOSH (2006) conducted laboratory and in-mine testing
- NIOSH (2006) Dust chamber sampling
  - Each PDM was cleaned after each day of use (unknown amount of time)
  - Maintenance performed: removed and cleaned cyclone grit pot, tapered element (TE) sensor module, filter, and cleaned inlet tube lines
  - CPDM units were pre-commercial versions
- NIOSH (2006) Mine sampling
  - In-mine testing involved 10 mines; 3-10 days at each mine
  - One full shift per day
  - No monthly or annual maintenance; 'KO' audit, flow, cyclone clean, re-calibration by factory
  - CPDM units were pre-commercial versions

Source: 2006 NIOSH Laboratory and Field Performance of a PDM, RI 9669D

Source: 2006 NIOSH Laboratory and Field Performance of a PDM, RI 9669

NIOSH 2006 CPDM Testing

- NIOSH evaluated 25 CPDM units with an average of 437 hours each of operating time (equivalent to 44 10-hr shifts)
- Results
  - 1,202 samples total
  - Approximately 11,000 hours of testing
  - Best units went 532 hours without repair
  - Failure rate defined as the number of invalid samples/ total samples was 9.8% (118 invalid samples / 1,202 samples)

NIOSH-Reported CPDM Errors

- Two main repairs (error) types identified
  - *Remedial* – software or hardware modifications including updates, failed displays, keypads
  - *Critical* – necessary for full functioning, ultimate instrument reliability
- Total number of repairs (errors)
  - Ranged from 1.6 to 11 repairs / 1,000 hours
  - Average of 4.75 errors per 1,000 hours

For three shift usage, units run average of 15 hours per day

If error occurs every 4.75 / 1,000 hours this is one repair or error every two weeks, some of them defined as “critical”

Source: 2006 NIOSH Laboratory and Field Performance of a PDM, RI 9669

Comments on NIOSH CPDM Testing

- CPDM units were pre-commercial versions
- No report of monthly or annual maintenance performed
- NIOSH (2006) was a limited study compared with number of sample hours and units needed to comply with the proposed rule in a given mine operation
- Some faults were observed in the study but more errors will likely occur with vastly increased frequency of CPDM use required by the proposed rule
- No data were provided to determine mean time between failure (MTBF) for critical parts on the CPDM
- Life of the CPDM unit not provided
- Not enough industry experience with the CPDM to determine full range of error conditions, practical problems during use, or what these conditions mean for data validity

Voided samples for MSHA gravimetric samples

- Error rates of MSHA data (1995-2004) reported in App. C of NIOSH (2006)
- Inspector data
  - 381,000 gravimetric samples from 1995-2004
  - 6.1% were voided (23,399)
- Operator data
  - 488,000 gravimetric samples from 1995-2004
  - 11.7% were voided (57,000)

Source: 2006 NIOSH Laboratory and Field Performance of a PDM, RI 9669, Appendix C

Invalid samples– CPDM compared with MSHA gravimetric samples

- MSHA Inspector data (1995-2004) void rate = 6.1%
- MSHA Operator data (1995-2004) void rate = 11.7%

- In comparing gravimetric void rates and potential PDM void rates, NIOSH (2006, p. 36) concluded:

  "Based on types of void rates and the expanded capabilities of the PDM, we estimate that about ½ of the MSHA voided samples could have been valid samples using PDM technology." (p. 36, NIOSH 2006)

Source: 2006 NIOSH Laboratory and Field Performance of a PDM, RI 9669, Appendix C

CPDM Error Investigation – Five MEC Mine Data

- Reviewed all records from five CPDM units in use from 2009-2010 in five mines.
- The percent of invalid samples to valid samples is 48/166 = 29%, this compares with a 9.8% invalid/valid percentage reported by the NIOSH 2006 report

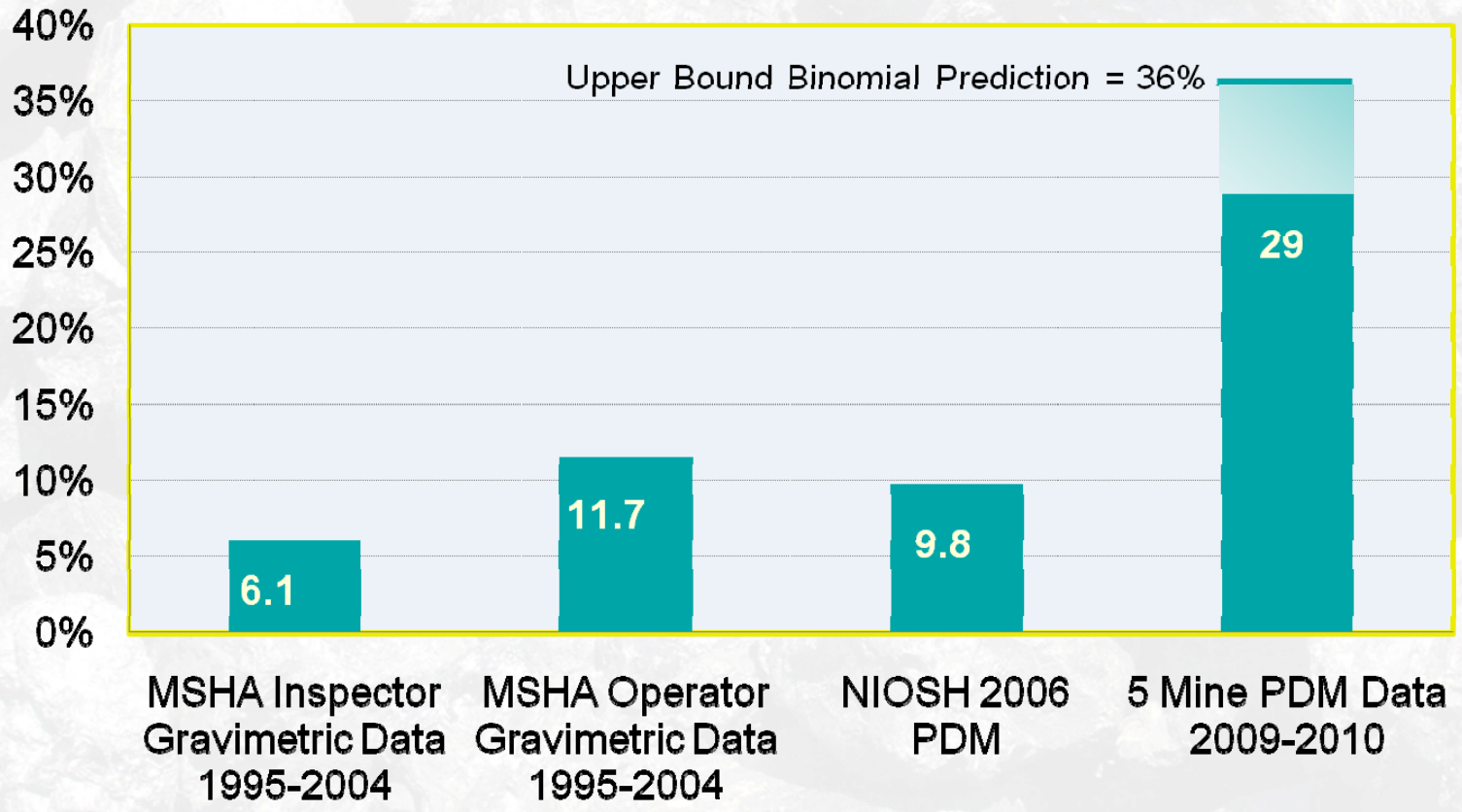
	Total Samples	Error (at least 1)	Percent voided	Time Hours	Error per 1,000 Hours
Mine 1	36	10	28	257	39
Mine 2	43	13	30	257	51
Mine 3	28	6	21	208	29
Mine 4	25	5	20	171	29
Mine 5	34	14	41	268	52
Total	**166**	**48**	**29**	**1,161**	**41**

Error Types with CPDM

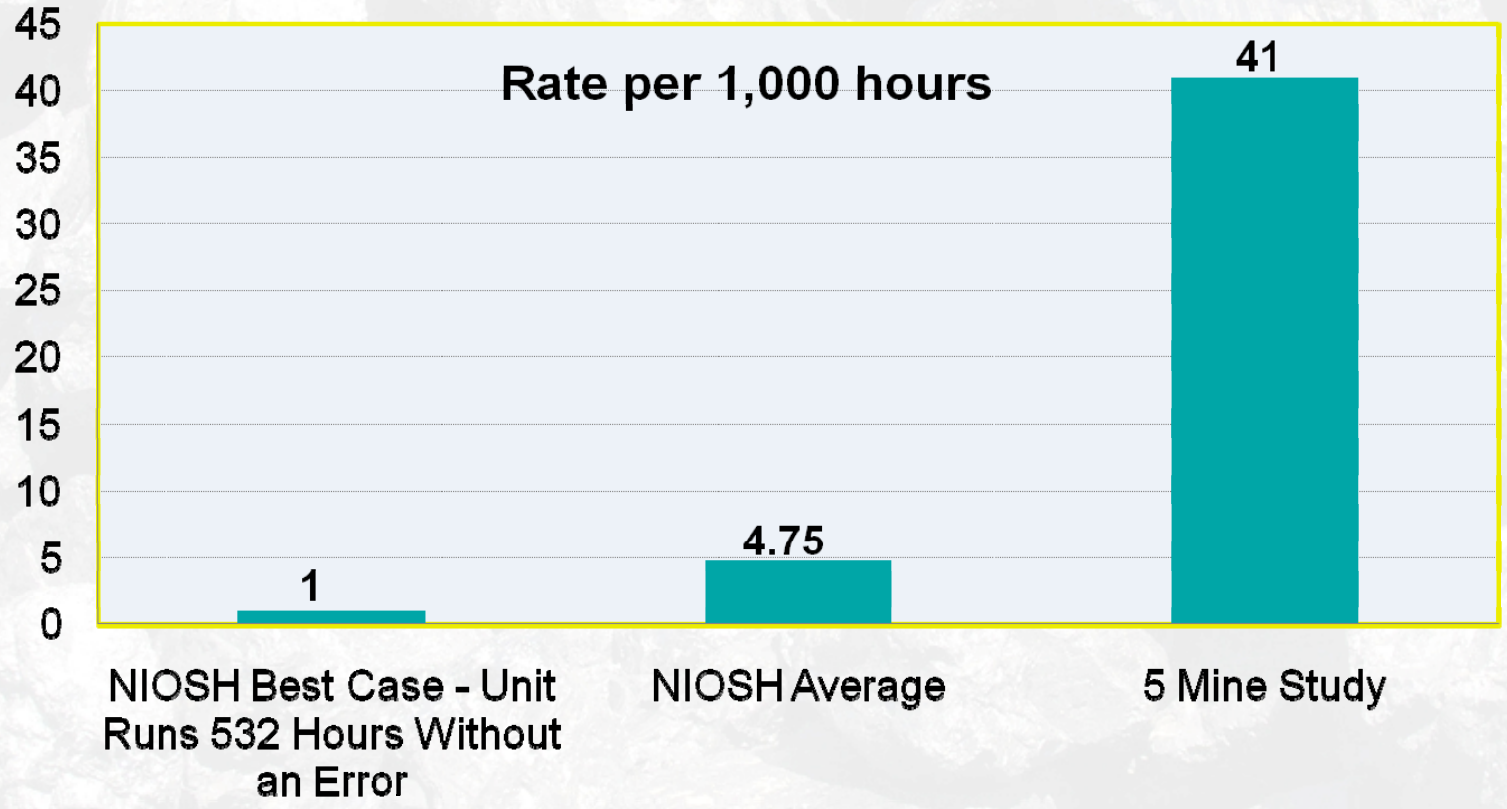
- Reported on all dust cards from five MEC mines during 2009-2010
- Errors occurred throughout the sampling period (early and late - not just early)
- Totaled errors (75) greater than 48 because some units reported more than one error per sampling event.

Error Type	Number of Errors
Total sample = 166	75
Flow out of range	9
High filter load	12
Mass offset error	25
Power low	12
Power low shutdown	11
TE frequency	4
TE not detected	2

Invalid Samples/Total Samples Comparison: Gravimetric vs. PDM



CPDM Error Rate Comparisons: NIOSH vs. MEC Five Mines



Rates are an average error per unit per 1,000 hours

Conclusions from PDM Error Evaluation

1. These data suggest that the true error rate of the CPDM in field use is not known.
2. More comprehensive understanding of the CPDM error rate (types of errors, frequency, maintenance requirements, etc.) should be known before relying on it for compliance purposes.
3. If the error rate is as high as observed in the five mines, this is not an acceptable tool to rely upon for compliance purposes.

CPDM Questions

- Why do the five mine error rates different from the NIOSH (2006) error rates?
- Do some units perform more poorly than others?
- What is the true fault rate for PDM units taking samples 15 hours per day, every day?
- What are the know or suspected interferences with the unit?
- In the 2006 NIOSH study, what were the mine conditions when the CPDM units were used?
  - Temperature range?
  - Relative humidity range?

CPDM Questions (cont.)

- What is the range of temperature and relative humidity conditions in U.S. mines?
- How does the unit fault rate increase over time; i.e., as the CPDM unit ages?
- What is the useful life of the PDM units?
- What are the MTBF rates for the critical components of the PDM?
- How long will it take to implement approved changes to the software, hardware of the CPDM?

What Happens When the CPDM Unit Faults?

- No effect?
- Is a resample required on a smaller portion of the shift?
  - Noting time to clean, restart, possibly recharge the unit
- Is another sample required on another shift?
- Are the fault dust data uploaded to MSHA?
- How are these counted?
- Is this a citation event?

Industrial Hygiene Perspective – How We can Improve Disease Prevention?

- Understanding causes of miner respiratory disease
- Differentiate factors - mixed dust respirable concentration, silica, mine size, coal rank, effect of age, smoking status, presence of other contaminants e.g. biologically available iron, solvent use, adhesive use, rock block (toluene diisocyanate, methylene diisocyanate)
- Careful evaluation of real-time exposure data
  - Instantaneous data to allow changes in work behavior (miner, engineering controls)
  - Relate exposure data to work practices

California PEL Process

- Public process
- 12 members
- Develop health-based standards
- Review literature
  Peer review + human = priority
- Establish guidelines of approach
- Determine NOEL, NOAEL, or LOAEL
- Agree on a PEL recommendation or range
- Generate a datasheet showing rationale, literature cited

- Public process
- Evaluate economic factors
- Evaluate technical aspects of monitoring including equipment reliability, no sole vendors, etc.
- Compliance issues in the industry
- Statistical review

Cal OSHA Standards Board Review and Adopt / Reject

Enforceable PEL

Lowering the PEL

Measuring the current mixed dust exposure

- ORA used compliance data to model exposure data
- QRA used data for mixed coal dust which does not differentiate other risk factors
- QRA did not account for silica. e.g. thin seams
- QRA used a subset of MSHA available data

  All Data

  Operator - vs- Inspector Data

  2004-2008 (first day data used)

  2008 data (adjusted and supplemented)

  reported average current exposure of

  0-5- 1.2 mg/m3

What is the current exposure estimate?

- QRA defined the range of current mixed coal dust adjusted exposures as 0.5 mg/m3 to 1.2 mg/m3 (p.34)
- However, the QRA also stated (p.24) that for 2004-2008 Inspector data:

  Table 9 shows that under current regulations and enforcement policies, average dust concentration measurements exceed the proposed FEL (of 1mg/m3) at a number of work locations in every occupational category.
- Occupations not meeting the 1.0 mg/m3 concentration
  - All job categories have percentage not meeting 1.0 mg/m3
  - Percentages of occupations not meeting a1.0 mg/m3 concentration range from 0.9 % to 72.2% with average of 20.5% for the nineteen occupations cited.

Feasibility of meeting a 1 mg/m^3 MSHA PEL: Gravimetric Data, 2008-2010

	Operator Samples over 1 mg/m^3	Operator Samples over 2 mg/m^3	Inspector Samples over 1 mg/m^3	Inspector Samples over 2 mg/m^3
Mine 1	210/646	48/646	138/581	30/581
	33%	7%	24%	5%
Mine 3	185/441	26/441	99/389	10/389
	42%	6%	25%	3%

Valid Samples only
Source: MSHA online data retrieval system

Feasibility of meeting a 1 mg/m^3 PEL: Single Shift PDM Data, 2009-2010

	Number of Valid PDM Samples	EOS Samples Exceeding 1 mg/m^3	EOS Samples Exceeding 2 mg/m^3
Mine 1	26	3	0
Mine 2	30	3	2
Mine 3	22	4	0
Mine 4	20	2	1
Mine 5	20	6	0
Total	**118**	**18/118 = 15%**	**3/118 = 2.5%**

Lowering the PEL - Feasibility

- Can 1 mg/m^3 be met with a 95% confidence interval (CI)?

- Proposed rule changes many variables at the same time
  - Bimonthly average of five samples to a per-shift value
  - Measurement tool is changing
  - Number of samples collected increased
  - Equipment maintenance requirements are increased
  - Higher invalid sample fault rate
  - Lack of experience with CPDM units in mines

Data Collection	Old Rule	Proposed Rule
Number of Samples	Operator Samples = 264 Samples per Year	7,155 per Year Based on 1 DO and 2 ODO/MMU, 5 MMUs, 3 shifts

Example of a MEC mine

Practical Considerations

- Data collection alone does not necessarily reduce miner exposures
- There appears to be significant feasibility challenges in meeting the 1 mg/m^3 PEL
- What happens to the data?
  - Inefficient design for a study; do not need 24/7 shift sampling at all mines in the US to determine trends
- Many variables are changing at the same time
  - Unique opportunity to do pilot studies
  - Establish efficient academic studies
- Encourage a cooperative approach with industry

Practical Considerations (cont.)

- Pursue NIOSH ergonomic review wearing CPDM especially for aging workforce
  - More susceptible population for MSD
  - Less ability to repair MSD injuries once present
- Request that MSHA Federal and State inspectors wear CPDM for six (6) months to collect and review data regarding unit faults and ergo experiences
- Pursue academic or third party design of a study to evaluate CPDM data collection and use in areas with highest prevalence of CWP and geared to determine factors influencing CWP incidence
- A mix and match strategy of a 2 mg/m^3 PEL, more timely respirable dust data, helmet airstream/respirator use when needed and miner work practice changes might better serve to reduce miner exposures

Work is Ongoing

- The data presented here are preliminary
- Additional data are being collected across the mining industry to assess CPDM usage
  - Error Rates invalid/valid samples
  - Maintenance issues
  - Miner Experience
- Final evaluation of information received will be provided in written comments in May 2011