

# The development of a personal dust monitor for coal mines

Direct Reading Exposure Assessment  
Methods Workshop

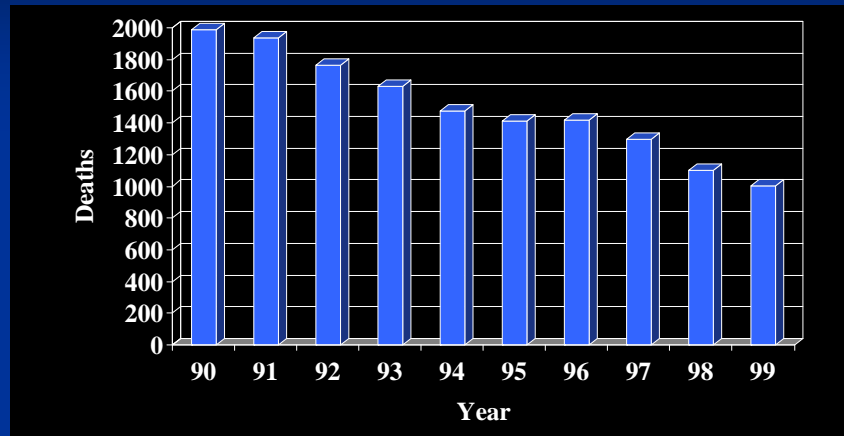
Washington, DC  
November 13, 2008

## Outline

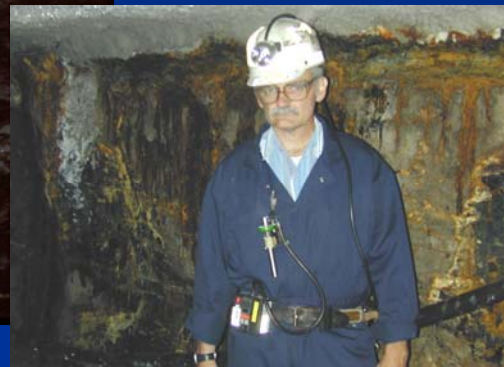
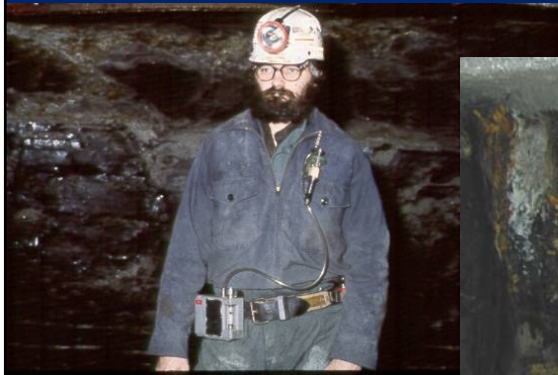
- Spoke on the worker aspects this am
- This talk focuses of the thought process of how to compare direct reading personal aerosol monitors with TWA
- Approaches to assess personal aerosol direct reading monitors
  - Laboratory
  - Field



## Number of Deaths Attributed to Coal Workers' Pneumoconiosis



## U. S. Coal Mine Dust Sampling



Little has changed in the last 30 years.



## Direct Reading Exposure Assessment Needs

- Under recommendation of Secretary of Labor and the 1995 Federal Advisory Committee on the Elimination of Pneumoconiosis among Coal Mine Workers, NIOSH mandated to improve personal dust monitoring instruments to **provide timely data output to miners**
- U. S. miners interested in **better technology** for coal mine dust sampling for the past 20 - 30 years
- In consultation with labor, industry, and government, NIOSH contracted with R&P for the development of new **mass based** monitoring technology for mining



## Direct reading dust monitors have been needed for a long time



## Decision by MSHA and BOM in mid-1990's to develop a mass based sensor

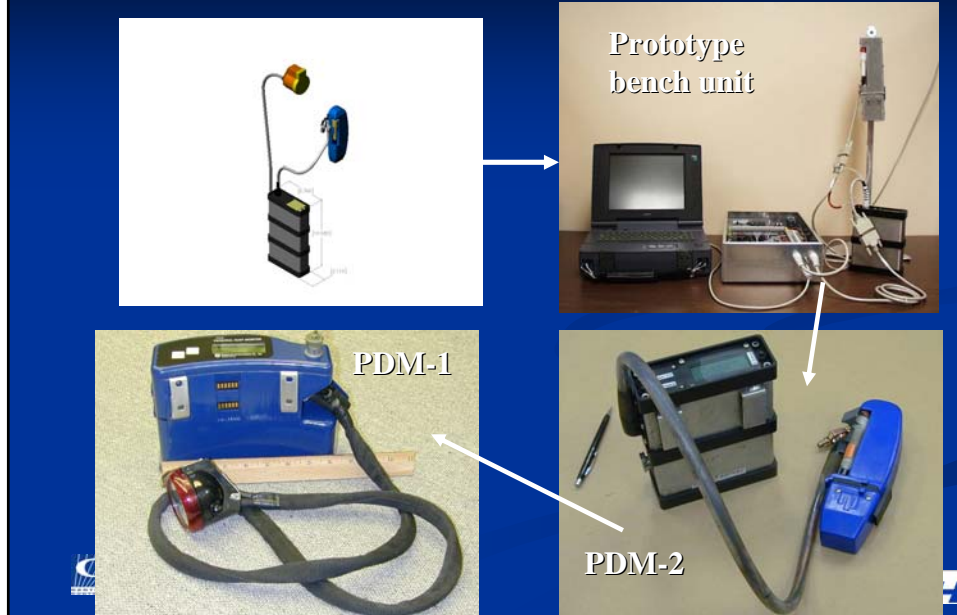
- Initial approach used existing fixed site environmental monitor
- Mount on mining machine much like a methane monitor
- 4 cu ft box weighing 160 lbs.
- Relied on area measurements, no data on personal exposure and not reliable



## Enabling technology



## Evolution of PDM Technology



## PDM Design Goals

- Equivalent to or better than the current sampler
- Provide accurate EOS reading for:
  - Mass
  - Cyclone bias – kept low
- Include cyclone with low bias relative to the MRE and ISO respirable dust convention
- Compliance with MSHA intrinsic safety requirements for both sampler and cap lamp



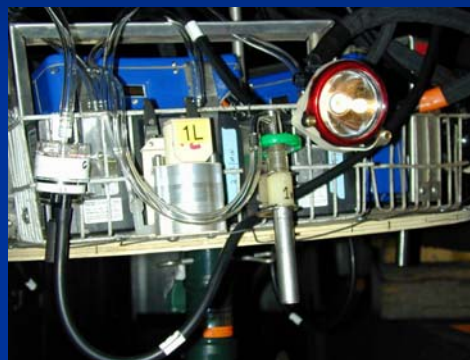
## Equivalency testing

- U. S. law uses MRE equivalency
- Compare PDM directly to MRE
- Use caution when comparing between samplers -- compounds error
- Reference samplers obsolete
- Used personal impactors as reference.



## Is the mass measurement correct

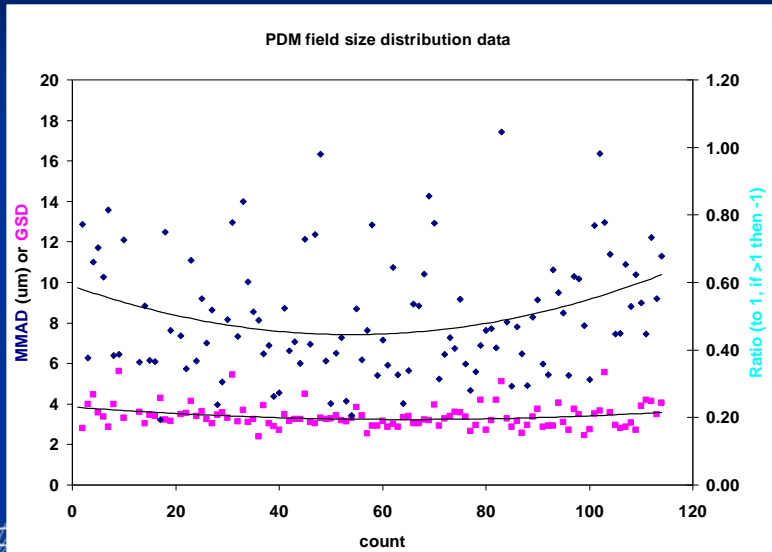
- Use the best weighing procedures – QC
- Minimize variables
  - Inlet loss
  - Transport loss
  - Identical size fractionation
- Direct comparison best



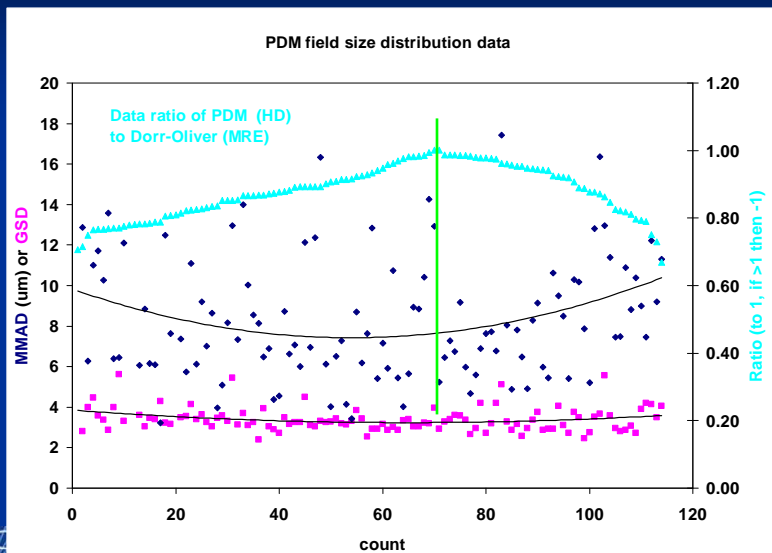
NIOSH RI 9663



## Why can't we directly compare instruments in the lab?



## Why can't we directly compare instruments in the lab?



## Break problem into testable hypothesis

- Direct mass to mass comparison – Does mass comparison meet recognized criterion?
- Direct determination of size selective bias. Is bias less than or equal to existing method?
- If both hypothesis are true, then direct field comparison of two methods over a wide range of aerosol size and type should be true.
- Confirm laboratory results with representative field sample



## Results of Accuracy Criteria Testing for Mass Measurement

- Side by side triplicate reference versus PDM with identical inlets
- Variables
  - 3 coal types/ 3 size distributions
  - 50% RH, 22° C
- RI 9663  
<http://www.cdc.gov/niosh/mining/pubs/pubreference/outputid114.htm>



Coal type	Unit serial	Bias	RSD x/r	accuracy	Confidence Limits
	number				Upper 95%
Overall	101	-0.04	0.06	12.50	15.10
	102	-0.08	0.06	15.80	17.70
	104	-0.05	0.05	11.30	12.90
	105	-0.12	0.06	20.00	21.90



## Cyclone comparison testing

- Compare results of impactor defined respirable mass fraction to triplicate cyclone collected mass fraction
- Calculate ratio and test for significance by coal/size type and overall.

<b>(MRE) Dorr Oliver /ISO</b>	<b>1.25</b>
<b>Higgins Dewell/ISO</b>	<b>1.15</b>
<b>(MRE)Dorr Oliver/ MRE</b>	<b>1.11</b>
<b>Higgins Dewell/ MRE</b>	<b>1.02</b>



## Laboratory Conclusions

- Mass measurement by PDM meets NIOSH accuracy criteria – for an individual observation, the method gives a result that is within +/- 25% with a probability of 0.95
- And, the individual result falls within an upper or lower confidence limit of 95%
- The bias of the HD cyclone is less than the DO cyclone
- Therefore, PDM is equal to or better than existing method.

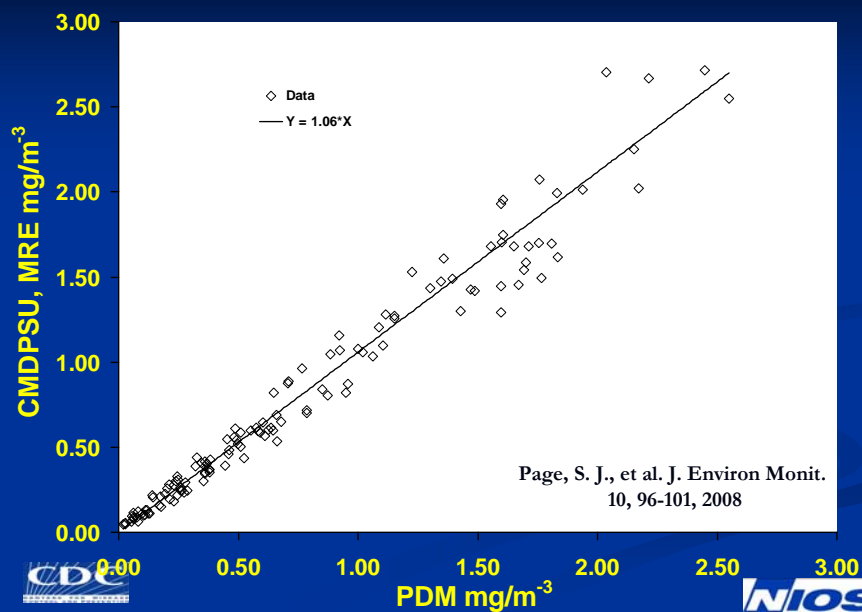


## Field testing apparatus

- Chamber type sampler to minimize spatial variability
- Purpose to compare instruments
- Used central dust inlet to
  - PDM
  - Personal sampler 2 lpm
  - Personal sampler 1.7 lpm
  - Marple impactor



## Field Equivalence to reference method



## Conclusions

- Direct lab comparison of instruments depends on reference aerosol
- For development purposes, break problem into testable hypothesis
  - Mass
  - Size selective bias
- If end use dictates -- field test to confirm



## Acknowledgements

- Joint Health and Safety Committee of the Bituminous Coal Operators and United Mine Workers,
- National Mining Association
- MSHA
- Individual mine managements
- The miners
- Thermo Fisher Scientific and formerly Rupprecht and Patashnick
- Pittsburgh Research Laboratory staff

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