

Use of CPDMs in Coal Mines

Metallurgical Coal Producers Association

PE Seminar

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Outline

- What is the CPDM?
- MSHA CPDM requirements.
- How to program a CPDM.
- Sampling with the CPDM.
- How to use the CPDM to change work practices to lower dust exposures.
- Advantages of the CPDM over traditional gravimetric samplers

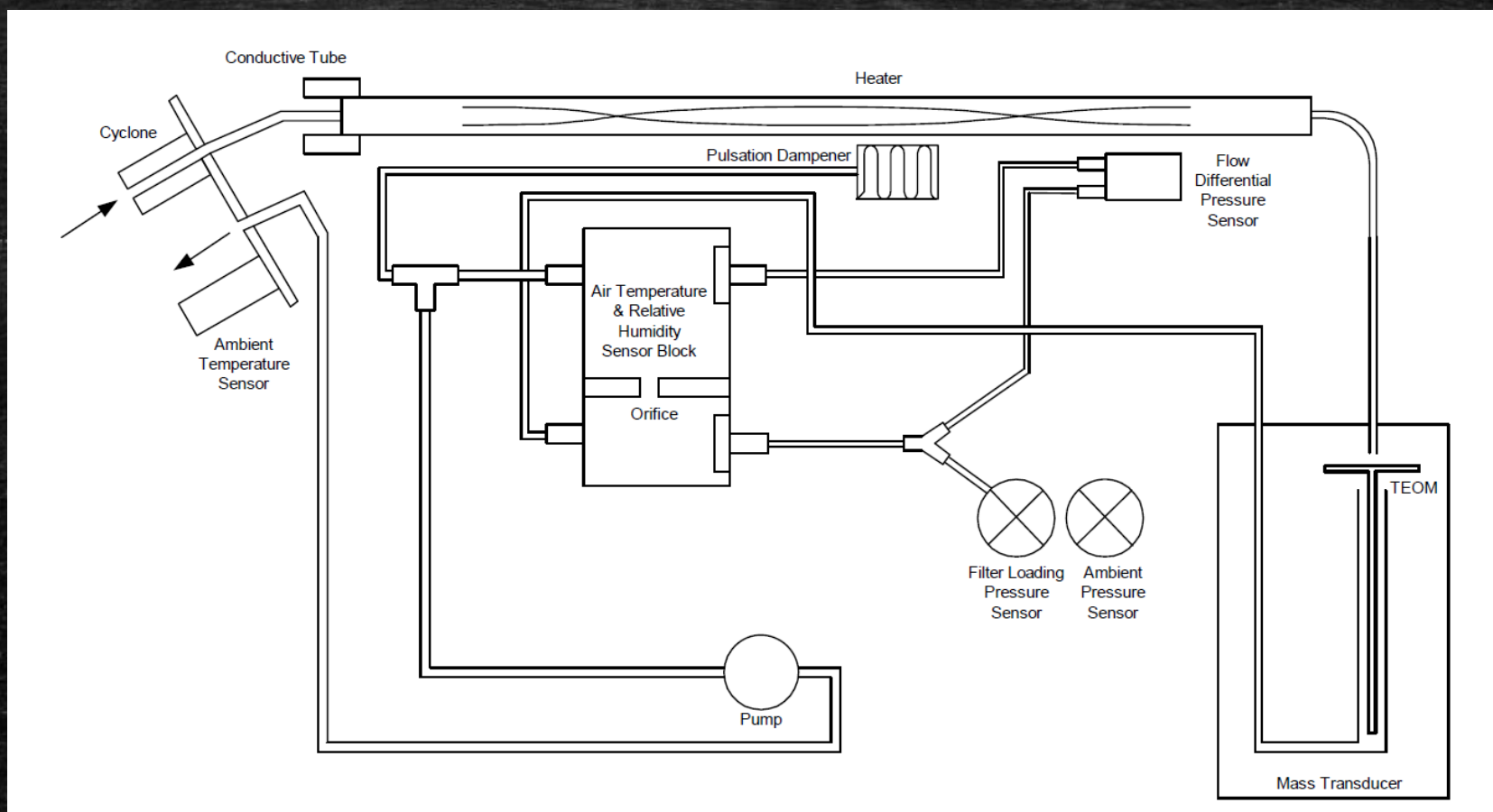
What is the CPDM?

- CPDM is an acronym for “Continuous Personal Dust Monitor”.
- The CPDM provides a continuous, “near real-time” (every minute) read-out of the respirable dust concentration in the air.
- The CPDM differs from a traditional gravimetric pump by utilizing a tapered element oscillating microbalance.
- Currently, there is only one NIOSH and MSHA approved CPDM: The PDM 3700 manufactured by Thermo-Fisher Scientific.
 - CPDM is a general acronym for the type of instrument.
 - PDM is the model name for Thermo-Fisher Scientific’s CPDM.

How does the CPDM function?

- Pump pulls sample air through a Higgins-Dewell cyclone at 2.2 LPM, which removes the non-respirable particles.
 - Non-respirable particles are deposited in the grit pot.
- Sample air is heated and dried.
- Air enters the mass transducer, which houses the TEOM.
- Air passes through the filter and dust is deposited on the filter.
 - See previous slide on how the TEOM calculates the mass and concentration.
- Air exits the TEOM and passes through various sensors that measure differential pressure, temperature, relative humidity, and filter loading pressure.
- Air exhausts out of the unit.

How does the CPDM Function?



Other PDM 3700 Features

- Every minute the PDM records data that can be accessed with a computer generated .csv file.
- The PDM has a tilt sensor that can provide corrections for the calculated mass.
- Minimum 12 hour run time (assumes the warm-up period is on the charger).
- PDM can be quick started or programmed to start.
- PDM provides a cumulative dust concentration since the start of the shift, as well as concentration for the past 30 minutes.
 - The Second Sample feature can be used to measure the dust concentration for a specific period. A 15 min cumulative concentration can also be provided.
- PDM also provides how far you are into exceeding the concentration limit for the programmed shift.
- PDM displays when a status condition has been recorded.

MSHA's CPDM Sampling Program

- The 2014 Dust Rule requires that coal mine operators use the CPDM for compliance sampling.
 - 15 representative samples for designated occupations and other designated occupations each quarter.
 - 5 valid representative samples for part 90 miners.
- 1.5 mg/m³ standard (0.5 mg/m³ for intake air and Part 90 miners)
 - Gravimetric pumps are still used by inspectors to determine if a reduced standard is necessary as CPDM samples can't be analyzed for quartz.
- Portal to Portal Sampling
- Operator must submit samples to MSHA using the MSHA portal.

Noncompliance

Operator Sampling

- Based on:
 - 2 or more of 5 valid respirable dust samples from a DWP, DA or Part 90 miner are \geq ECV **70.209,71.206,90.207**
 - 3 or more of 15 valid respirable dust samples from a DO or ODO are \geq ECV
 - “Or” the average for all valid respirable dust samples in a sampling set are \geq ECV (average of 5 or 15)

MSHA Sampling

- A single valid respirable dust sample \geq ECV (single sample)

ECV

(Excessive Concentration Value)

Accounts for margin of error between true dust concentration and observed dust concentration measurement. The appropriate chart for instrument, number of samples and standard must be utilized (Table 70-1 is one Example).

TABLE 70-1 - EXCESSIVE CONCENTRATION VALUES (ECV) BASED ON SINGLE, FULL SHIFT CMDPSU/CPDM CONCENTRATION VALUES

Applicable standard (mg/m ³)	ECV (mg/m ³)	
	CMDPSU	CPDM
2.0	2.33	2.26
1.9	2.22	2.15
1.8	2.12	2.04
1.7	2.01	1.92
1.6	1.90	1.81
1.5	1.79	1.70
1.4	1.69	1.58
1.3	1.59	1.47
1.2	1.47	1.36
1.1	1.37	1.25
1.0	1.26	1.13
0.9	1.16	1.02
0.8	1.05	0.91
0.7	0.95	0.79
0.6	0.85	0.68
0.5	0.74	0.57
0.4	0.65	0.46
0.3	0.54	0.34
0.2	0.44	0.23

Program PDM Unit from Computer

- Connect PDM unit to charging unit
- Connect charging unit to personal computer
- Open WinPDM software
- Choose a connection type
 - Note “Connected To PDM” message and Serial #
- Click “Program Shift” in upper left



WinPDM will only run on a Windows operating system

Program PDM Unit from Computer

(Continued)

- Enter all data that can be filled in such as:
 - Wearer ID, Mine ID, Mine Name, Company Name, MMU DA/SA, etc.
- Click “OK”
- Click “Done”

Note: the Shift Concentration Limit is the applicable standard

The screenshot shows the Thermo Scientific WinPDM software interface. The main window is titled "PDM - COM1" and contains a data entry form with the following fields and values:

Wearer ID	John Doe	Current Time	12/10/2015, 10:38:05	Warm-up Start Time	12/10/2015, 10:35:00
Mine ID Number	1234567	Contractor Code	0	Sample Start Time	12/10, 11:10
Mine Name	Under Mountain No. 1	Type of Sample	2 Non Designated Occupation	Sample Time (hrs:mins)	04:00
Company Name	Round The Mountain	Average Expected Temperature	48 - 59°F (9 - 15°C)	Sample Time (minutes)	
MMU DA/SA	9030	Part 90 Miner Sampled MIIN		Respirable Dust Standard	2.0 mg/m³
Occ Code	006 ROCK DUSTER	MRE Equivalent Enabled			

Below the form, there is an "Auto Shift Setup" section with checkboxes for Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday. At the bottom right, there are "Clear Fields", "OK", and "Cancel" buttons. A "NOTICE" is displayed at the bottom center: "NOTICE - Knowingly making any false statement representation, or certification on this document is a violation of the federal criminal code which may be punished by a fine or by imprisonment or both." The PDM Firmware Version is 0.00.



PDM unit can now only be stopped by a computer or designated run time

Programming – Notes

- Expected temperatures are based on the temperature of where the PDM will begin and end sampling, not the expected mine temperature
- By default the PDM reports dust concentrations as an MRE equivalent
- When programming for ODO sample enter 4 digit ODO identification number for MMU value
- The wearer ID can be the miner's MIIN, company's employee number or whatever other means the mine has to identify the employee
(The SSN MUST NOT be entered as the wearer ID)

Warm-Up Period

- The PDM 3700 requires a 35 minute warm up period before sampling starts.
- Warm-up period is necessary to bring the temperature to the correct set point.
- Several set points can be used, but every ambient temperature range has an optimal set point.
 - If the ambient temperature gets lower than the recommended range for the selected set point, decreased battery life can be expected.
 - If the ambient temperature gets too high, a TEMP OUT OF RANGE status code can occur.

Table 1–2. Temperature of Mass Transducers and Heaters

Ambient Operating Temperature	Air Inlet Heater Set Point (C) (Az)	TE Heater Set Point (C) (Tz)
98–104 °F (37–40 °C)	57 °C	60 °C
86–97 °F (30–36 °C)	50 °C	53 °C
73–85 °F (23–29 °C)	43 °C	46 °C
60–72 °F (16–22 °C)	36 °C	39 °C
48–59 °F (9–15 °C)	29 °C	32 °C
35–47 °F (2–8 °C)	22 °C	25 °C
23–34 °F (-5 to +1 °C)	15 °C	18 °C
10–22 °F (-12 to -6 °C)	8 °C	11 °C
-2 to +9 °F (-19 to -13 °C)	1 °C	4 °C

Before Sampling

- Make sure the CPDM has a new filter
- Make sure the sample line is cleaned out
- Program the personal samples
- If using the manual start for area samples, make sure the appropriate settings are programmed in the CPDM (MRE equivalent, dust standard, ambient temperature setting)
- If you program the sample, the CPDM will automatically start warming up when needed to start sampling at the right time
- If manual starting, make sure the CPDM is started at least 35 minutes before sampling needs to be started

Sampling with a CPDM

- While the CPDM is required for taking compliance samples it can also be used as an engineering tool to quickly determine dust concentrations.
 - This allows for on-the-fly changes during a shift with regards to ventilation and other dust controls.
 - The CPDM can also be used to help miners identify and avoid high dust concentrations.
- Different strategies can be used for personal and area sampling.

How Miners Have Used CPDMs

- In the 2007 NIOSH publication “ Miners’ Views about Personal Dust Monitors” several miners were interviewed on how they utilized the CPDM.
- Miner’s used the information on the CPDM to lower their dust concentration by:
 - Adjusting position
 - Kept ventilation curtains closer to the face and tighter
 - One miner wore his respirator more often on tasks he identified as being dusty

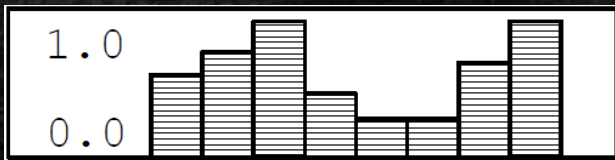
How to Use a CPDM During a Dust Survey

- Personal samples
 - Program the CPDM in WinPDM just like a compliance sample
 - PDM will start and stop automatically
 - Utilize second sample feature to sample exposure during various tasks in the mining cycle
 - Compare second sample results with the primary sample results for the whole day to determine dusty tasks/activities
- Area samples
 - Programmed start not necessary, though it can be used
 - Use the second sample feature to sample areas of interest
 - CPDM can also be used to quickly identify areas with high concentrations
- Always write down start and stop times for second samples and the CUM2 number at the end of the second sample
- Make sure you monitor mining activities that could effect the sample results

Display Screens

30 MIN CONC	0.22
CUM1 CONC	1.21

- 30 Min CONC – Average concentration for the past 30 minutes
- CUM₁ CONC – Average Concentration since the start of the shift



- 30 min concentration bar graph – most recent 30 minutes on the right and the oldest on the left
- Top number is the highest concentration and bottom number is the lowest concentration

SHIFT LIMIT	2.00
PERCNT OF LIMIT	25%

- Shift Limit– Programmed concentration limit
- PERCNT OF LIMIT– How close you are to getting an exposure

TIME	15 MIN	1.10
01:00	CUM2	0.37

- 15 MIN – Average concentration for the past 15 minutes
- CUM₂ – Average Concentration since the start of the second sample
- Time – Length of the second sample

Examples

- Longwall Mine – different types of cuts were examined using the second sample feature
 - Two occupation samples on the shearer operator and the shieldman
 - One area sample near the shieldman

Table 7. PDM Occupational and Area Cumulative Respirable Dust Concentrations Collected on the January 8th Day Shift

Cut Sequence	Start Time	PDM Carrier	Cum. Conc. (mg/m ³)	Sample Time (minutes)
tailgate cutout	8:49 am	shearer operator _o	0.74	9
		MSHA (near shearer operator) _A	0.70	10
tail-to-head pass*	8:49 am	MSHA (near shearer operator) _A	0.85	34
tail-to-head pass	8:56 am	shieldman _o	1.21	26
	8:58 am	MSHA (near shieldman) _A	0.81	27
	8:59 am	shearer operator _o	0.49	23
headgate cutout	9:25 am	shearer operator _o	0.24	25
		MSHA (near shearer operator) _A	0.74	25
head-to-tail pass	9:46 am	MSHA (near shieldman) _A	0.70	49
		shieldman _o	0.61	49
	9:51 am	shearer operator _o	0.80	41
		MSHA (near shearer operator) _A	1.11	41

Examples

Table 3. Cumulative Respirable Dust Concentrations for Area Samples

Tipple	Area	Start Time	Cumulative Concentration (mg/m³)	Sample Time (minutes)
Sorensen	Feeder Room	10:19 am	0.91	73
	Sort Cutter Room	11:34 am	3.01	70
Elkol	Truck Loadout Bay #2	9:15 am	0.01	17
		12:58 pm	0.22	34
	Operator's Control Room	1:38 pm	0.00	16

- Different types of area samples in a surface coal operation using the second sample function.
 - Unlike a gravimetric sampler, the CPDM can be used to quickly identify dusty areas.

Examples

- CPDMS comparing personal sample results on different cuts with different Air Quantities.
- Continuous Miner Operator was able to reduce his concentration by changing position after cut 6.

Table 2. Short-Term Personal Respirable Dust Concentration Results per Cut

Cut Number	Continuous Miner Operator	Roof Bolter	Shuttle Car Operator #1	Shuttle Car Operator #2	Air Quantity (cfm)
(1)	1.46	0.08	1.65	2.14	8,651
2	1.12	0.09	2.05	0.87	14,614
3	1.00	0.20	1.99	1.76	11,071
4	2.05	1.11	1.75	1.87	13,324
5*	0.18	1.19	0.42	0.20	Exhaust
6	2.06	-	0.93	1.21	12,293
7*	0.29	2.16	0.27	0.34	28,859
8	0.58	0.05	2.26	2.14	12,428

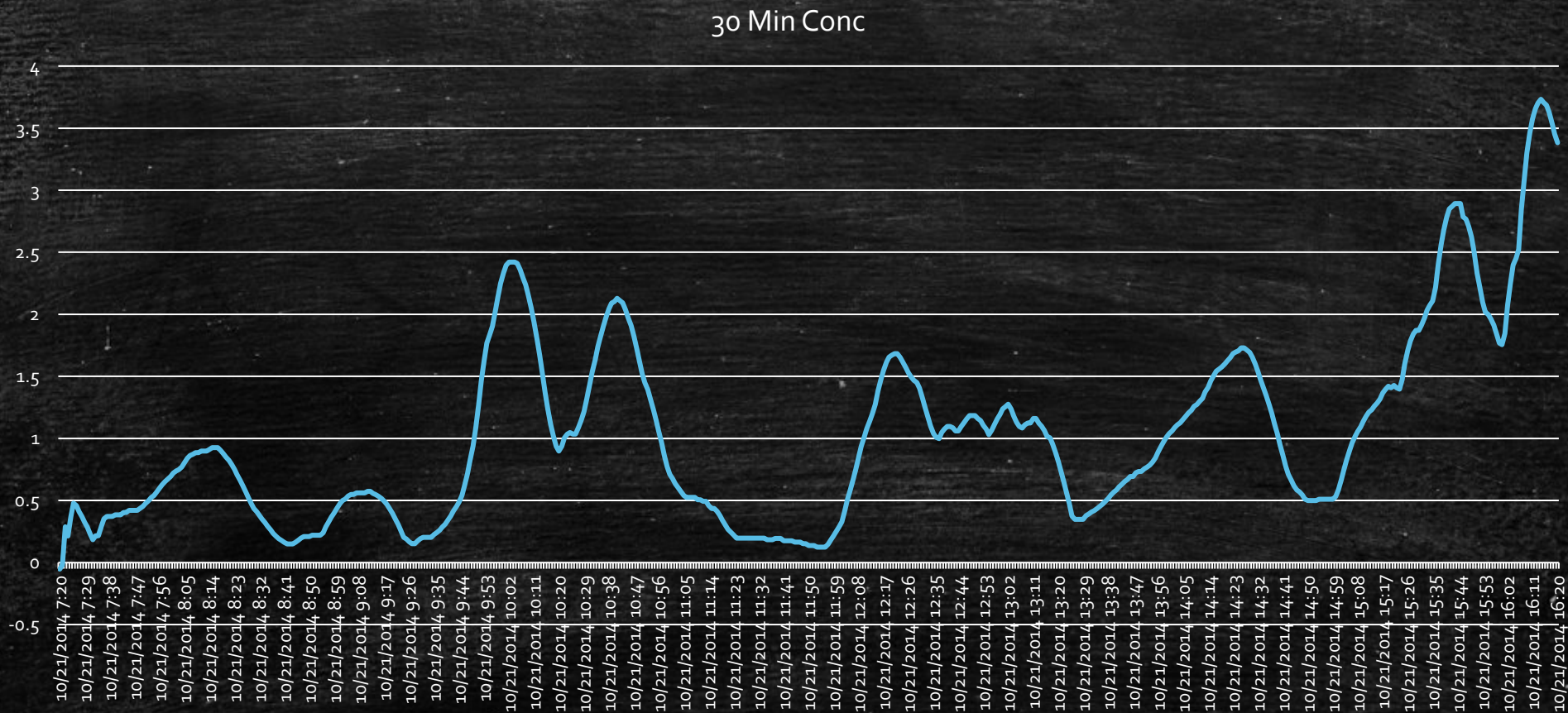
* – indicates cut cannot be used to evaluate blowing line curtain

() – indicates a cut that did not utilize the higher line brattice air quantity

Data Analysis

- The data that the CPDM collects can be downloaded in a .csv file
 - Cum 1 Concentration, Cum 2 Concentration, 30 min concentration, and 15 min Concentration can be seen for the entire sampling period
 - Status conditions, if they occur, will be listed for each minute that they occur.
- WinPDM can generate charts for all data recorded each minute.
- Similar charts can be generated from the .csv file for certain time ranges in the sampling period
- Periods of high dust concentrations that were missed during sampling can be found by reviewing these charts
- If needed, things such as ambient temperature and humidity can likewise be tracked.

Example of a Miner Operator



Why Use CPDMS Over Gravimetric?

- CPDMS give instant results. No need to wait for a lab to analyze them.
- Second samples can be taken on the CPDMS used for personal sampling
- Area sampling is much easier on a CPDMS. No need for swapping cassettes.
- CPDMS can be used to identify dusty areas for area sampling
- Since the CPDMS can be programmed and saved data, pumps will be turned off automatically (if programmed) and area samples do not have to be turned off or even have the value written down
- Cost per sample is cheaper
- Sampling data can be analyzed to identify points in the sampling period where there are high dust concentrations.

Information

- [Certified Person; Sampling Presentation](#)
- [Certified Person; Maintenance and Calibration Presentation](#)
- [Operators Manual](#)

Contact Information

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