PINSSAR
PROTECT EVERY BREATH

MDEC - MVPC Presentation

Case studies of Reducing DPM in Underground Mining

pinssar.com.au

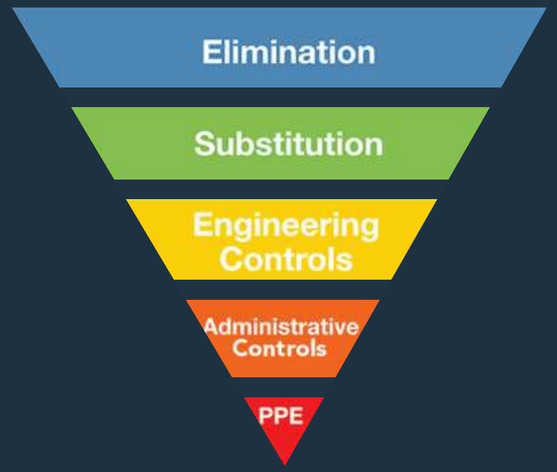
Continuous Real-time Diesel Emissions Monitoring Solutions.

Key points & themes

- Case studies of 4 mine sites on 4 different continents. The Authors are grateful for opportunities to be involved.
- The case studies also show different DPM journeys, including 1 mine starting out and another mine very far advanced.
- DPM is not a single person’s responsibility, nor a single department.
- DPM should not be seen as only the Ventilation department’s problem to control.
- Bugarski *et al* 2012 reference – DPM committee with Management buy-in/support.

Key point:- Controls

- Bugarski *et al* 2012 identified over 40 controls to reduce DPM. (Ref link here).
- Hierarchy of controls, - what controls are available to your mine?
    - Each mine will be different.



Most common / available

Global view – OEL's

- OEL's around the world ;
  - Countries, ref Fig 1,
  - Provinces, ref Fig 1,
  - Jurisdictions, ie QLD coal,
  - Companies, ie BHP
- OEL's are ceilings, not targets.
- Compliance should not be the only objective.
- ALARP / ALARA is what the overall objective should be.

TABLE 1

DPM OEL's applicable to mining in western countries.

Global DPM OEL's				
Country	**Province**	**mg/m³**	**µg/m³**	**TC/EC**
Europe (2023)	ALL	0.05	50	EC
UK/Australia	ALL	0.1	100	EC
North America	ON	0.12	120	EC
	USA/SK	0.16	160	TC
	QC/NL	0.4	400	TC
	BC, NB, NS, YK, NWT, NU	1.5	1500	TC

Case study #1

Fruta del Norte (FDN) mine, Ecuador – early in their DPM journey

- No OEL in Ecuador, mechanized underground mining is a relatively new industry in Ecuador, which will grow.
- FDN are taking the opportunity to set the standard for Ecuador.
- Canadian owned,
    - backing of DPM initiatives at the Exec level & at Mine Management level.
- Canadian province OEL adopted for the FDN mine.

Case study #1

Fruta del Norte (FDN) mine, Ecuador – early in their DPM journey

- Remote location, which brings further challenges:-
  - Diesel fuel quality,
  - Mobile fleet – old tier Engines, difficult to get newer classes of mobile equipment,
  - Other DPM mitigating technologies – not in Ecuador.
- Great skillset recruited from other LATAM mining countries and within Ecuador.

Case study #1

Fruta del Norte (FDN) mine, Ecuador – early in their DPM journey

- The beginning of the journey….
- 4 X continuous DPM monitors installed mid 2022, then another 3 followed.
    - Data gathering - Let them run for long periods.
        - Establish base lines
            - Implement “soft controls” (administrative) – behaviors.
    - Notifications set, - dispatch radio U/G supervisors when levels rise.
        - Supervisors respond, investigate, react and report back.

Case study #1

Fruta del Norte (FDN) mine, Ecuador – early in their DPM journey

- The results:-

Report # 4			
1st June to 30th Nov 2023			
Location	samples taken	sample size (days)	reduction from original install
Kisa Rampa	51,741	180	12%
1245	48,550	169	n/ a
1170	51,675	179	47%
1155	43,494	151	49%
1130	50,788	176	22%
1105	24,445	85	0%
1080	50,330	175	33%

Case study #1

Fruta del Norte (FDN) mine, Ecuador – early in their DPM journey

- What next? - The next stage of the journey….
- On site DPM committee formed with Management input*
  - DPM champion nominated*
  - Various departments have input into the DPM committee*.
    - Long term and short term strategies developed collaboratively*.
      - Each change will be managed and monitored as a separate project
        - This will provide evidence of how effective each new control is…

Case study #1

Fruta del Norte (FDN) mine, Ecuador – early in their DPM journey

- What next? - The next stage of the journey….
- Long term project – eliminate/substitute
- Short term projects
  - Maintenance of fleet to focus on DPM. Tail pipe testing, emissions-based maintenance.
  - Potential to highlight the “high emitters” – to assist with longer term replacement strategies.
    - Next will be to investigate fuel additives
      - Next will be to install DPF filters
- Intention is for continuous DPM monitoring will remain and increase

Case study #2

Broadmeadow, Australia – advanced in their DPM journey

- The BHP journey :-
- 2012 : WHO declared DPM a group 1 carcinogen.
- 2013 : Driscoll Review, BHP set OEL at 50 µg/m3 (Aust is 100 µg/m3).
- 2014 – 2106 : Further reviews, incl Inst. of Occupational Medicine to conduct a review of the published literature.
- 2016 : BHP OEL 30 µg/m3 Introduced (Aust is 100 µg/m3)
  - As low as technically feasible, Continue implementing initiatives.
    - 2019 Early Adopter of continuous DPM monitoring.

Case study #2

Broadmeadow, Australia – advanced in their DPM journey

- The BHP journey :-
- 2012 : WHO declared DPM a group 1 carcinogen.
- 2013 : Driscoll Review, BHP set OEL at 50 µg/m3 (Aust is 100 µg/m3).
- 2014 – 2106 : Further reviews, incl Inst. of Occupational Medicine to conduct a review of the published literature.
- 2016 : BHP OEL 30 µg/m3 Introduced (Aust is 100 µg/m3)
  - As low as technically feasible, Continue implementing initiatives.
    - 2019 Early Adopter of continuous DPM monitoring.

Case study #2

Broadmeadow, Australia – advanced in their DPM journey

- The Broadmeadow journey :-
- 2013 : Site based DPM committee formed.
- 2013 – 2017 : Entire workforce engaged, trial and implement initiatives. (ongoing in 2024)
    - 2018 : Results presented at QMIHS :-
        - 2013 Ave 98 µg/m3
        - 2017 Ave 12 µg/m3
    - 2019 Early Adopter of continuous DPM monitoring.

Case study #2

Broadmeadow, Australia – advanced in their DPM journey

- The Broadmeadow journey with continuous monitoring :-
- 2019 : Early adopter.
- 2019 – 2020 : Phase 1, Testing and Comparison of technologies on the surface.
- 2021 : Phase 2, During Longwall move :-
    - “Let the Pinssar run” and then a retrospective review after LW move was complete.
    - Retrospective review included comparing the 5040 personal sample exceedance data with the Pinssar data.

Case study #2

Broadmeadow, Australia – advanced in their DPM journey

- The Broadmeadow journey with continuous monitoring :-
- 2021 : Phase 2, Retrospective review revealed:-
    - The majority of the 5040 personal sample exceedances aligned with the Pinssar data trends.
    - DPM Committee conclusion = let’s include the Pinssar in our DPM Management plan next LW move.

Case study #2

Broadmeadow, Australia – advanced in their DPM journey

- The Broadmeadow journey with continuous monitoring :-
- Feb 2022 : Decisions from Broadmeadow DPM Committee meeting:-
    - Increase Pinssar sampling during next LW move, 2 more monitors purchased.
    - Sampling to be in the in Mains and LW take-off (when possible, ERZ v NERZ).
    - Site to actively view the Pinssar data in real-time during the longwall move.
    - Develop a trial TARP was developed, various trigger points assessed.
    - District Superintendents to investigate when trends start to increase (real-time)

Case study #2

Broadmeadow, Australia – advanced in their DPM journey

- The Broadmeadow journey with continuous monitoring :-
- The results:-
    - 2021 Longwall move (phase 2, not actively using the Pinssar data in real-time)

      = 23 exceedances (BHP OEL of 30 ug/m3) recorded by personal samples.
    - 2022 Longwall move (phase 3, actively using the Pinssar data in real-time)

      = 5 exceedances (BHP OEL of 30 ug/m3) recorded by personal samples.

- *"We implemented a number of changes, one of these was to use the Pinssar in real-time. The Pinssar system was an important contributor to the significant reduction in exceedances"*

Case study #2

Broadmeadow, Australia – advanced in their DPM journey

- Along with the continuous DPM monitoring, Other initiatives were introduced for the 2022 LW move:-
- Modifying its existing fleet of diesel-powered equipment by installing low emission engine upgrades.
- Processes to ensure that the contractor’s diesel fleet used to do the longwall move was developed to an improved and acceptable standard.
- Training of operators to perform their tasks as much as possible in locations that would not be effected by upstream emissions from nearby vehicles. Plus Reinforcement of training.

Case study #3

Sibanye Stillwater, Nye and East Boulder mines, Montana USA

- DPM reduction strategy (called the P reduction strategy), which has a three-pronged approach to reducing diesel particulates:

1. Diesel engine maintenance.

2. Provision of adequate dilution ventilation.

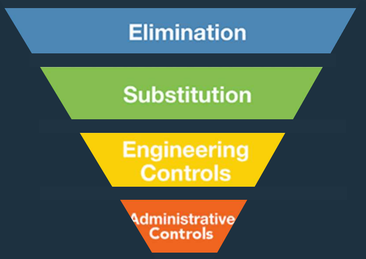
3. Operational discipline such as traffic management.

- To enable the Operations to continuously track the progress and success of the P reduction strategy, continuous real-time DPM monitors were purchased.

Case study #3

Sibanye Stillwater, Nye and East Boulder mines, Montana USA

- Traffic management identified as a requirement due to narrow workings and concern around the DPM contribution from the light vehicle fleet.
- The decision was made to limit the number of the light vehicles underground.
- Mine site traffic rules were put in place, the Engineering teams and control rooms both view the continuous DPM data on dashboards and use the data for real-time, traffic management.
- The results :- This control resulted in the DPM levels shown by the continuous DPM systems dropped below 160 µg/m3 – and as the operations further refined the rules, the operations were able to get the levels under 100 µg/m3.
- Future plans include: clean fuel initiatives, further focus on small vehicle fleet engines, testing of battery-electric LHDs and investing in lower or zero emissions utility vehicles.



Case study #4

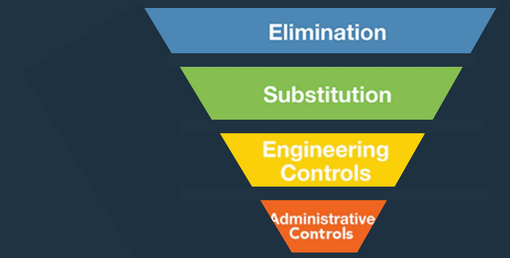
Khutala Colliery, South Africa

- Emissions assisted maintenance strategy employed.
- The industry standard practice for DPM is to focus on the vehicle exhaust and filter system.
  - Bugarski *et al* (2012) says because of the nature of diesel engine utilisation in underground mines, crank-case emissions can significantly contribute to a miner's exposure to DPM.
  - Hill *et al* (2005) also states that crankcase emissions proved to be an extremely strong contributor to the overall particulate emissions.
- Khutala set up continuous DPM monitoring systems at strategic traffic locations.

Case study #4

Khutala Colliery, South Africa

- A video camera was installed on top of the monitor.
- Each vehicle was then driven past the Pinssar systems so that Engineering could establish a baseline of each particular vehicle.
- During operation, when an outlier reading is detected by the Pinssar systems, Engineering take a look at the footage corresponding to the high reading.
- Engineering then radio the operator of the vehicle identified to be emitting highly and the operator is given the directive to take the vehicle to the surface for inspection and rectification by the maintenance department.



Summary – 4 X case studies : - controls used

13 X different controls used outside of ventilation

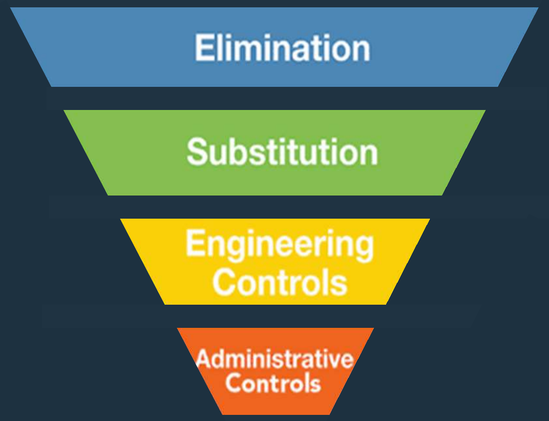
- Traffic Management.
- Emissions assisted maintenance.
- Supervisors Investigating and reacting in real-time.
- Operator behaviors (with training).

- Low emission engine upgrades,
- standard for contractor's diesel fleet,
- Operator positioning (with training)
- Clean fuel initiatives,
- DPF filters,
- Fuel additives,
- Focus on small vehicle fleet engines,
- Testing of battery-electric LHDs,
- lower or zero emissions utility vehicles,




More case studies to come…

MVPC 2025….



Summary – Key take aways

- DPM is not one single person or department's responsibility
- Needs to be a whole of mine approach
- Compliance is one piece to the puzzle - Focus on ALARP / ALARA
- There is no silver bullet to mitigating DPM
- There are some great resources available (ie Bugarski *et al* 2012)
- Is random, sporadic, monitoring really testing your controls?
- Why? Continuous improvement =
  - Improved conditions in working environment.
  - Reduce risk
  - Improved Health outcomes