EFFECTIVENESS OF FAIL-SAFE MECHANISMS ON CONTINUOS MINER DUST CONTROL

Innocent Mahlangu

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PROJECT PURPOSE

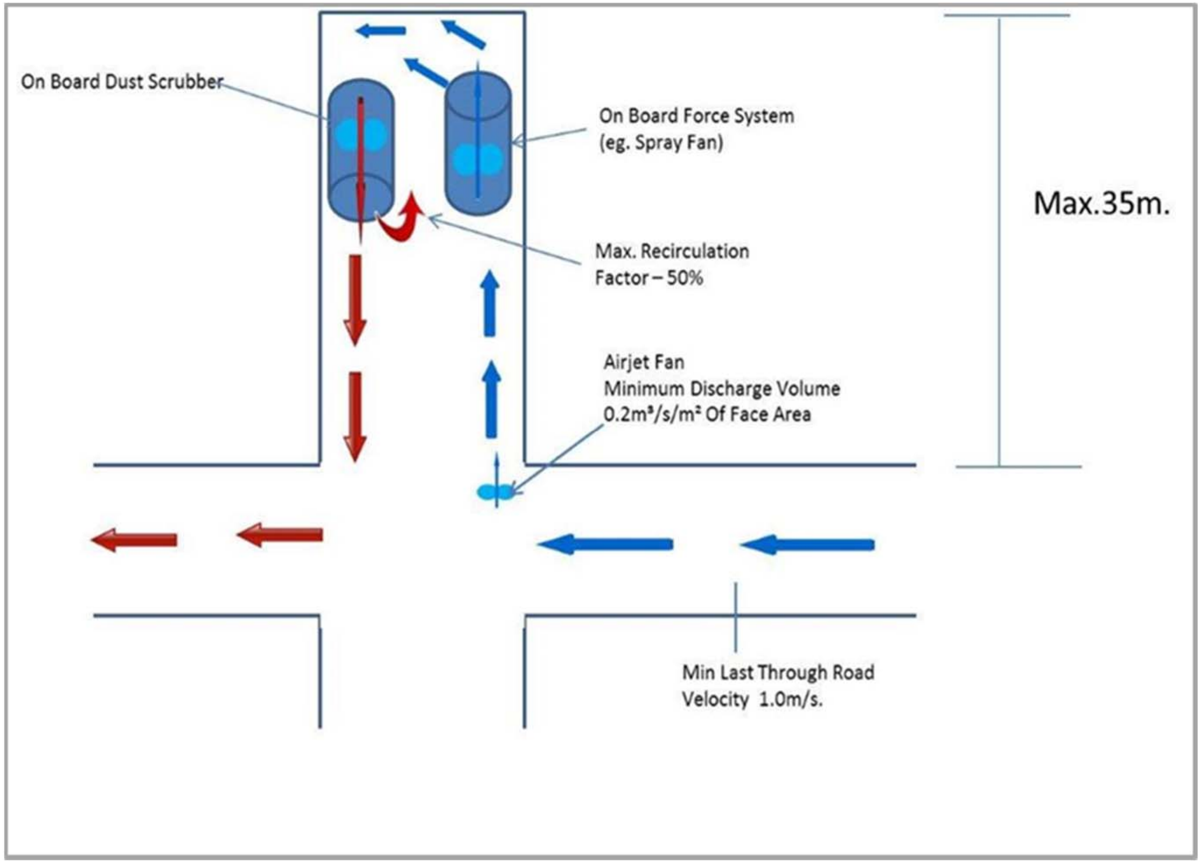
Demonstrate the mine’s ability to comply with Directive B7 and investigate effectiveness of CM dust controls fail-safe mechanisms to reduce dust at the coal face. The long term objective is to eliminate incidence of CWP thus to achieve 2024 milestones.

CONTENTS

OBJECTIVES

- Demonstrate and reinforce the mine's ability to manage the Directive B7 requirements.
- DMR application for 16 m plunge depth exemption.
- Determine potential of currently implemented CM dust control systems to manage extended plunge depths.
- Determine whether the fail-safe mechanisms trip level settings are fit for purpose and adequate.
- Investigate the fail-safe mechanisms technology.
- Share learnings with other mines in this context.

DIRECTIVE B7 (1997) REQUIREMENTS



CM Eng Dust < 5 mg/m^3

CH_4 < 1.4%

LTR Velocity = 1.0 m/s

Scrubber System & Auxiliary Fan

Face Area Vent = 0.2 $m^3/s/m^2$

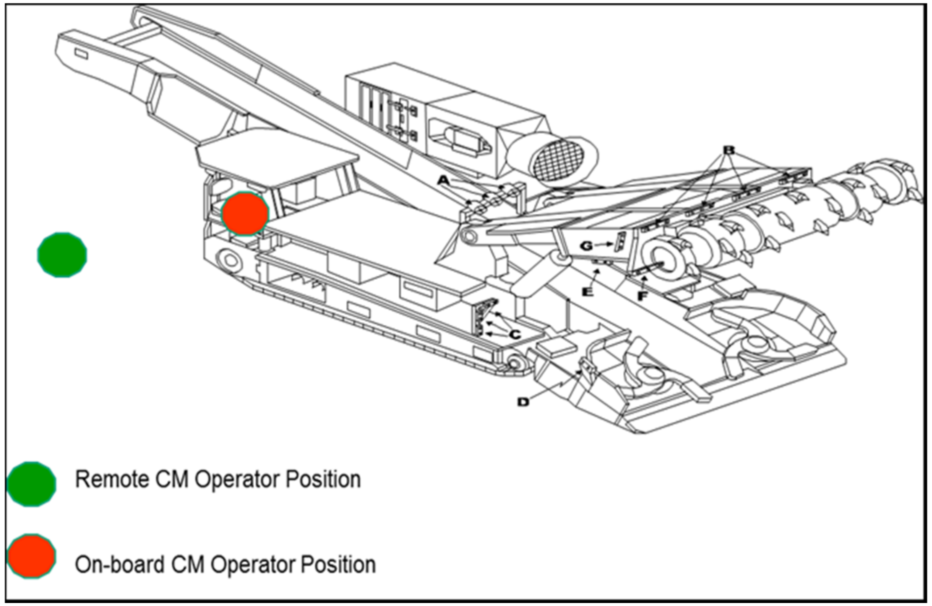
CM Operator Velocity = 0.4 m/s

Scrubber Recirculation = 50%

KLOPPERSBOS & OEM CM DUST SUPPRESSION DESIGN

KLOPPERSBOS DUST SUPPRESSION DESIGN

- 34x Directional Sprays (including air movers over conveyor)
- Spray Nozzles (1.6 mm inlet and 2.0 mm outlet)
- Wetting of Coal Pressure = 2000 kPa (20 bar)
- Water Flow Rate (outlet) = 110 l/min
- Wet Fan Scrubber (inlet cone) = 10 – 12 m³/s
- Air curtain

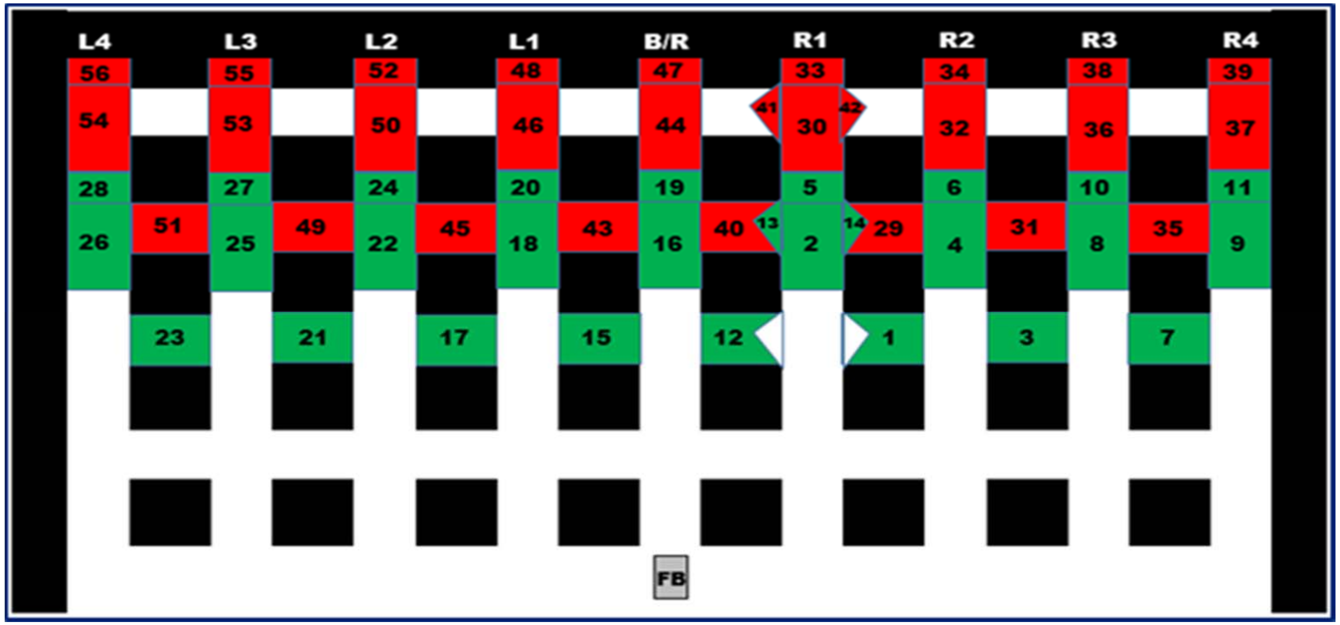


OEM SPECIFICATIONS – DUST CONTROL						
Machine	Spray Nozzle	Number of Spray Nozzle	Operating Flow (l/min)	Operating Pressure (bar)	Trip Level Water Flow (l/min) Min	Trip Level Pressure (bar) Min
SANDVIK	ITP	33	103	20	96.8	15
JOY	Hollow-Cone	34	122-136	20	85	15

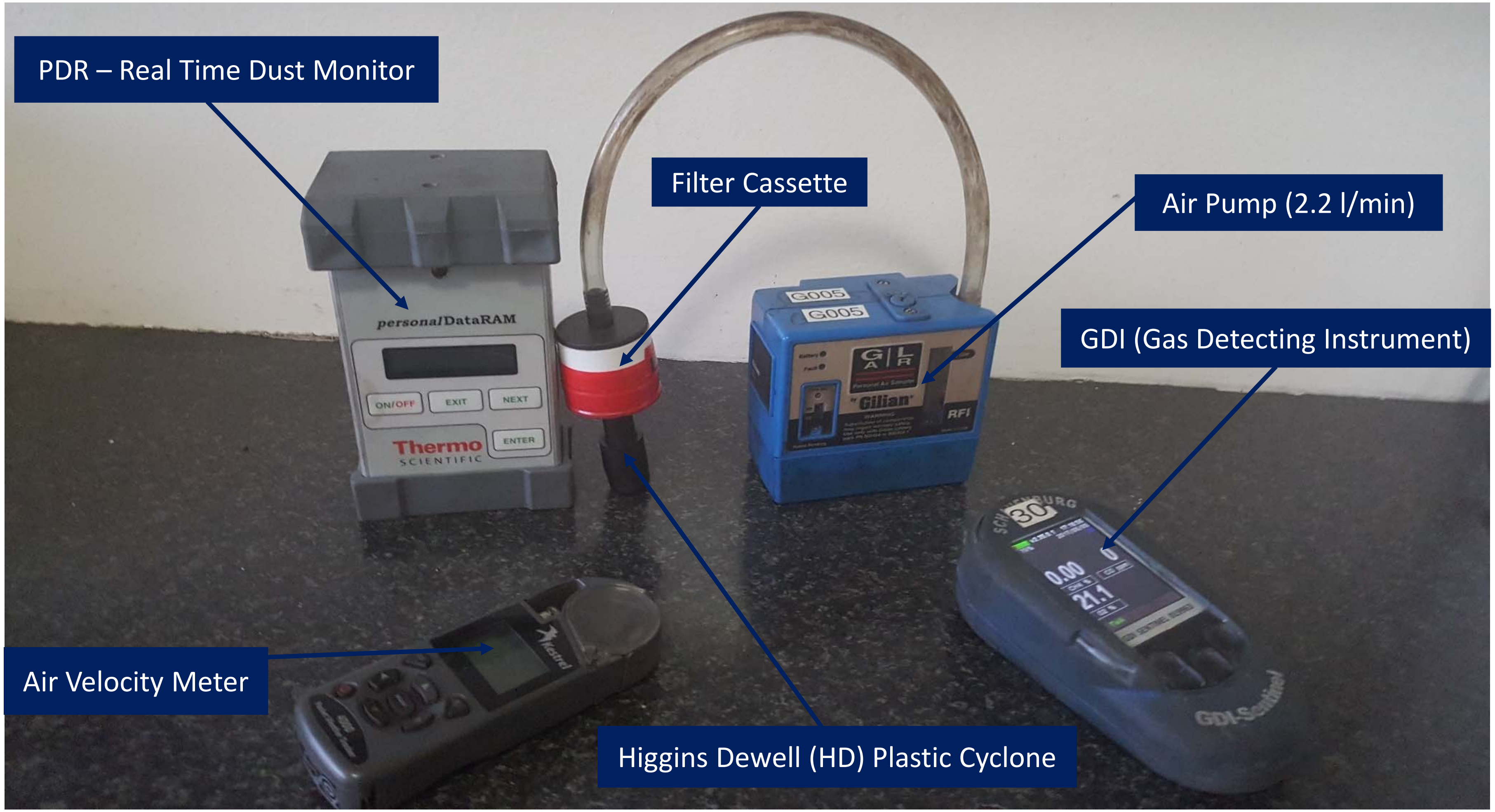
TESTS CONDUCTED – 12 m CUTTING RULE

Two tests of different cutting scenarios:

- *Test 1*: CM cutting 2nd lift in roadway Left (L) 4, heading face already advanced 3 m.
- *Test 2*: CM cutting opening the split to the right from roadway Right (R) 4 to Right (R) 5.



SAMPLING EQUIPMENT

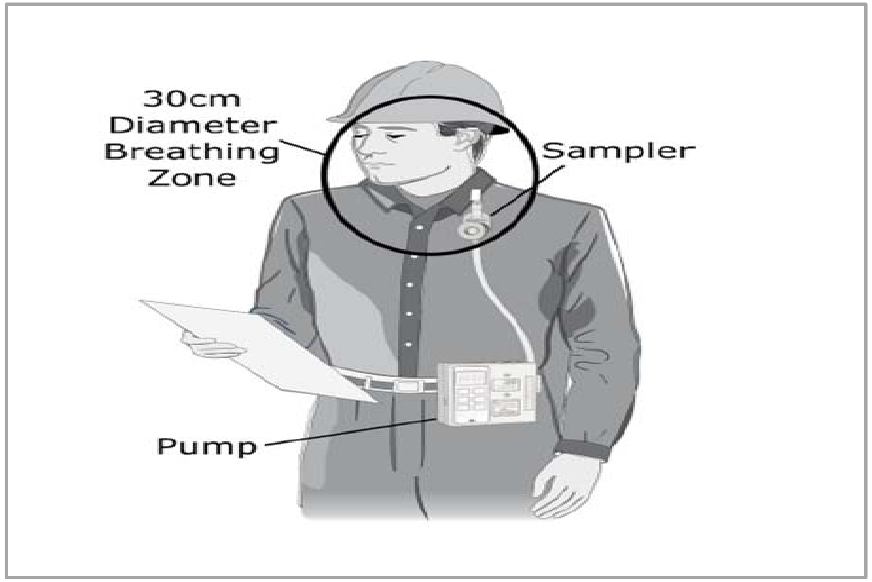


SAMPLING PROCEDURE

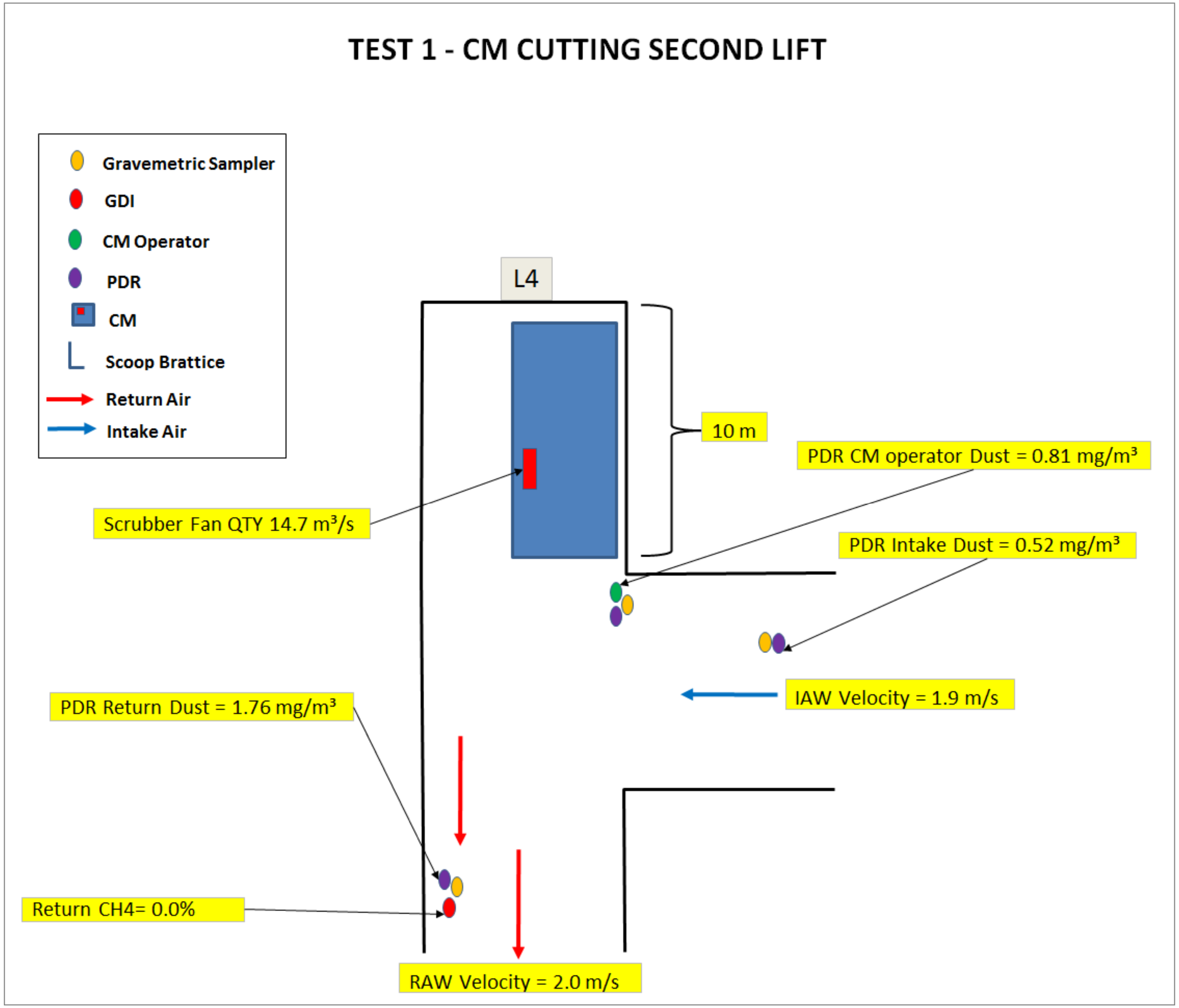
Pair-wise dust samplers (gravimetric and PDR) strategically positioned:

- Intake Airway (upstream of CM)
- CM Operator (breathing zone)
- Return Airway (downstream of CM)

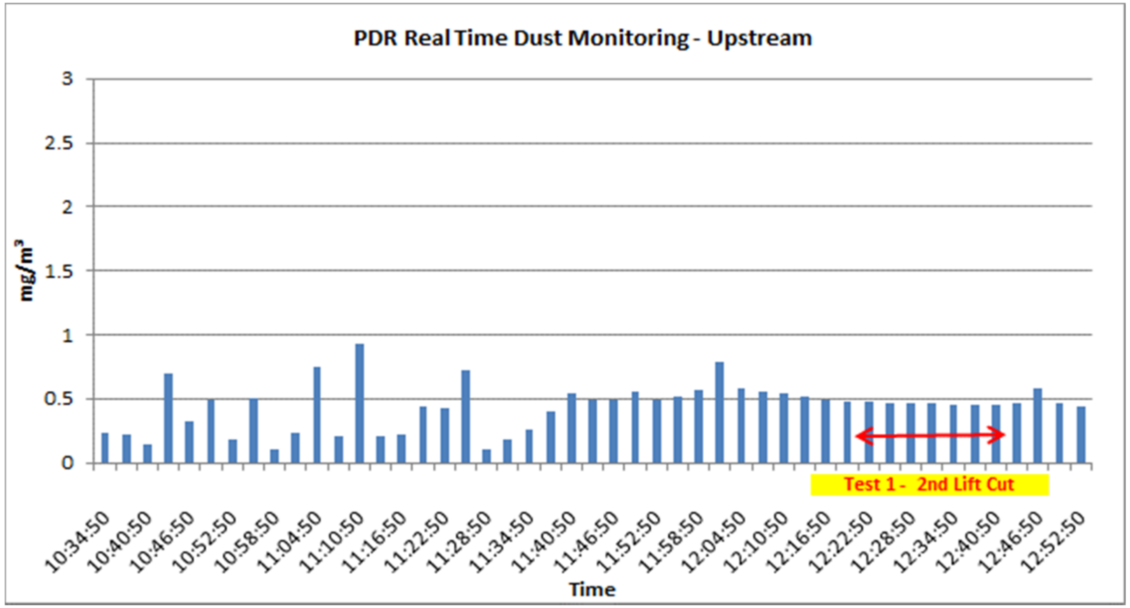
Velocity, CH4 and recirculation measured/tested



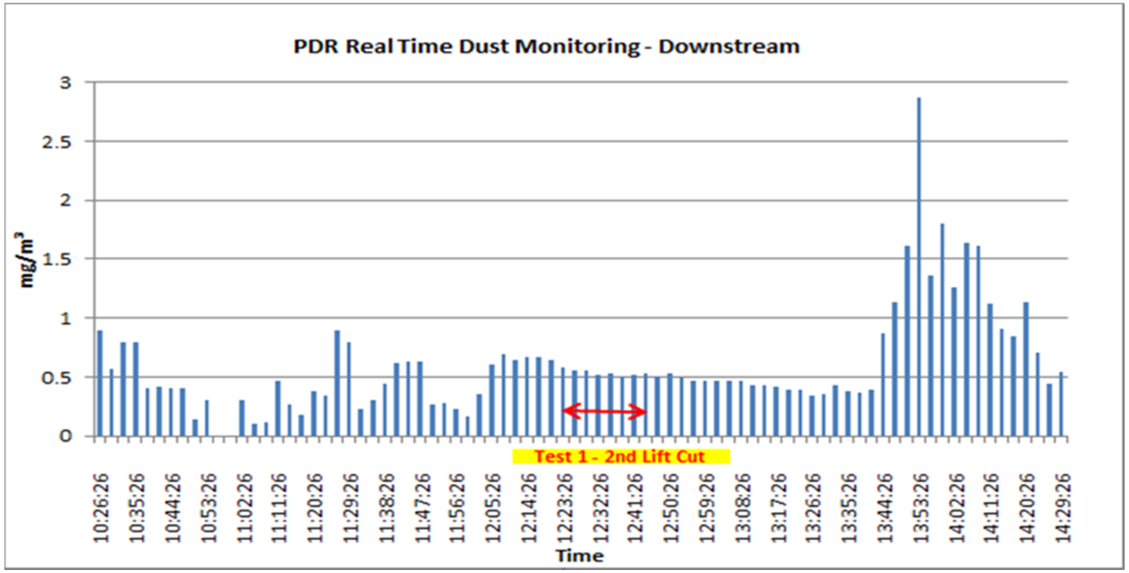
TEST 1 – CM CUTTING SECOND LIFT



TEST 1 - PDR AND GRAVIMETRIC SAMPLE RESULTS

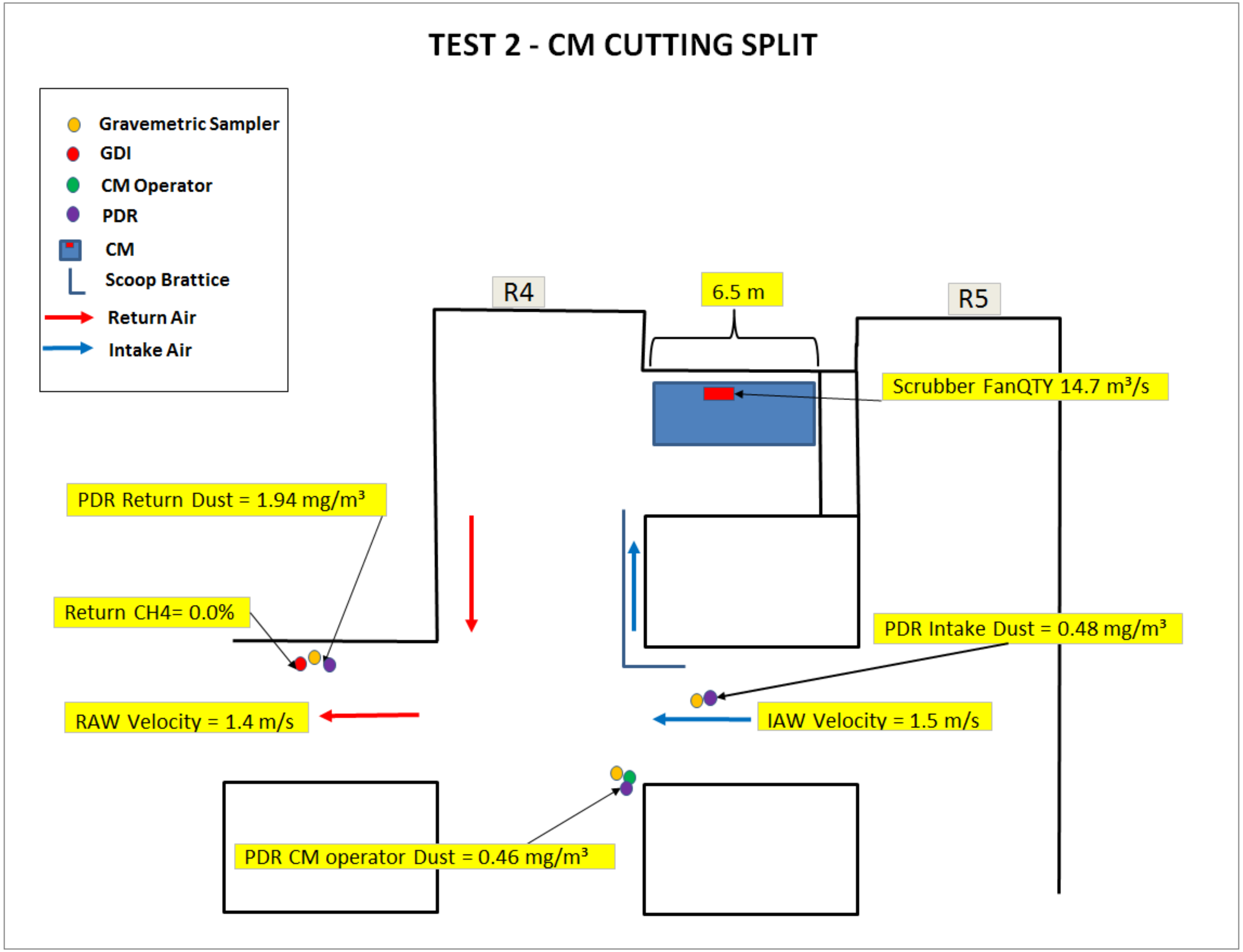


Test 1 – PDR Dust Statistical Analyses for Downstream of the CM	
Sample	**Downstream of CM**
Mean (mg/m³)	0.46
Maximum (mg/m³)	0.49
Minimum (mg/m³)	0.43
Standard Deviation (mg/m³)	0.02
Variance (mg/m³)	0.00
Median (mg/m³)	0.46
Sampling Time (minutes)	17

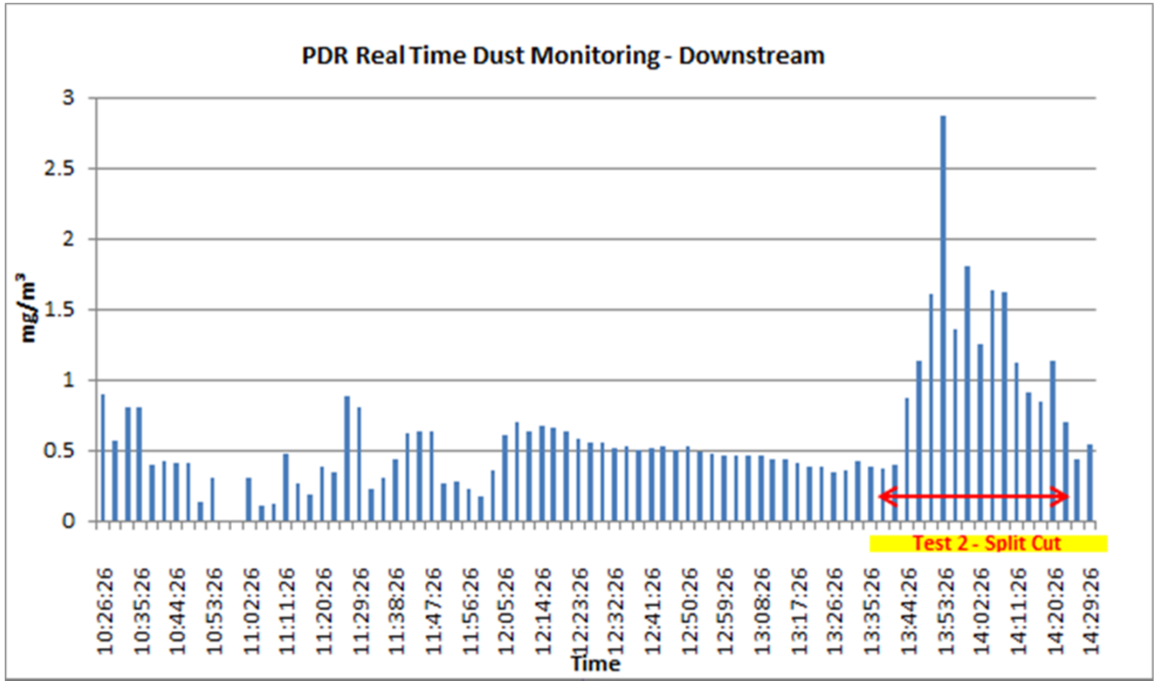


Gravimetric Respirable Dust Results - Test 1	
Dust Pump Position	**TWA (mg/m³)**
Section Intake	0.51
CM Operator (breathing Zone)	0.65
Downstream of CM	1.30

TEST 2 – CM OPENING SPLIT



TEST 2 - PDR AND GRAVIMETRIC SAMPLE RESULTS

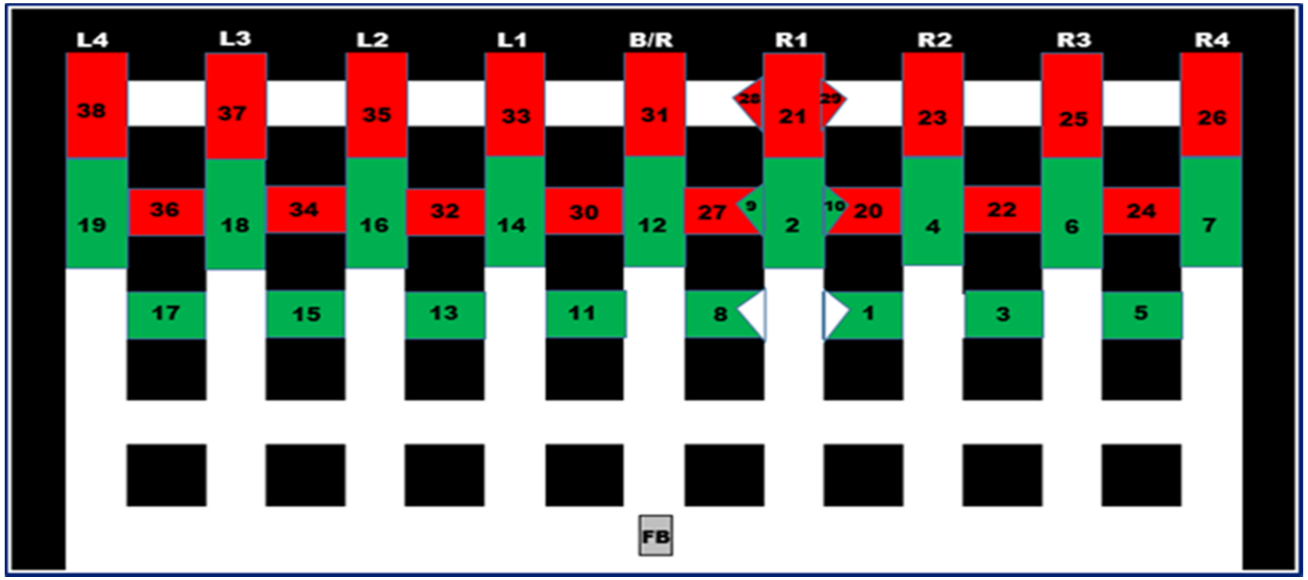


Test 2 – PDR Dust Statistical Analyses for Downstream of the CM	
Sample	**Downstream of CM**
Mean (mg/m³)	1.21
Maximum (mg/m³)	2.87
Minimum (mg/m³)	0.37
Standard Deviation (mg/m³)	0.64
Variance (mg/m³)	0.38
Median (mg/m³)	1.14
Sampling Time (minutes)	43

Gravimetric Respirable Dust Results - Test 2	
Dust Pump Position	**TWA (mg/m³)**
Section Intake	0.55
CM Operator (breathing zone)	1.12
Downstream of CM	1.12
CM Engineering Sample (full shift conc mg/m³)	3.46

16 m CUTTING RULE TRIAL - GRAVIMETRIC DUST

CM Engineering Gravimetric Dust Statistical Analyses for Downstream of the CM	
Sample	**CM Engineering Dust - Gravimetric**
Mean (mg/m³)	1.55
Maximum (mg/m³)	3.50
Minimum (mg/m³)	0.65
Standard Deviation (mg/m³)	0.83
Variance (mg/m³)	0.42
Median (mg/m³)	1.33
Number of samples	27
Ave Sampling Time (minutes)	510



CM DUST CONTROL FAIL-SAFE MECHANISMS

Mine Dust Control Fail-Safe Mechanisms – CM Interlocked

- Booster Pressure Sensor
- Water Flow Rate (sprays) Sensor
- Blocked Scrubber Amps - Joy CM's
- Fan hydraulic Pressure Sensor - SANDVIK CM's
- Intake Airflow Velocity Sensor Interlock.

OEM	Model	Scrubber Type	Scrubber Operation	Scrubber Trip Level Setting	Scrubber Backflush Cycle (minutes)	Low Water Flow Trip Setting (l/min)	Low Water Pressure Trip Setting (bar)
JOY	12HM31	Type 24/30 Twin/Single Scrubber (Howden)	Electric Motor	12 Amps (Current) at 30 min trip delay	30	80	15
SANDVIK	MC470	CDC Integrated	Hydraulic	130 bar (low pressure) and 300 bar (high pressure)	30	90	15

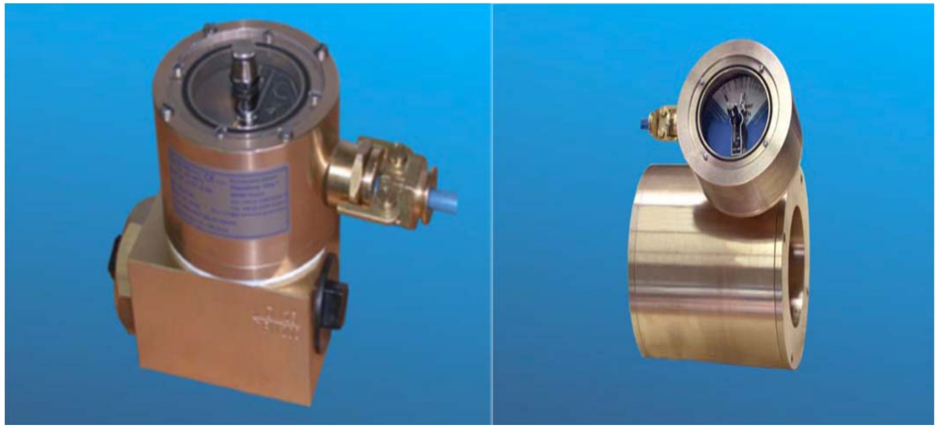
CM DUST CONTROL FAIL-SAFE MECHANISMS

Eight Channel Logger (Flow and Pressure)

- Water pressure sensor measuring range is 0 – 100 bar, maximum overload 300 bar.
- Water flow sensor measuring range for 0 – 150 l/min.

Pressure Switch

- Pressure setting range: 0.85 - 1 bar; 0.2 - 2 bar; 0.5 - 8 bar; 1 - 16 bar and 1 - 20 bar.



Flow control device type DAK

- The type DAK 025 measuring ranges: 0 – 30 l/min; 0 – 50 l/min; 15 – 80 l/min and 15 – 120 l/min at the nominal pressure of 200 bar.
- The type DAK 032 measuring ranges: 20 – 200 l/min at the nominal pressure of 100 bar.

CONCLUSIONS

- Implemented CM dust control systems are effective and able to comply with the Directive B7.
- Poor correlation between CM engineering dust and Operator personal dust exposure concentrations.
- Engineering dust sampling concentration is not good leading indicator of Operator personal dust exposure.
- Field evaluation report formed part of 16m plunge depth exemption application.
- Implemented dust controls can manage extended plunge depth.
- Gravimetric sample lab results turnaround time is two days and reactive.
- Effective dust control fail-safe mechanisms and real-time dust monitoring at Operator position will proactively manage dust.
- Water pressure trip level setting is in line with recommended Kloppersbos design and OEM specifications.
- Water flow trip level is largely below the recommended Kloppersbos design and OEM specified/operating trip level.

CONCLUSIONS

- Motor scrubber trip level setting is below OEM recommended trip level and trip delay is too long.
- Motor scrubber trip level setting is based on old scrubber type no longer in use.
- Hydraulic scrubber pressure trip level setting is largely below the required average airflow.
- Scrubber screen automatic scrubber screen backflush cycle does not allow for the scrubber screen to be cleaned effectively.
- Occasionally high CM engineering dust sampling results are attributed to ineffective or inadequate trip level settings of CM dust controls fail-safe mechanisms.
- CM’s use the latest monitoring systems available in South African industry. However the real-time data logger transmission system is not implemented.

RECOMMENDATIONS

- ❑ Water flow trip level setting to be changed.
- ❑ Determined optimal scrubber fan trip level settings.
- ❑ Increase scrubber screen backflush cycle.
- ❑ Install real-time data logger transmission system.
- ❑ Install Airflow Monitoring System (real-time airflow display).
- ❑ Strict restriction of trip level setting responsibility.
- ❑ Regular inspections and maintenance.
- ❑ Review engineering sampling practice, consider proactive Operator sampler PDM3700.
- ❑ Intake/Return continuous dust monitoring.

Day to day best practices:

- ❑ Effective dust suppression water filtration.
- ❑ Compliance to cutting sequence and adequate section ventilation.
- ❑ Correct Operator position.
- ❑ Intake dust control and Roofbolter dust bags.

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