Compliance to Recognised Standard 15 By Quantifying the Efficiency of Installed Engineering Controls for Respirable and Silica Dust Mitigation

"Dust Monitoring ensures compliance to Statutory Exposure Levels"

"Dust Measurement provides compliance to Recognised Standard 15"

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Presentation Content

- **Objectives and Significance of Efficiency testing engineering controls**
- **The Problem**
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Objectives and Significance

Presentation Objectives：

Show that:

- Through scientific measuring methods, we can assess the respirable and silica dust mitigation efficiency of installed engineering controls for compliance to Recognised Standard 15 and Section 89 and 89A of the Coal Mine Safety and Regulation 2017.

- Through scientific measurement processes a robust and repeatable respirable and silica dust load production and control mitigation efficiency can reliably be obtained.

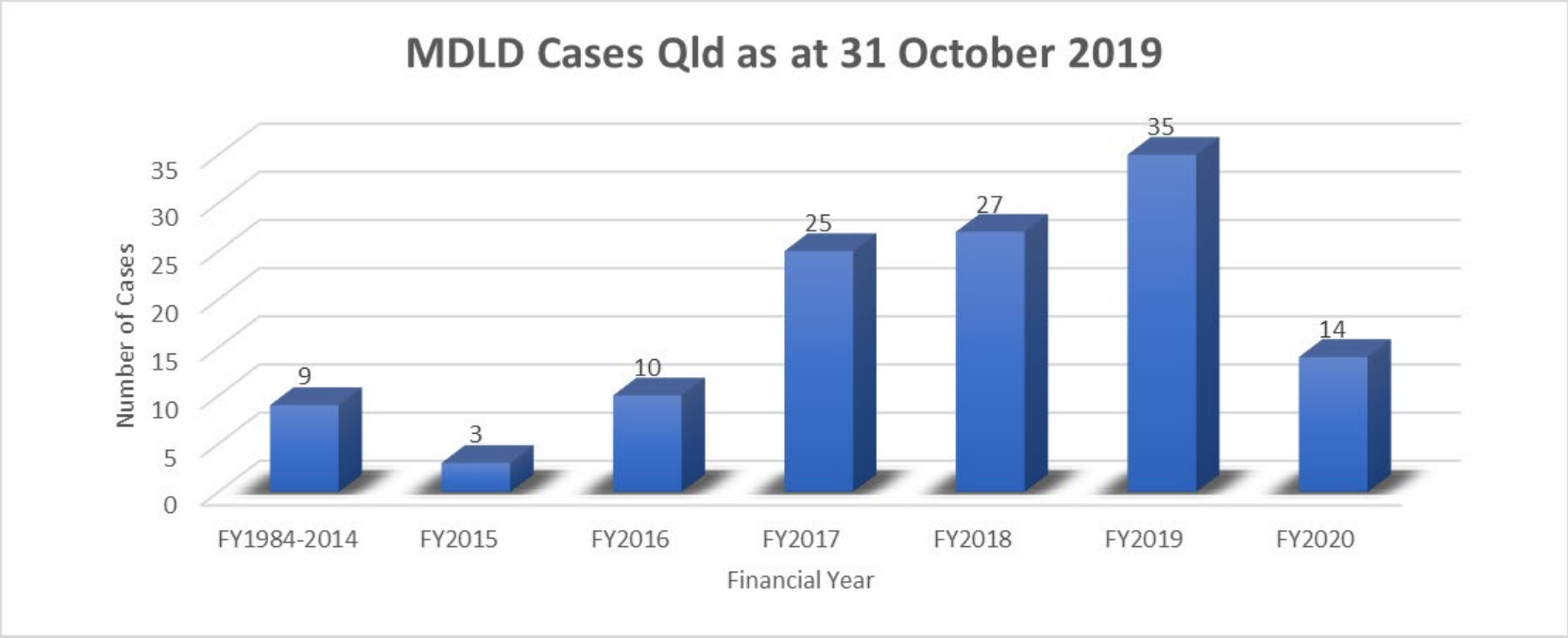
Significance：

Respirable and silica dust mitigation is of great significance to the health of all workers, workplaces, communities and the environment.

The Problem

Total individuals with MDLD reported to the DNRM for all mining, since 1984 (current as at 31st October 2019)

124



- https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/accidents-incidents/mine-dust-lung-diseases

Law Lesson

Legal definition and intention of wording in Acts, Regulations and Guidelines.

STANDARDS AUSTRALIA

STANDARDISATION GUIDE 009: PREPARATION OF STANDARDS FOR LEGISLATIVE ADOPTION

Section 5 - Use of Must, Shall and Should

- In accordance with the International Organization for Standardization (ISO) Directives, the word ***'shall'*** is used to state ***that a requirement needs to be followed in order to conform*** to the Standard.

- Consequently, there can be ***no deviation from that requirement***, other than a specified tolerance.

Law Lesson

- Standards Australia notes that in legislation and specifications it is ***common*** to use the word ***'must' to express a requirement***.

- Where Standards are ***adopted in legislation***, the word ***'shall'*** in the Standard ***should be considered as equivalent to 'must' in the legislation***.

- The word 'must' ***is not used*** in Standards in place of 'shall'.

- The word ***'should'*** introduces a ***suggestion or recommendation*** that is ***not*** a ***requirement***.

- It is not necessary that such recommendations or suggestions be followed in order to conform to the Standard.

Law Lesson

Practicable and Reasonably Practicable

HOW TO DETERMINE WHAT IS REASONABLY PRACTICABLE TO MEET A HEALTH AND SAFETY DUTY

Safework Australia - May 2013

Section 2.1 How is ‘reasonably practicable’ defined?

Section 18 of the WHS Act defines the standard that is to be met and describes the process for determining this.

Law Lesson

- **‘Reasonably practicable’, in relation to a duty to ensure health and safety, means that which is, or was at a particular time, reasonably able to be done to ensure health and safety, taking into account and weighing up all relevant matters including:**

- the likelihood of the hazard or the risk concerned occurring; and

- the degree of harm that might result from the hazard or the risk; and

- what the person concerned knows, or ought reasonably to know, about the hazard or risk, and about the ways of eliminating or minimising the risk; and

Law Lesson

- the availability and suitability of ways to eliminate or minimise the risk; and;

- after assessing the extent of the risk and the available ways of eliminating or minimising the risk, the cost associated with available ways of eliminating or minimising the risk, including whether the cost is grossly disproportionate to the risk.

CMSH Act

***Coal Mining Safety and Health Act 1999*, Part 2, Division 1, 29, parts (1) (a) and (b):**

29 What is an acceptable level of risk

(1) For risk to a person from coal mining operations to be at an *acceptable level*, the operations must be carried out so that the level of risk from the operations is—

(a) within acceptable limits; and

(b) as low as reasonably achievable.

Recognised Standard 15

Recognised Standard 15 – Section 5 - General strategy for dust control

Due to the variability in mining operations, during development of the dust control strategy (and ongoing reviews of the Dust Management Plan), each mine SSE ***shall***:

(remember the word ***'shall'*** is used to state ***that a requirement needs to be followed in order to conform*** to the Standard.)

- review competencies related to dust control
- identify relevant engineering and technical expertise (for the dust control strategy)
- identify relevant occupational hygiene expertise (for the monitoring strategy)
- review the design risk assessment for the consideration of dust controls

Recognised Standard 15

- assess potential hazards from the operational tasks and the risk posed by those hazards to the safety and health of persons conducting these operations or who may be affected by these operations;
- review any existing process for adequately identifying dust sources (determining when, where, who, how);
- undertake short-term and long-term planning to effectively manage dust controls (including resources, identifying when changes in operation will increase dust exposure);
- ***validate the adequacy and effectiveness of the controls being applied in-shift;***
- review any existing dust management plan, ensuring it is subject to a continuous improvement and review process triggered by the results of any inspections or audits of the mining activities and the results of any monitoring for respirable dust—this review process will be relevant to the specific mining process or equipment used and will meet the requirements of s. 62 of the Act (***ensuring the risk to coal mine workers' health and safety is at an acceptable level***)

Recognised Standard 15

Recognised Standard 15 in relation to Section 5 - Technical Guidance. This Technical Guidance states that the variability in underground operation practices means that each mine SSE will need to:

- identify sources of dust generation in all areas of the underground mine workings
- develop and implement dust controls for each activity in an underground coal mine
- follow the hierarchy of control principles to manage the risk of dust exposure to acceptable limits

Recognised Standard 15

- develop a Trigger Action Response Plan (TARP) for the purpose of mitigating personal exposure when critical dust controls are not functioning to their designed specification
- incorporate dust control measures into shift and daily routines that are documented and adequately resourced in short-term and long-term planning processes
- review the effectiveness of controls in a systematic way
- inspect, maintain and monitor controls and equipment (the inspection, maintenance and monitoring should be performed by appropriately trained and competent personnel).

Recognised Standard 15

Appendix B: Equipment selection, purchasing and life-cycle approach

- As part of meeting the intent of s. 62 of the Act to ensure the risk to coal mine workers' health and safety is at an acceptable level, ***measures to minimise and control dust generation*** (a known hazardous substance) shall be considered for equipment specified and installed in the mine.

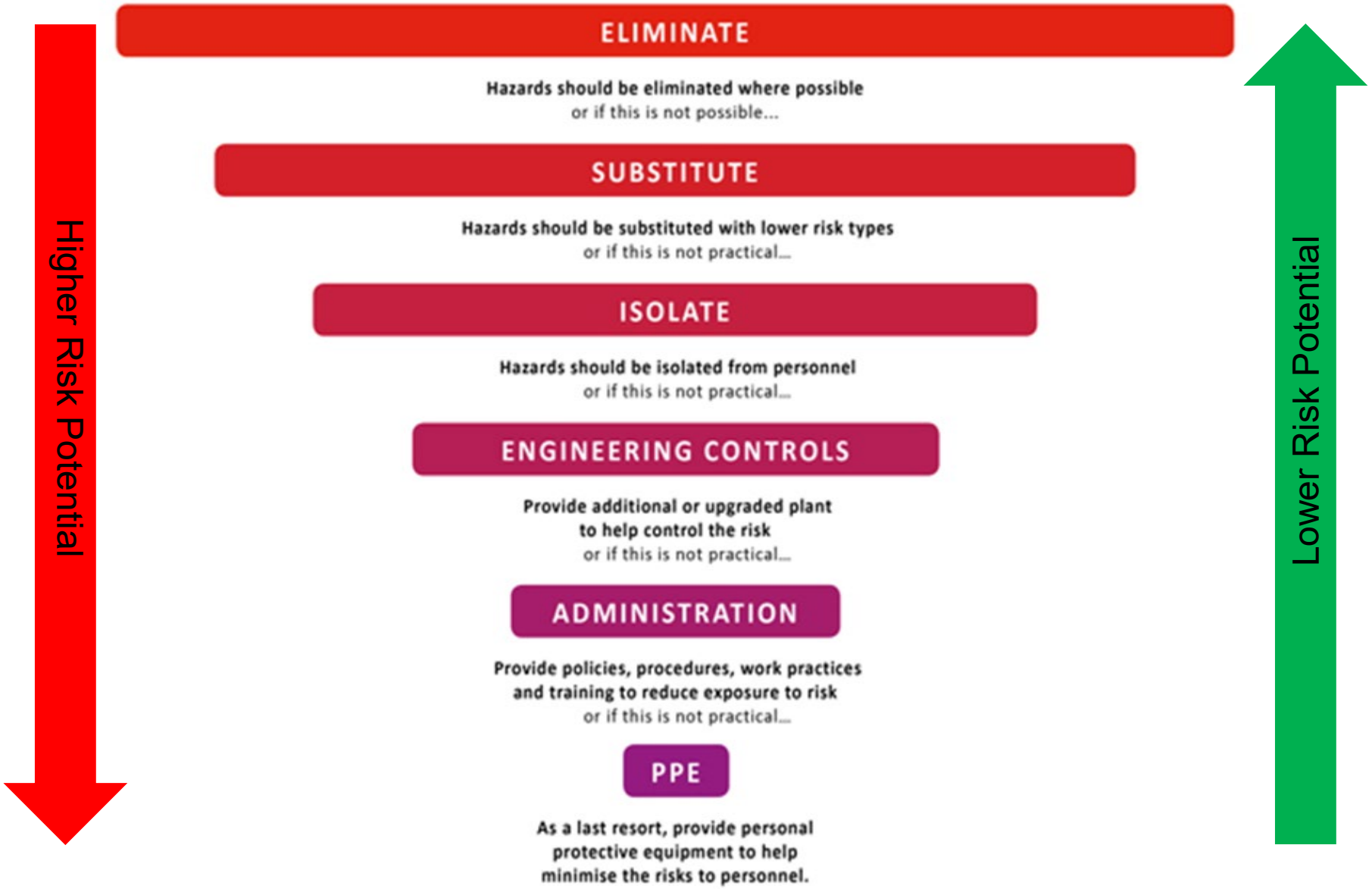
- Equipment specifications ***shall include requirements for commissioning plans that confirm the supplied equipment meets the specification requirements for dust control and include a test plan to establish baseline effectiveness of the dust control equipment***, as well as allowing for training of key personnel and adequate spare parts.

Engineering Controls

Engineering controls for respirable and silica dust mitigation are the principal strategy in underground coal mining;

- It is difficult to implement strategies for Elimination, Substitution and Isolation;
- As engineering controls are the principal strategy for respirable and silica dust mitigation, it makes sense that we need to know ***how much actual respirable and silica dust they remove***;
- That is, we need to know if the ***controls work***;
- The industry relies heavily on Administrative controls by removing the person from the dust, and PPE;
- These are the ***bottom and second bottom of the Hierarchy of Controls***;

Hierarchy of Controls



Statutory Sampling v's Control Efficiency Sampling

➢ What is a benchmark dust sampling?

- A benchmark dust sample measures the ***dust loads*** produced at independent sources of dust generation presented as a mg/tonne of coal produced, or mg/m advanced.
- Once this benchmark is established, installed controls can be measured to quantify how much respirable and silica dust they actually remove.

➢ How does this sampling differ from the Statutory testing process?

- The current Statutory testing process measures ***exposure levels*** of employees usually over the period of a shift. This is presented as mg/m^3 and relates to the amount of respirable and silica dust an employee is exposed to in the natural course of his or her employment.

Benchmark Establishment

➢ Why establish a benchmark dust production?

- For any respirable or silica producing activity, there is a need to understand the behaviour and characteristics of produced dust during the cutting cycle.

- This need has increasingly climbed the list of WHS priorities for mine management, employees, contractors and all other mine personnel.

- Dust management is becoming increasingly important as all underground personnel could potentially be exposed to life threatening dust disease or explosions in the underground coal mining environment.

Benchmark Establishment (cont'd)

- Dust suppression controls are expensive and no quantifiable information is available to prove their efficiency.
- The benchmark testing determines where a coal mine can get the best "bang for buck" when purchasing dust suppression products.
- Considerable savings could be made through increased production and reductions in maintenance .
- This reduction can be achieved by measuring the amount of dust produced and establishing a Dust Management Plan to remove as much produced dust as possible.

Benchmark Establishment (cont'd)

➢ How is the benchmark established?

- The dust collection process is arranged so that there is a collection of respirable and silica dust at each independent source of dust generation.

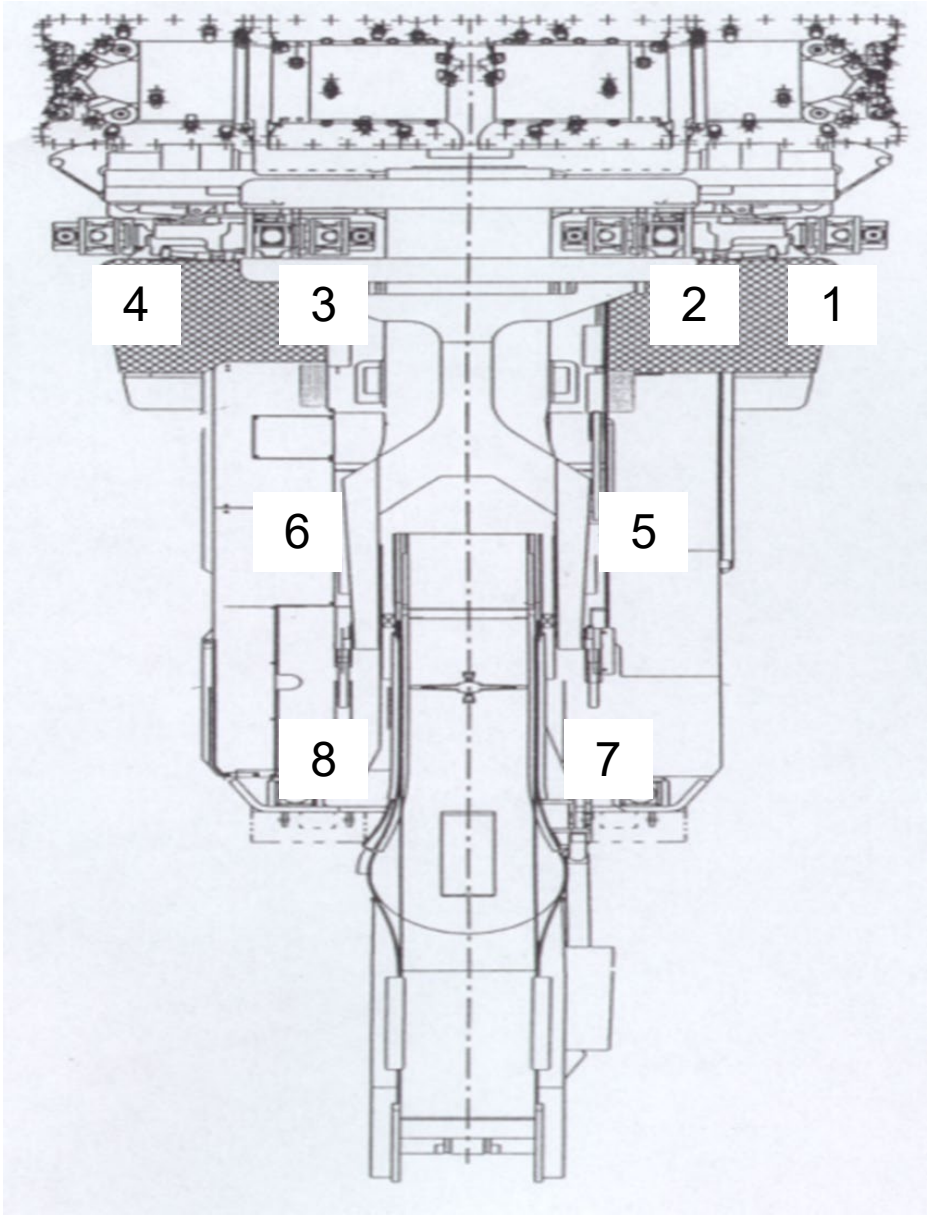
- In each location, separate monitors and heads will be used to sample both respirable and silica dust loads.

Control Efficiency Testing

Process for Quanitifying Installed Control Efficiencies:

- All samples are collected as per AS2985 - Method for sampling and gravimetric determination of respirable dust.
- A benchmark dust load is established by making the installed control inactive.
- Sampling is taken for an agreed tons cut, meters cut or task undertaken.
- This allows for the raw weight of the sample, less the initial weight of the filter, to be applied empirically.
- The results are in mg/tonne, mg/m or mg/task.

Sampling Locations



Control Efficiency Testing

Respirable and silica dust are collected via gravimetric heads and SKC pumps in accordance with AS2985 – Method for sampling and gravimetric determination of respirable dust;



Efficiency Testing Undertaken

MB650 Dust Curtains – Full Face of Stone



Cutting Face



Curtains Rolled Up and Inoperable - Benchmark



Curtains Down and Operating



Side by Side Comparison

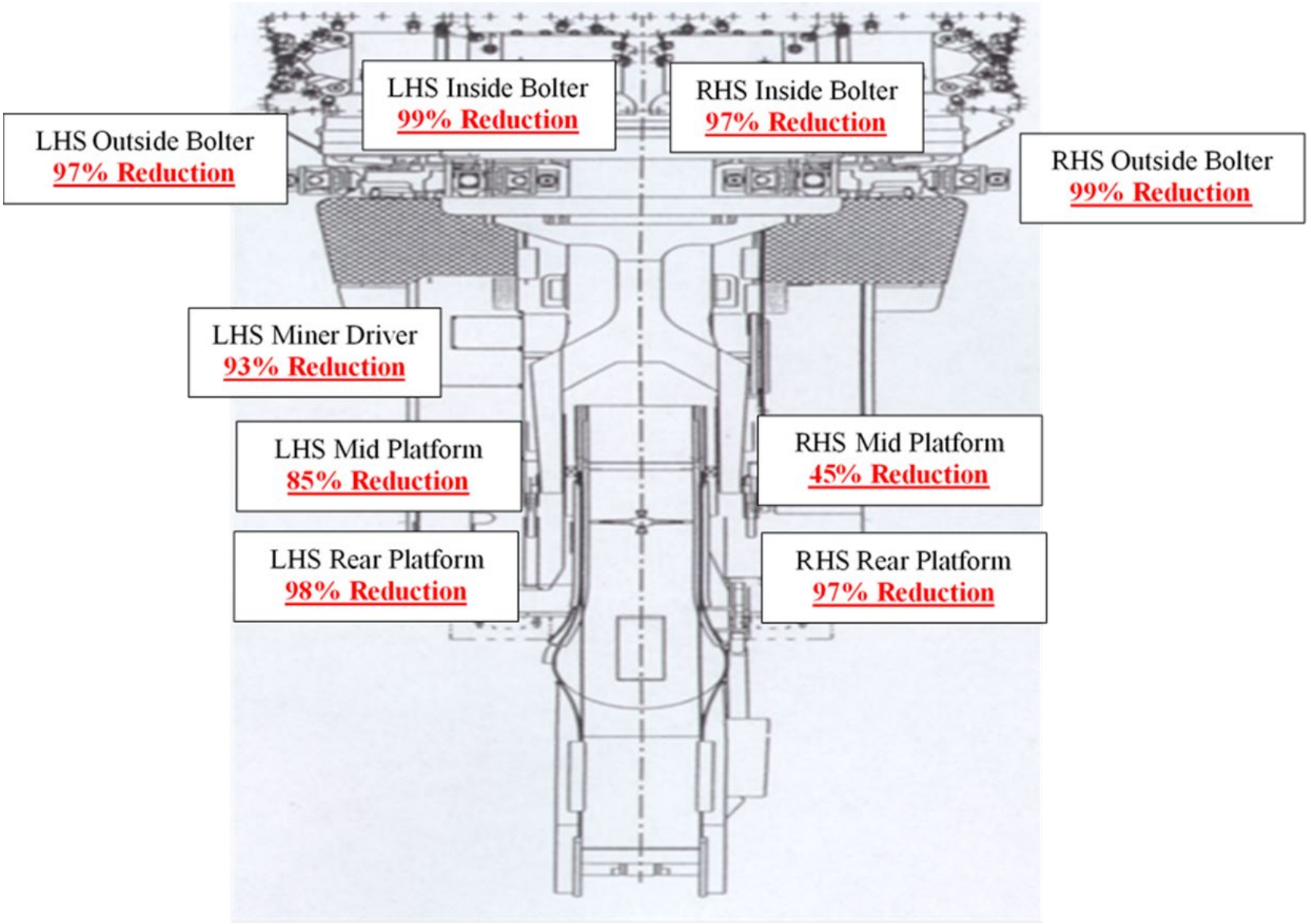
Curtains Down and Operating



Curtains Off



Removing the Curtains

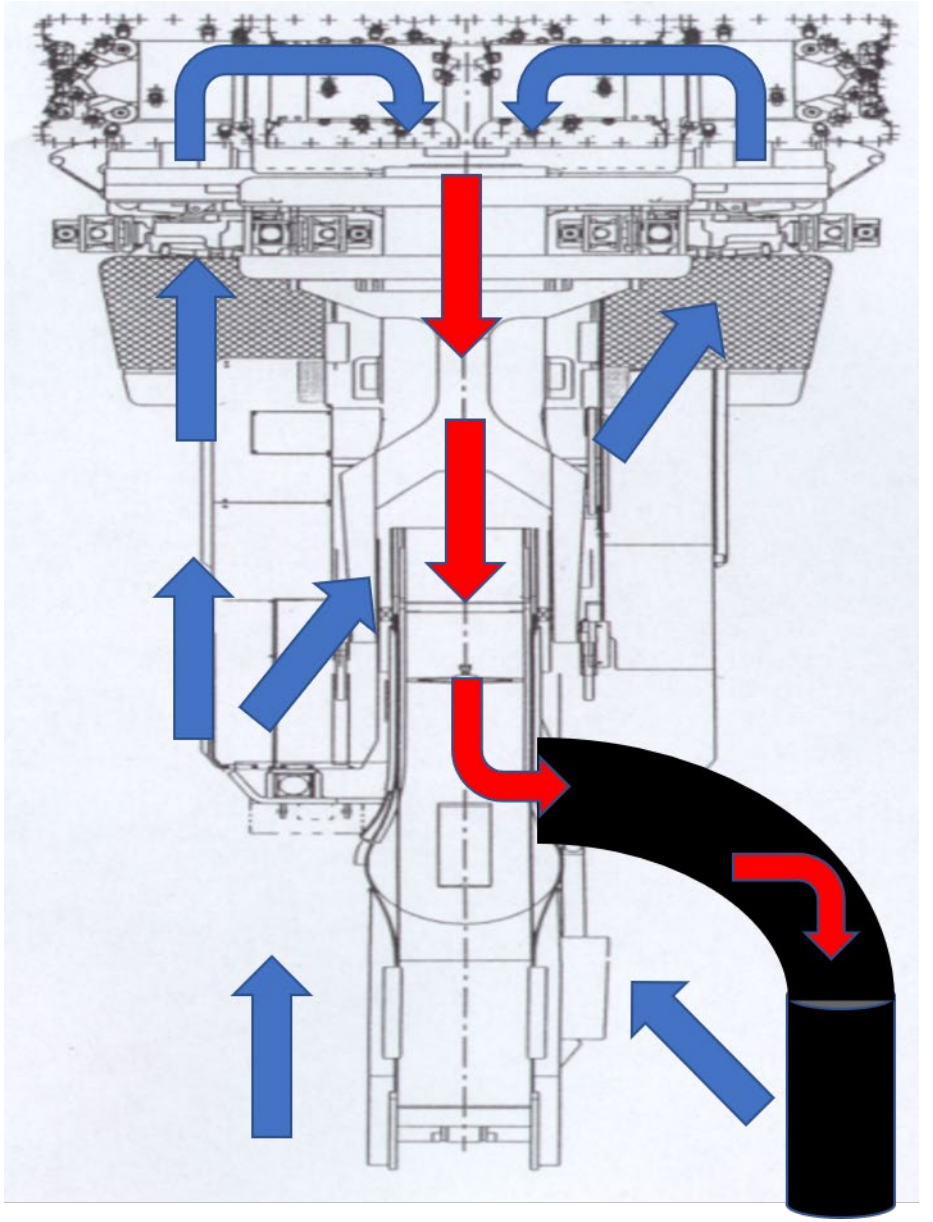


Conclusion for Curtain Efficiency

- **The results have quantified that the installed curtains were NOT suitable as an engineering dust control.**
- **By removing the curtains significant benefits were obtained:**
  - Higher ventilation flow to the face and in to the exhaust ventilation;
  - Increased face pressure holding the produced respirable and silica dust against the face allowing the exhaust ventilation to remove it as designed;
  - No dust roll back over operators;
  - Easier to access the front of the machine to change picks and sprays;
  - Much cooler on the platform due to increased airflow;
  - Cost savings in replacing damaged curtains and maintenance;
  - Increased visibility for operators to see the face and the cutting head;
  - Increased production.

Analysis

- The results obtained indicate that the RHS mid platform of the CM did not experience the same control efficiencies as the rest of the miner.
- The reason for this is that the elephants trunk was on the RHS of the CM and created resistance for the intake ventilation.
- This created an area of low pressure around mid platform as the ventilation was pushed to the high pressure side on the left due to the trunk resistance with the LHS ventilation pushing to the low pressure side mid platform.

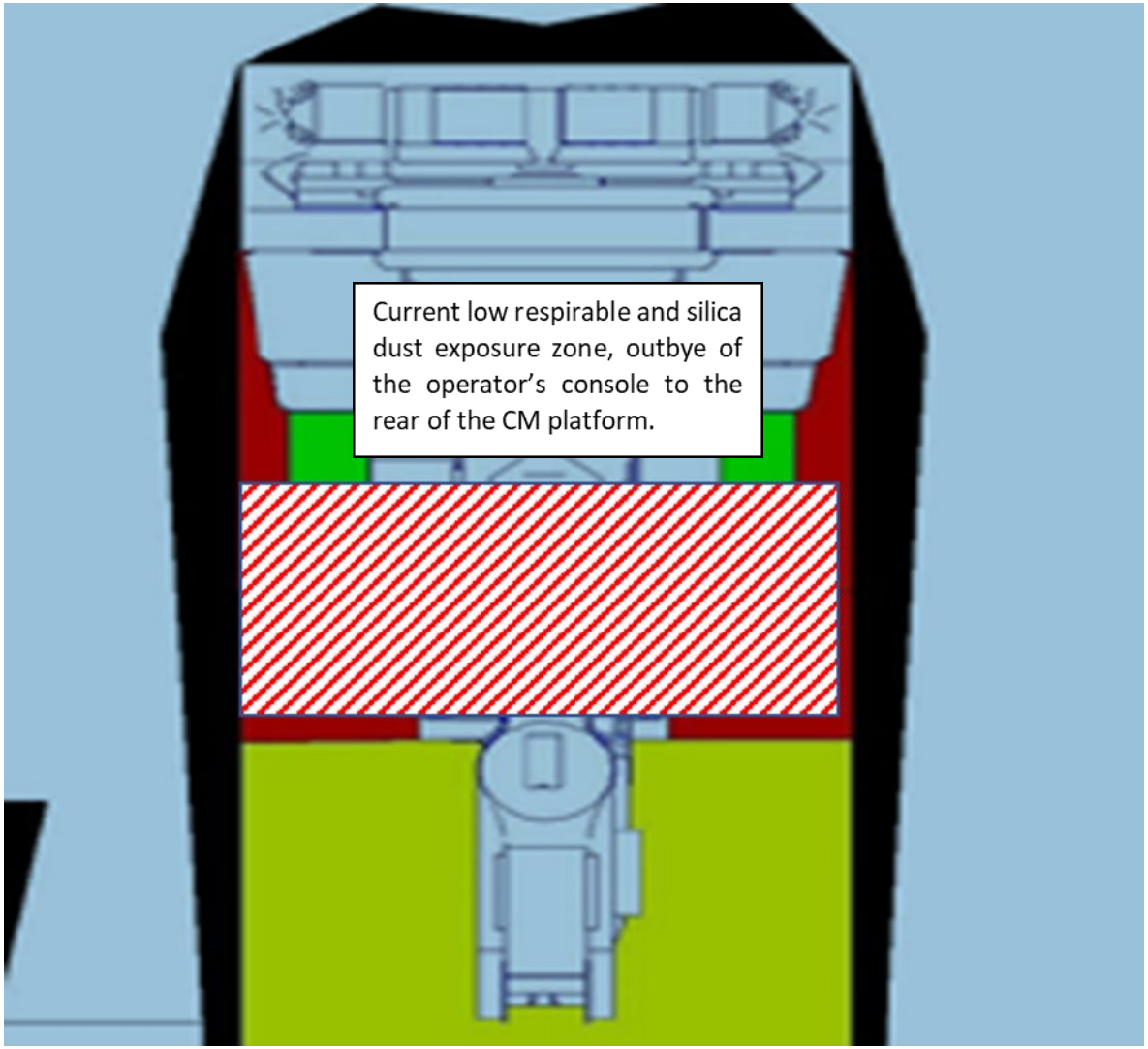


Trunk on RHS of CM



Efficiency Testing Outcome

Development of a low risk respirable dust exposure zone on either side of the CM platform.



Efficiency Sampling Throat and Tail Sprays

Efficiency test throat and tail sprays on MB650

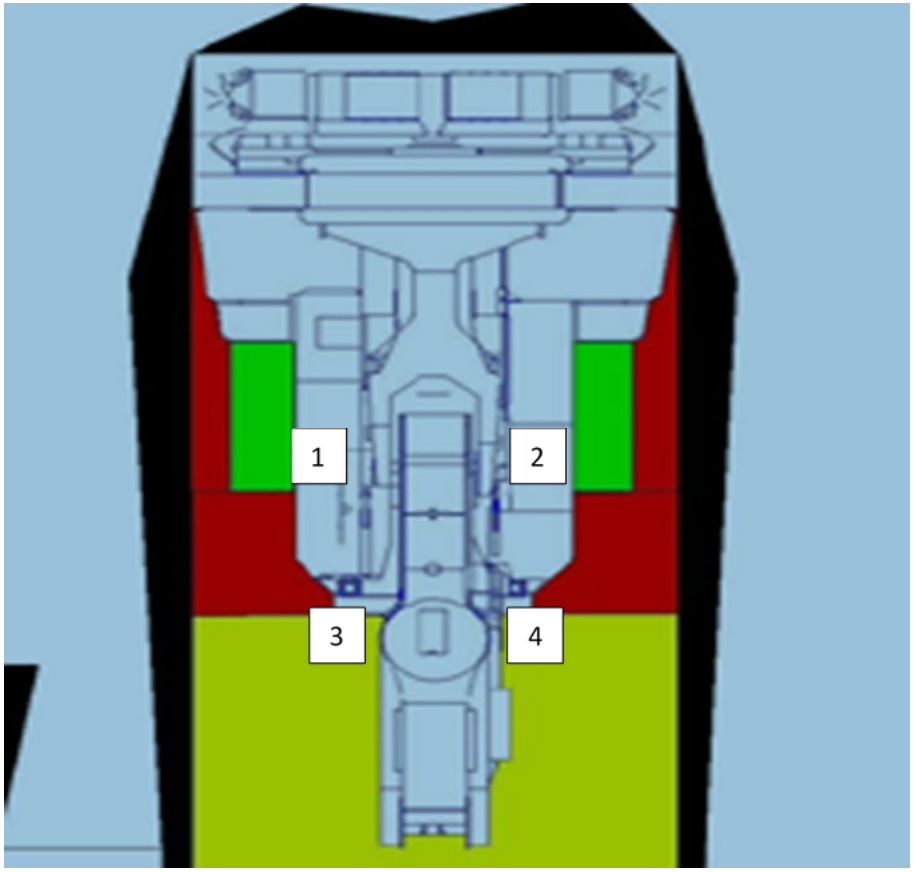
- The efficiency of the throat and tail sprays was determined by turning the throat sprays off for a meter advance and then on for a meter, changing the respirable head after each meter.

- The tail spray efficiency was determined the same way

Efficiency Sampling Throat and Tail Sprays

Heads and pumps were placed as follows:

- Heads and Pumps 1 and 2 were placed on or near the operator's console to sample the efficiency of the throat sprays on both sides of the CM; and
- Heads and Pumps 3 and 4 were placed on the rear of the supply's cassettes to sample the efficiency of the tail sprays on both sides.



Efficiency Sampling Throat and Tail Sprays

Observations During Efficiency Sampling

- Velocity on the RHS platform was measured at 0.7m/s.
- Velocity held face produced dust against the face until drawn away by extraction.
- CM was mining through a fault with approximately 500mm of stone in the floor.
- Throat sprays did not seem to atomise as much as previously observed



Tail Sprays On



Tail Sprays Off



Side by Side Comparison

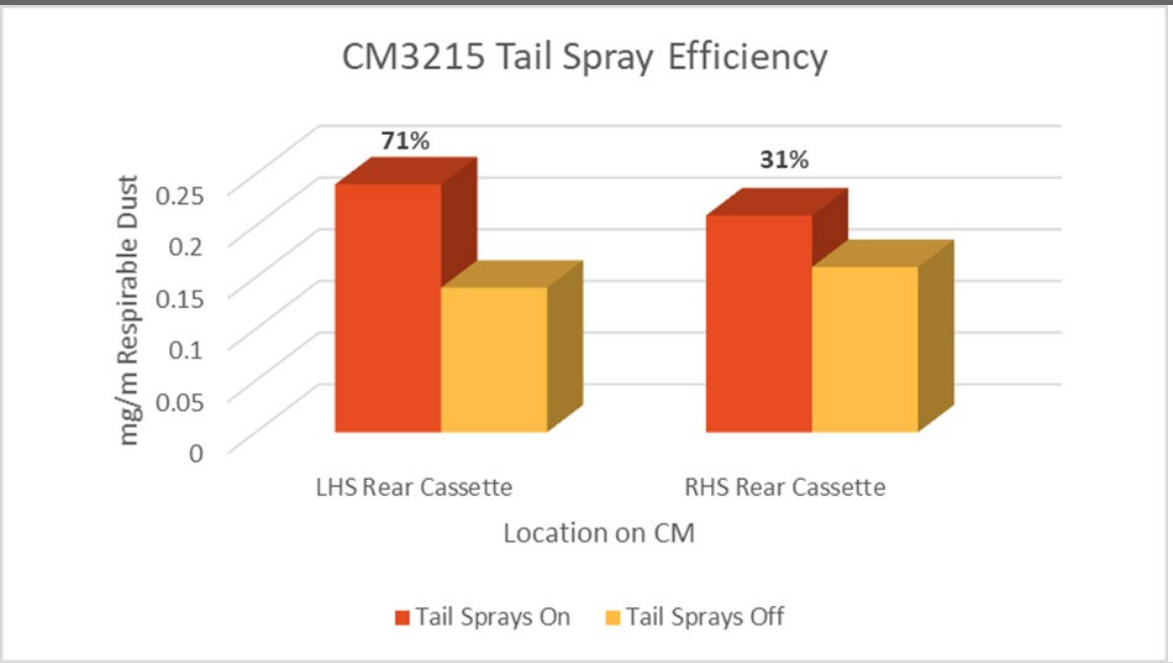
Sprays On

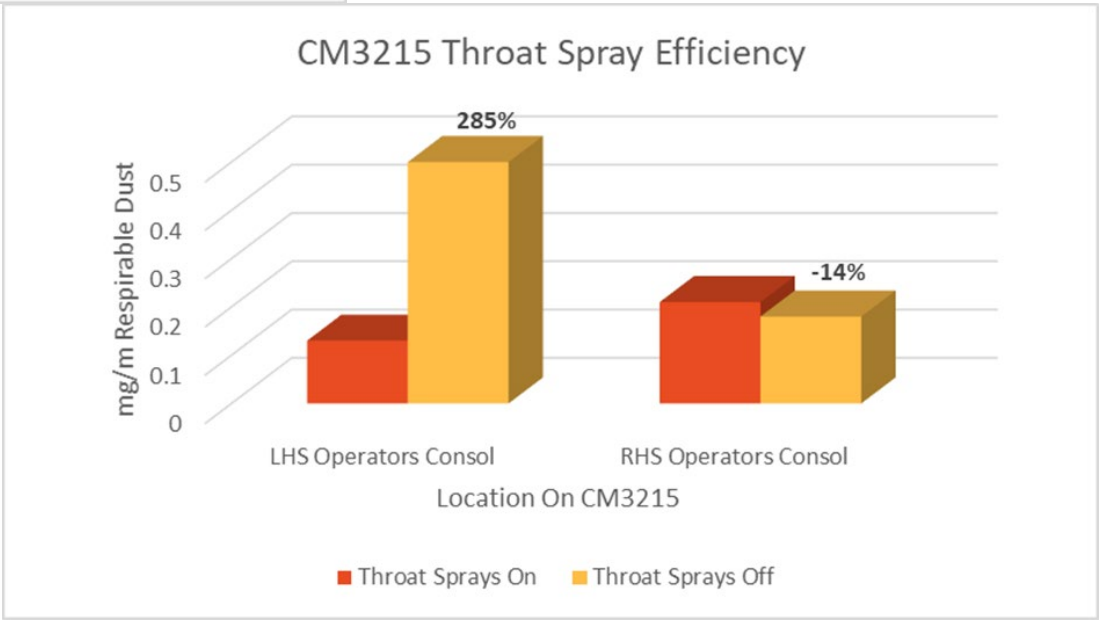


Sprays Off



Results


CM3215 Tail Spray Efficiency
71%
31%
mg/m Respirable Dust
0.25
0.2
0.15
0.1
0.05
0
LHS Rear Cassette
RHS Rear Cassette
Location on CM
Tail Sprays On
Tail Sprays Off


CM3215 Throat Spray Efficiency
285%
-14%
mg/m Respirable Dust
0.5
0.4
0.3
0.2
0.1
0
LHS Operators Consol
RHS Operators Consol
Location On CM3215
Throat Sprays On
Throat Sprays Off

Conclusion and Recommendations

- The results indicate that the sprays create more dust than they remove. This occurs as a result of incorrect pressure, flow, orifice size, spray angle, spray location or spray type, causing respirable dust to be blown off the coal by the sprays and in to the airways as the water droplets are too large.

- The following recommendations are made relative to Recognised Standard 15 Section 5.1, General strategy for dust control, page 10, (8th dot point) “validate the adequacy and effectiveness of the controls being applied in shift”:

Conclusion and Recommendations

Investigation to confirm spray design and function which will include, but not be limited to:

- Spray type (hollow cone, solid cone, flat fan);
- Spray orifice size;
- Spray pressure for maximum agglomeration;
- Spray water flow;
- Spray angle; and
- Spray location.
- Once detailed design parameters have been established by spray designer (OEM ??), sprays will be re-tested for conformance to design specifications and re-tested to confirm efficiencies.

Stopping Shot Crete Efficiency Testing

- This project involved testing the efficiency of a new stopping shotcrete product.

- Testing was undertaken with 6 x 25kg bags of the old product loaded in to a hopper and sprayed on to a rib. This was the benchmark.

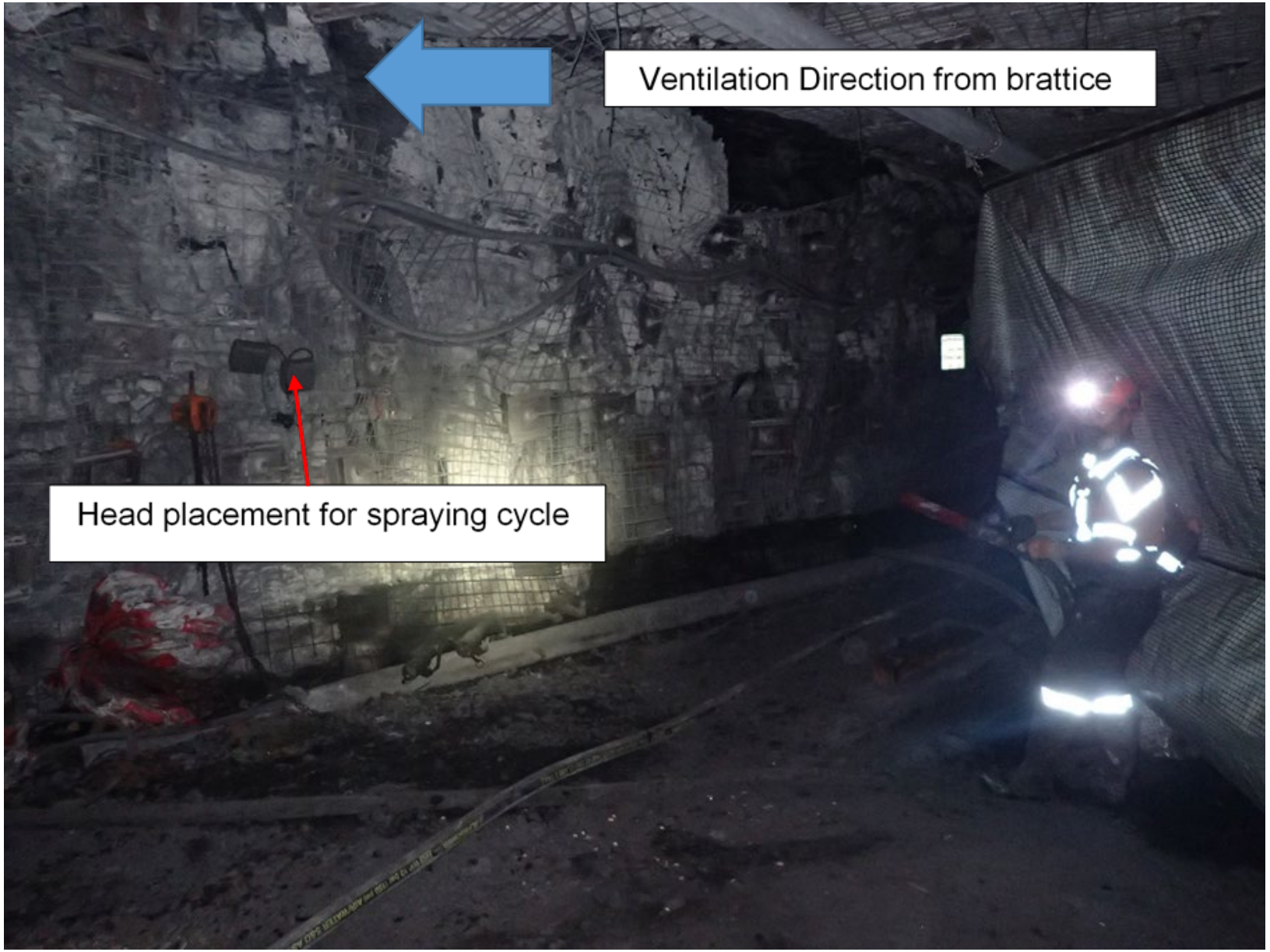
- A second test was undertaken with the new product with 6 x 25kg bags loaded and applied as per above.

Stopping Shot Crete Efficiency Testing

The sample points were taken inbye of the product loading hopper and on the outbye side of the spraying nozzle for both sets of tests.



Stopping Shot Crete Efficiency Testing



Results

Old Product Loading



New Product Loading



Results

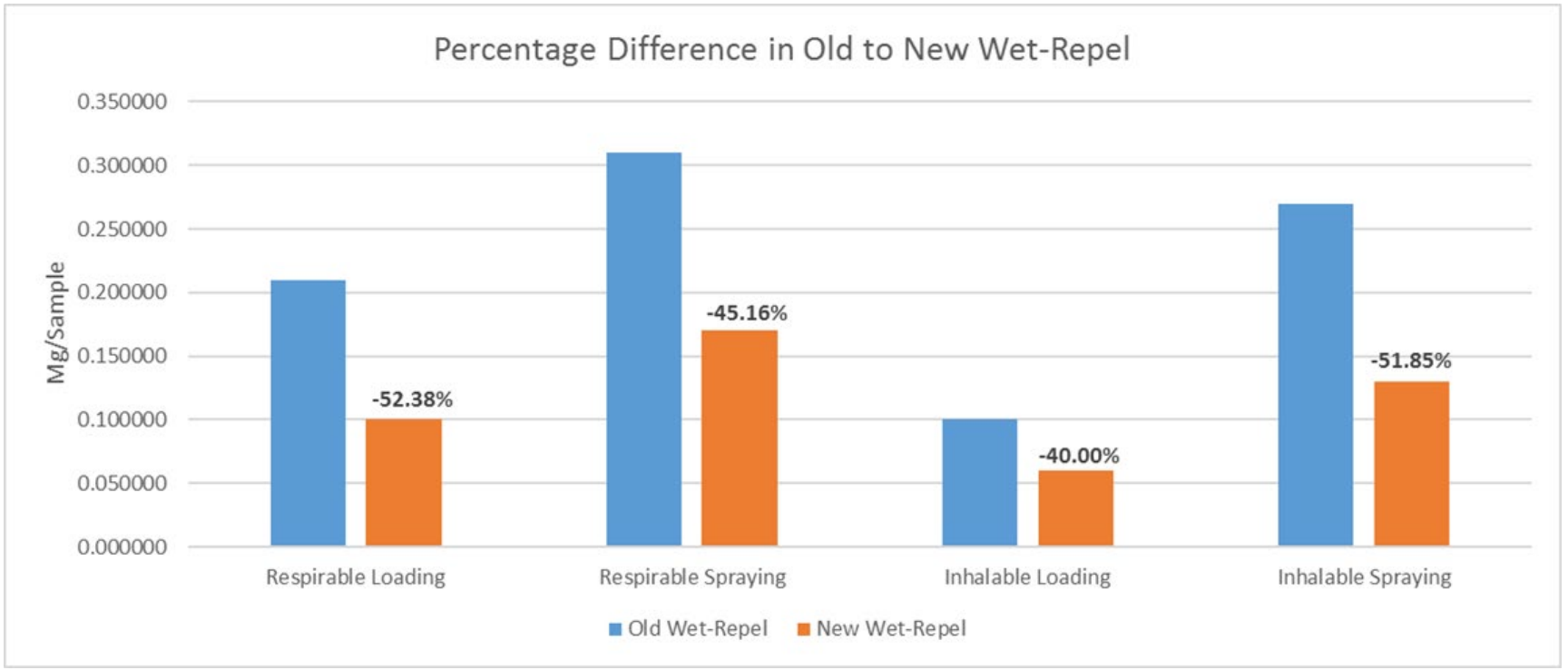
Old Product Spraying



New Product Spraying



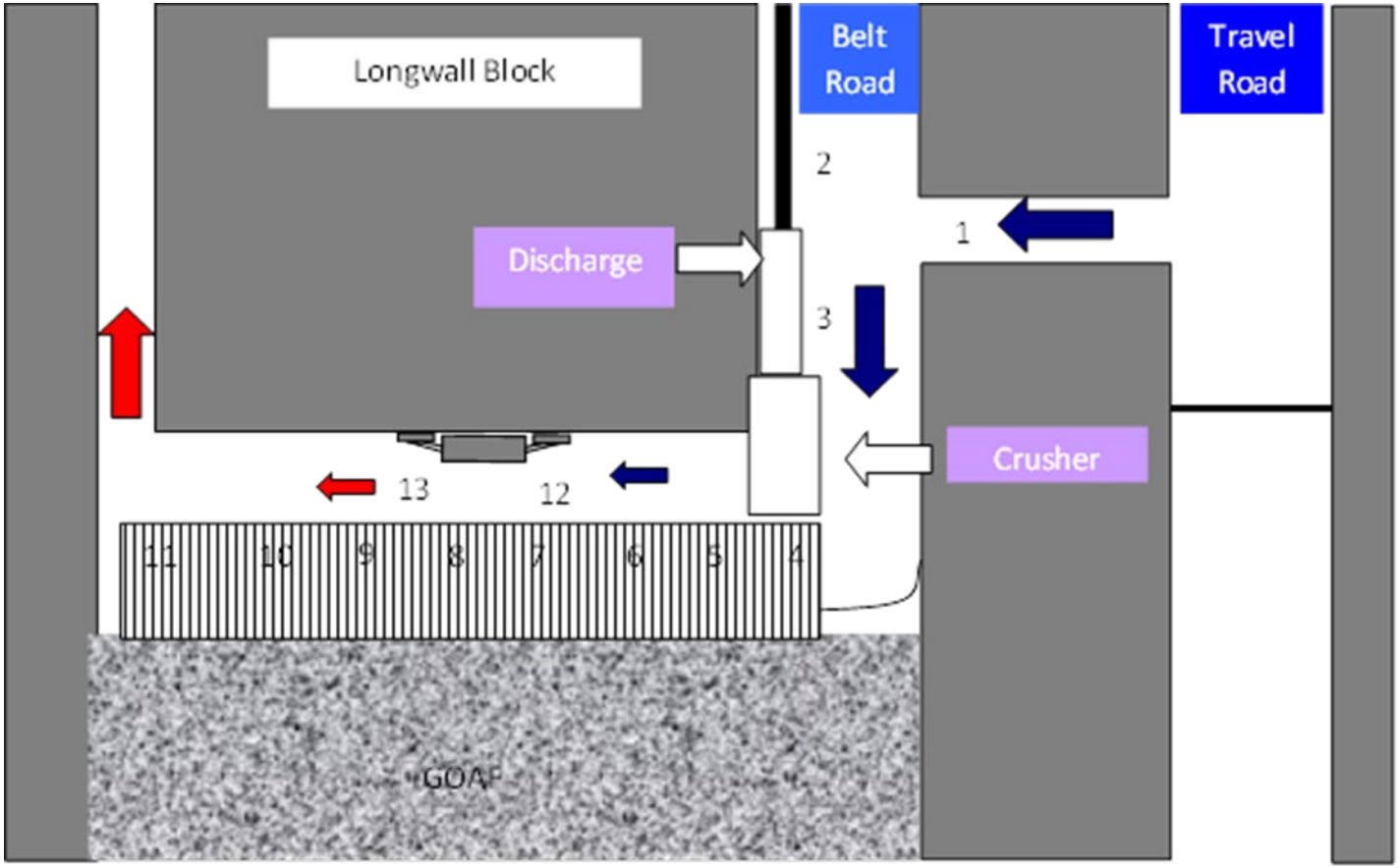
Results


Percentage Difference in Old to New Wet-Repel
Mg/Sample
0.350000
0.300000
0.250000
0.200000
0.150000
0.100000
0.050000
0.000000
-52.38%
-45.16%
-40.00%
-51.85%
Respirable Loading
Respirable Spraying
Inhalable Loading
Inhalable Spraying
Old Wet-Repel
New Wet-Repel

Other Efficiency Testing Undertaken

Efficiency Testing has been undertaken in the following areas:

- Longwalls;



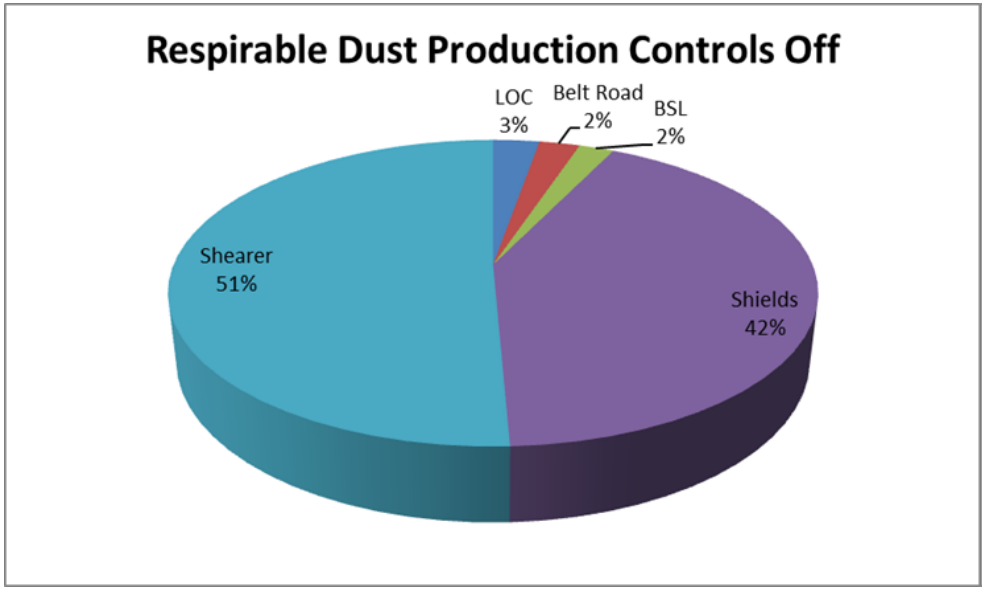
Other Efficiency Testing Undertaken

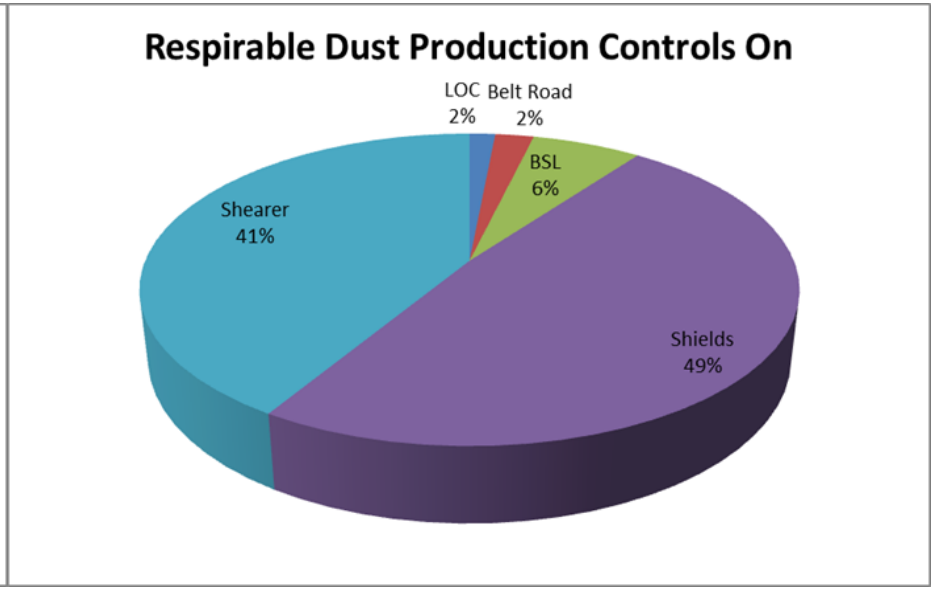
- Pumps and heads are usually placed when the shearer is cutting toward the tailgate for uni-di cutting. This allows continued cutting.
- One or more shears are completed (as agreed with longwall management) with all dust controls turned off excluding pick sprays for frictional ignition.
- The heads are changed at the completion of the agreed shears and the same amount of shears is repeated with the new heads in place with all dust controls turned on.
- The pumps and heads are removed after the second set of shears.
- The heads are then taken to a lab, the filters removed and post-weighed.

Other Efficiency Testing Undertaken

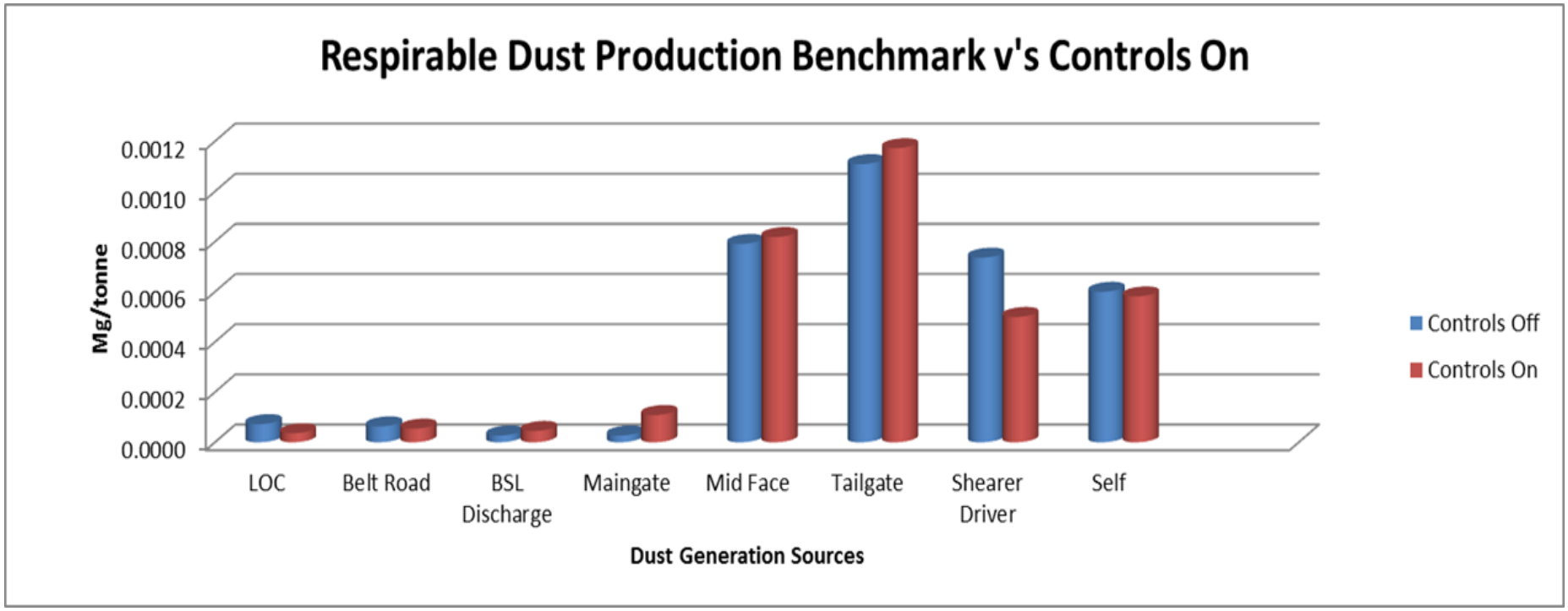
The testing identifies the percentage of total face dust produced for respirable dust at each independent source of dust generation with controls off and controls on.

Respirable Dust Production

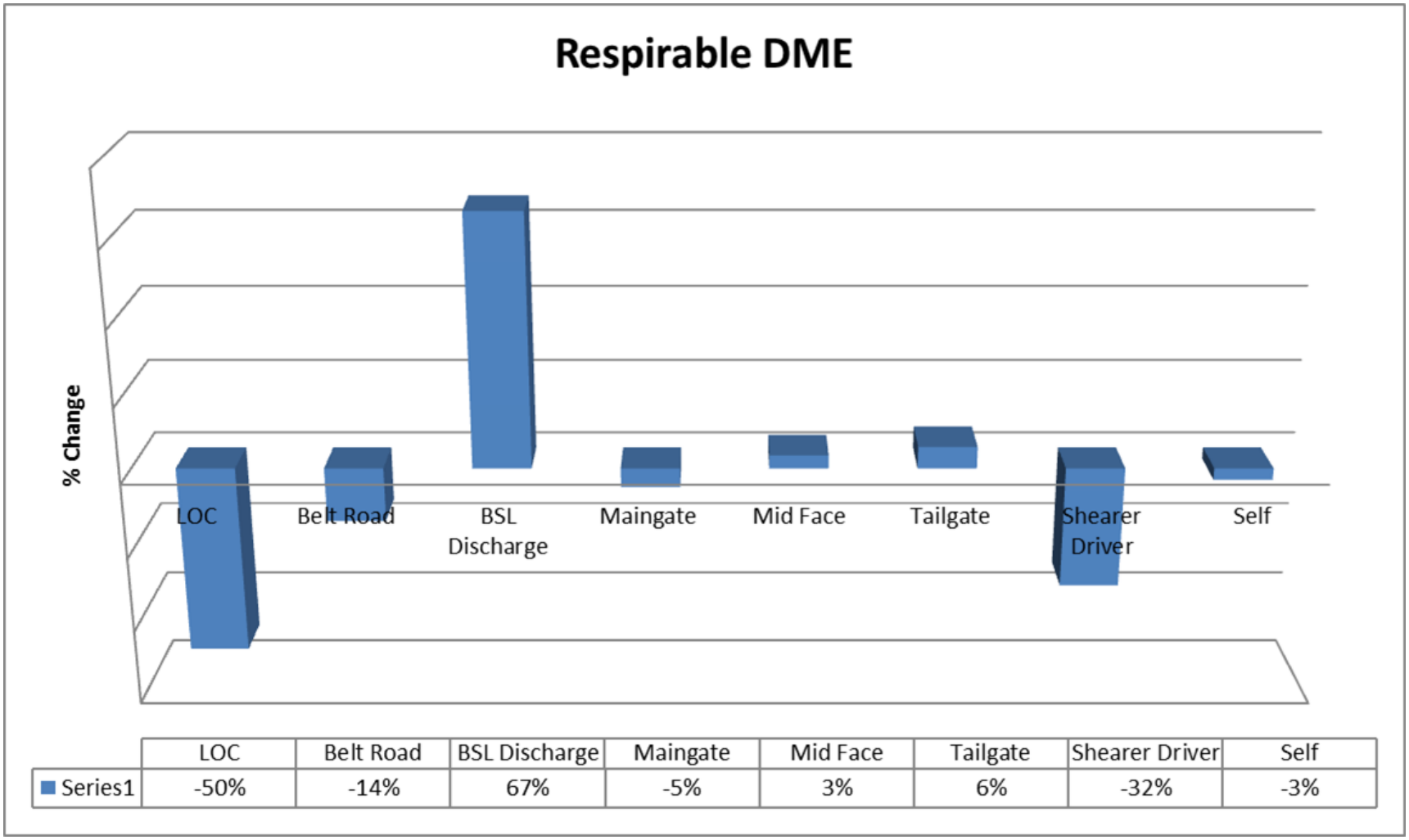




Other Efficiency Testing Undertaken



Other Efficiency Testing Undertaken



	LOC	Belt Road	BSL Discharge	Maingate	Mid Face	Tailgate	Shearer Driver	Self
Series1	-50%	-14%	67%	-5%	3%	6%	-32%	-3%

Other Efficiency Testing Undertaken

Seal Spraying

- The task of shotcreting a stopping produces large amounts of respirable sized particles.
- The sample was undertaken over a period of 11 minutes, which is the time taken to spray 1 complete bulka bag of wet repel.
- Sampling was undertaken whilst a stopping was being sprayed, with a pump and gravimetric head placed on the nozzle operator.

Max Exposure 3mg/m3					
Shotcreting	W	Q	V	T	Exposure Level
[redacted]	0.68	2.2	0.0242	11	**28.099174**

- This task requires immediate action to mitigate the risk to personnel in and around the shotcreting task.

Other Efficiency Testing Undertaken

Deputies walking the belts;

- Deputy belt road inspections are a task undertaken by the statutory officials.
- The belts are walked to identify any problems or issues that may affect the coal transport from the pit.
- 2 sets of tests were undertaken to establish the respirable dust that the Deputies would be exposed to while performing this task as part of their normal statutory duties.
- The first samples were taken when the belts were not running and there was no coal on the belts.
- A second set of samples for the same inspection by different deputies was taken with the belts running and coal on the belts.

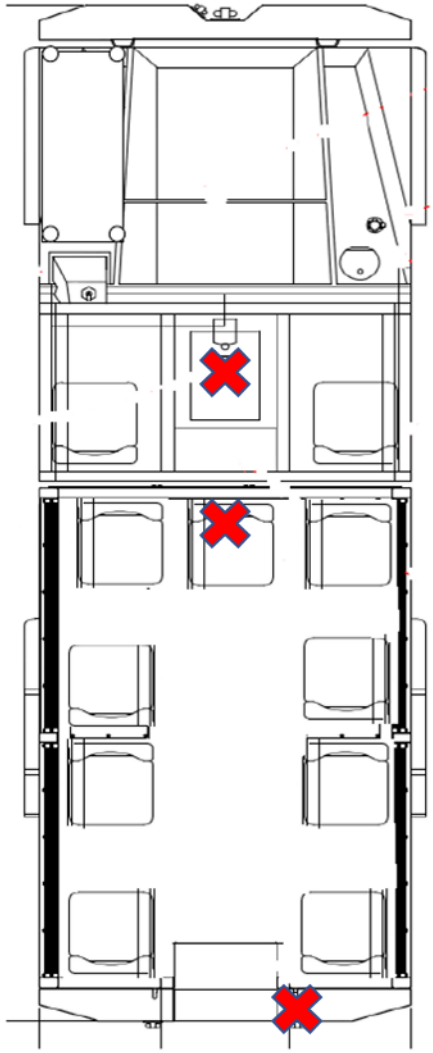
Other Efficiency Testing Undertaken

	Max Exposure 3mg/m3					
7-May	**Tube Bundle Rectification Returns**	**W**	**Q**	**V**	**T**	**Exposure Level**
No Coal		0.18	2.2	1.122	510	**0.160428**
7-May	**Belt Road Inspection**	**W**	**Q**	**V**	**T**	**Exposure Level**
No Coal		0.33	2.2	0.58	265	**0.566038**
14-May						
Invalid		0.45	2.2	0.4048	184	**1.111660**
23-May		0.29	2.2	0.1298	59	**2.234206**
7-May		**W**	**Q**	**V**	**T**	**Exposure Level**
No Coal		0.58	2.2	0.66	300.00	**0.878788**
14-May						
Coal		0.64	2.2	0.16	72.00	**4.040404**

Other Efficiency Testing Undertaken

Travel roads in vehicles;

- The travel roads in to each of the mining areas was undertaken as a task risk potential analysis to understand the exposure level to workers whilst travelling in vehicles to their work destination.

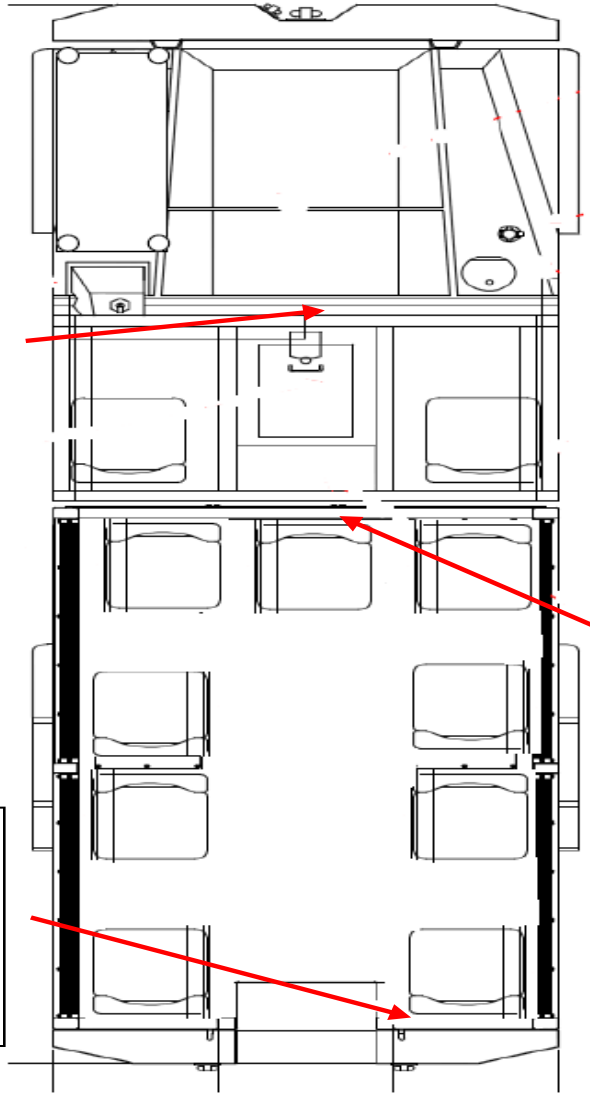


Other Efficiency Testing Undertaken

Max Exposure 3mg/m3					
Transport drift to pit bottom	**W**	**Q**	**V**	**T**	**Exposure Level**
Middle of driving cabin	0.02	2.2	0.0198	9	**1.010101**
Entry to rear seating	0.04	2.2	0.0198	9	**2.020202**
Front of rear seating	0.02	2.2	0.0198	9	**1.010101**
Pit bottom to LOC of mains	**W**	**Q**	**V**	**T**	**Exposure Level**
Entry to rear seating	0.03	2.2	0.0242	11	**1.239669**
Front of rear seating	0.02	2.2	0.0242	11	**0.826446**
Middle of driving cabin	0.06	2.2	0.0220	10	**2.727273**
Travel road to	**W**	**Q**	**V**	**T**	**Exposure Level**
Entry to rear seating	0.01	2.2	0.011	5	**0.909091**
Front of rear seating	0.03	2.2	0.011	5	**2.727273**
Middle of driving cabin	0.03	2.2	0.011	5	**2.727273**
LOC from mains	**W**	**Q**	**V**	**T**	**Exposure Level**
Entry to rear seating	0.02	2.2	0.0484	22	**0.413223**
Front of rear seating	0.06	2.2	0.0484	22	**1.239669**
Middle of driving cabin	0.04	2.2	0.0484	22	**0.826446**
entry to ERZ Boundary	**W**	**Q**	**V**	**T**	**Exposure Level**
Entry to rear seating	0.02	2.2	0.0154	7	**1.298701**
Front of rear seating	0.05	2.2	0.0154	7	**3.246753**
Middle of driving cabin	0.07	2.2	0.0154	7	**4.545455**
entry to ERZ Boundary	**W**	**Q**	**V**	**T**	**Exposure Level**
Entry to rear seating	0.08	2.2	0.022	10	**3.636364**
Front of rear seating	0.08	2.2	0.022	10	**3.636364**
Middle of driving cabin	0.09	2.2	0.022	10	**4.090909**

Other Efficiency Testing Undertaken

Middle of driving cabin	mg/m3
Transport drift to pit bottom	1.0
Pit bottom to LOC of mains	2.7
Travel road to [redacted]	2.7
LOC from mains [redacted]	0.8
[redacted] ERZ Boundary	4.5
ERZ Boundary Test #2	4.0



Front of rear seating	mg/m3
Transport drift to pit bottom	2.0
Pit bottom to LOC of mains	0.8
Travel road to [redacted]	2.7
LOC from mains [redacted]	1.2
[redacted] ERZ Boundary	3.2
ERZ Boundary Test #2	3.6

Entry to rear seating	mg/m3
Transport drift to pit bottom	1.0
Pit bottom to LOC of mains	1.2
Travel road to [redacted]	0.9
LOC from mains [redacted]	0.4
[redacted] ERZ Boundary	1.3
ERZ Boundary Test #2	3.6

Other Efficiency Testing Undertaken

Fit testing face masks

- Sampling was undertaken whilst fit testing was being performed.
- A pump and gravimetric head were placed on the technician for the period of the task.

	Max Exposure 3mg/m3					
Date	Hygienist	W	Q	V	T	Exposure Level
17-May		0.14	2.2	0.0396	18	**3.535354**
17-May		0.07	2.2	0.0396	18	**1.767677**
6-Jun		0.03	2.2	0.0176	8	**1.704545**
6-Jun		0.06	2.2	0.0154	7	**3.896104**
6-Jun		0.06	2.2	0.0176	8	**3.409091**
6-Jun		0.11	2.2	0.0308	14	**3.571429**
6-Jun		0.08	2.2	0.0176	8	**4.545455**
6-Jun		0.09	2.2	0.0176	8	**5.113636**

Other Efficiency Testing Undertaken

- **Coal ports**
  - Train unloading;
  - Ship loaders;
  - Control rooms;
  - Coal sampling labs;
  - Many other applications

Diesel Particulate Matter (DPM)

- DPM is a major health risk for workers in and around the mining environment.
- The Efficiency testing process has been applied to quantifying the efficiency of installed DPF's.
- This provides mine management with data on which DPF is the most efficient at mitigating DPM allowing them to maximise value whilst minimising costs.
- In many cases, once the DPF efficiency has been quantified, additional machines have been approved to enter the production area, increasing production whilst maintaining air quality.

DPF Efficiency Testing

- Samples are collected as per AS2985
- The sampling pumps and heads were placed as close as possible to the exhaust sampling points.
- The sampling points for connection prior to the installed filters and after the installed filters were a 3/8” BSP socket welded into the exhaust system with a 3/8” BSP to JIC 6 fitting installed.
- Wire braided stainless steel hoses were placed on these attachment points to place the pumps and sampling heads as far away as possible from the heat zone.
- The piping is also critical to cool exhaust gasses before they enter the sampling head.

DPF Efficiency Testing

Installed hosing on the inlet and outlet of an
MT6020 Haul Truck DPF





DPF Efficiency Testing

Installed hosing on the inlet and outlet of a second MT6020 Haul Truck DPF





DPF Efficiency Testing

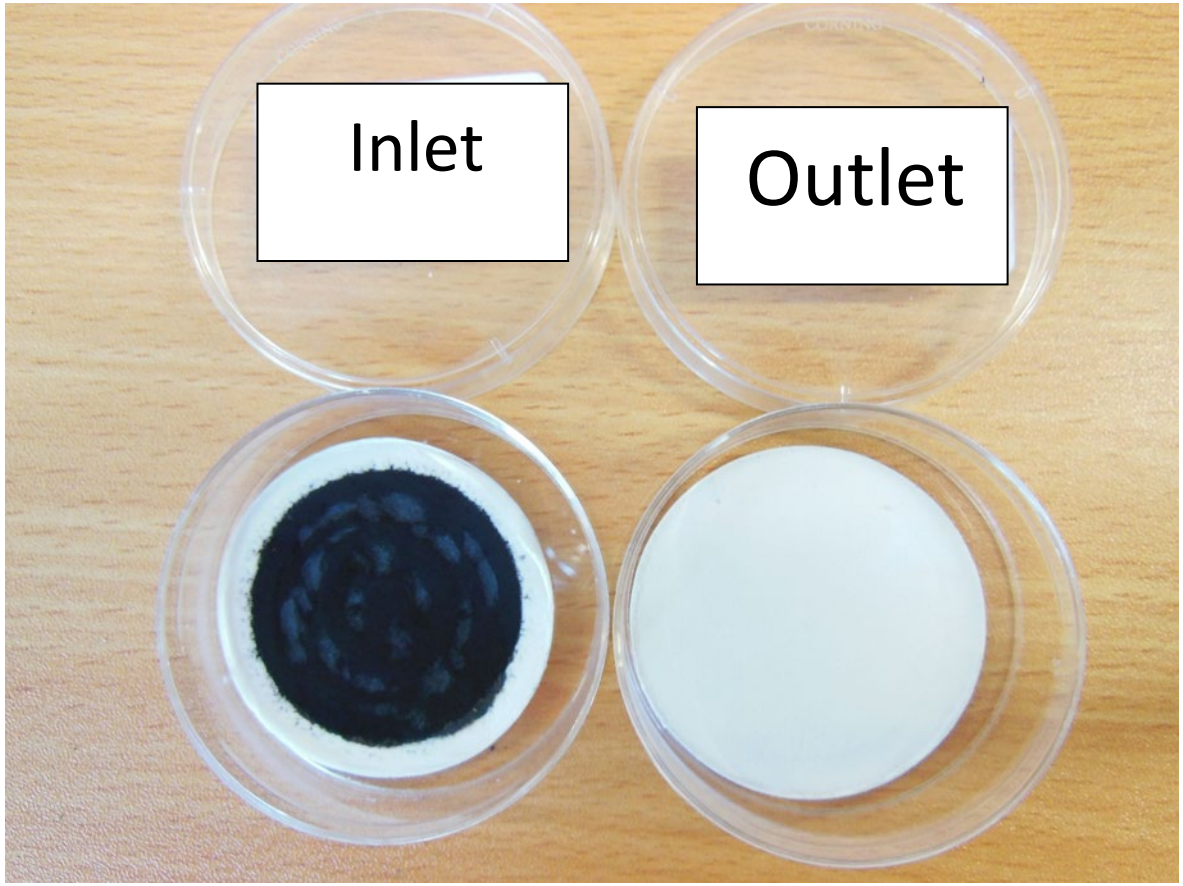
Installed hosing to the pumps and heads on
the MT6020 Haul Truck





DPF Efficiency Testing

DPM collected on the filter papers before and after the installed DPF



DPF Efficiency Testing

Vehicle	November 2015 DPF Efficiency	March 2016 DPF Efficiency	August 201 DPF Efficiency
MT6020 DPF	99.70%	75.59%	87.59%
MT6020 DPF	95.70%	92.42%	94.07%
MT6020 DPF	99.40%	76.85%	93.46%

- **Thank you for your attention.**
- **Questions please!**