2018

Improving Respirable Coal Dust Exposure Monitoring and Control

David Cliff
University of Queensland

Nikky LaBranche
Simtars

Mark Shepherd
Coal Services Pty Ltd

Fritz Djukic
Department of Natural Resources and Mines, Queensland

Publication Details

David Cliff, Nikky LaBranche, Mark Shepherd and Fritz Djukic, Improving Respirable Coal Dust Exposure Monitoring and Control, Proceedings of the 18th Coal Operators' Conference, Mining Engineering, University of Wollongong, 300-304.

IMPROVING RESPIRABLE COAL DUST EXPOSURE MONITORING AND CONTROL

David Cliff[1], Nikky LaBranche[2], Mark Shepherd[3], Fritz Djukic[4]

ABSTRACT: This paper will present the progress results of this research project commissioned by ACARP to establish the state of the art with respect to:

- Current dust suppression and prevention controls and their effectiveness,
- The basis for setting an exposure standard for respirable coal dust,
- The current trends in exposure data and any underlying points of concern or interest,
- The capacity to monitor respirable coal dust in real time – what techniques are available and what are their limitations,
- Current research into reducing exposure to respirable coal dust,
- Future directions for research into better control of respirable coal dust exposure.

INTRODUCTION

Since the first case of Coal Workers Pneumoconiosis (CW) was reported in Queensland in 2015 in over twenty years there have now been a total of 56 confirmed cases of Coal Mine Dust Lung Diseases (CMDLD) among current and former Queensland mine workers (DNRM,2017a). Coal mine dust lung diseases are caused by long-term exposure to high concentrations of respirable dust, generated during mining and quarrying activities. CMDLD include a range of occupational lung conditions including:

- Asbestosis;
- Coal Workers' Pneumoconiosis (CWP);
- Chronic obstructive pulmonary disease;
- Silicosis.

Two parliamentary inquiries - one Federal and one State, have been convened. Because of these there will be major changes in the way mines and the State Government approach the management of worker exposure to respirable coalmine dust. Much effort has already been devoted to improving the coal worker health scheme to remove the problems in diagnosis that were found by the Monash Review (Sim *et al*, 2016), including coverage for retired workers. It has also generated a number of questions relating to monitoring and control of the coal dust exposure. In recognition of this ACARP established a project C 26048, this research seeks to answer or at least provide more detail on and allow for better definition of a number of questions. These questions include:

- Do we need better dust control systems?
- Are current monitoring techniques adequate?
- Do we need a lower coal dust exposure standard?
- Is coal dust the problem?
- What are the gaps in our knowledge of respirable coal dust exposure?

[1] *David Cliff, Professor, University of Queensland. Email: d.cliff@mishc.uq.edu.au Tel: +61 7 3346 4086*
[2] *Nikky LaBranche, Principal Mining Engineer, SIMTARS. Email: Nikky.LABRANCHE@simtars.com.au Tel: +61 7 3810-6358*
[3] *Mark Shepherd, Compliance Manager, Coal Services Pty Ltd. Email: mark.shepherd@coalservices.com.au Tel: +61 2 4922 4461*
[4] *Fritz Djukic, Inspector of Mines-Occupational Hygiene, Department of Natural Resources and Mines. Email: fritz.djukic@dnrm.qld.gov.au Tel: +61 7 4999 8504*

CURRENT RESPIRABLE COAL DUST EXPOSURE

In response to the CWP situation DNRM has issued two recognised standards – one on monitoring of dust (Recognised Standard14, DNRM, 2017b) aimed at improving the quantity and quality of the respirable coal dust monitoring and the other on dust control techniques (Recognised Standard 15, DNRM, 2017c).

In 2015, the DNRM initiated a program to collect all the respirable coal dust monitoring information from underground mines in Queensland. The DNRM currently reports this data on a quarterly basis. Figure 1 shows the trends in exposure data since 2014 for the Longwall Similar Exposure Group (SEG) by de-identified mines. Following an increase in the focus on dust control since 2015 the average exposure has fallen from close to the regulatory exposure standard of 3 mg/m^3 to around 1 mg/m^3. This would suggest that if applied the current technology mines have is capable of bringing the exposure down to well below regulatory limits.

In conjunction with DNRM this research project staged two workshops in Central Queensland where mines were able to present their current respirable dust control strategies. They demonstrated that major improvements in reducing respirable dust exposure have been achieved through:

- Automation – removal of worker from the active longwall face during mining;
- Greater use of water sprays to suppress the dust – not just on the shearer but also on the shields, rear walkways and AFC;
- Dust maps have been developed identifying areas of high potential exposure so that workers can avoid them – utilising real time dust monitors;
- Experimenting with different types of water sprays and the use of surfactants and foams;
- Enclosure of crushers and transfer points.

This improved application of controls has been supported by greatly increased personal exposure monitoring utilising both whole of shift gravimetric analysis and real time monitoring.

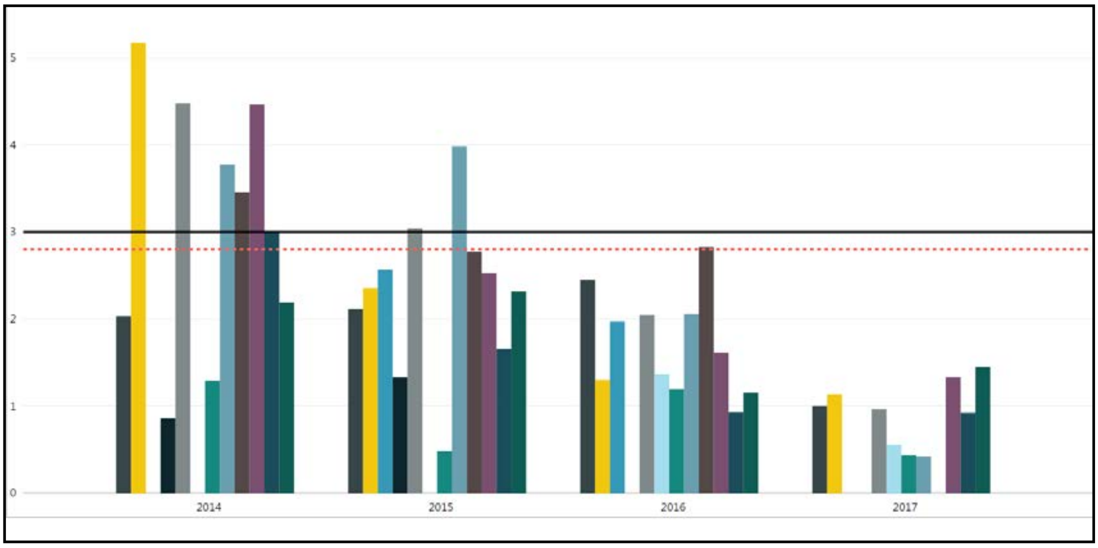

Figure 1: Longwall SEG exposure (mg/m^3) for Queensland underground coalmines (DNRM, 2017d)

In NSW there is a centralised monitoring regime in place implemented by Coal Services under orders 40 and 42. In addition, a tripartite standing dust committee meets quarterly to review the monitoring results. The results for 2015-2016 are displayed in Figure 2. Only 0.7 % of samples collected in 2016 in NSW Longwall mines exceeded the NSW exposure standard of 2.5 mg/m^3. There were higher levels of exceedances for respirable quartz and inhalable dust.

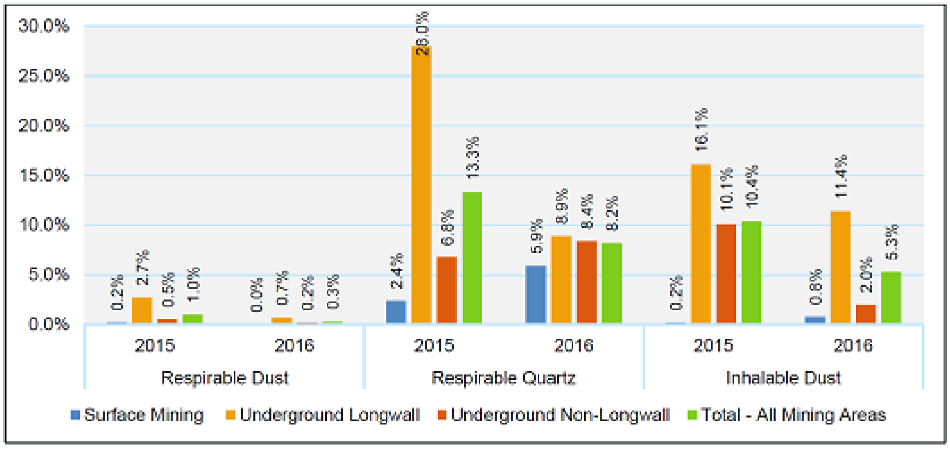

Figure 2: NSW airborne dust exposure exceedance (Coal Services, 2017)

RESPIRABLE COAL DUST MONITORING

Traditionally monitoring of worker exposure to coal dust has been undertaken using cyclone elutriators for gravimetric analysis of a worker exposure over an entire shift.

This technique is designed for measuring compliance with the exposure standard and does not permit identification of individual dust sources nor whether controls are effective. Control effectiveness is best measured using real time devices that can quickly pick up changes in operating conditions. Real time respirable dust monitors have existed for more than twenty years.

The current research project is carrying out trials to compare a range of real time and near real time monitoring devices for suitability. No one device meets all the required criteria. Ideally a real time dust monitoring device would be:

-
- Intrinsically safe
- Light weight and comfortable to wear
- Capable of running for at least 12 hours
- Report actual respirable coal mine dust concentration in real time, unaffected by moisture.

The PDM3700 using tapered element oscillating microbalance (TEOM) technology is approved for use in the USA by MSHA and has been designated as the default monitoring device there (Volkwein, 2017). It is not certified for unrestricted use here but can be used as uncertified portable electrical equipment. It has been widely applied over the past twelve months in Australia and has generated much useful data. Unlike other real time devices it actually undertakes gravimetric analysis in near real time – providing the user with a running 15 minute average concentration of respirable coal dust. Apart from the difficulties in certification the other minor issues with its operation that have been identified relate to its bulk and cost.

The majority of other real time devices utilise some form of light scattering technology to determine the dust concentration. This requires the calibration of the device with the dust of interest to get an accurate response. In addition water droplets such as are used in suppression systems would be detected by these devices, causing inaccurate readings. The PDM 3700 utilises a heated inlet system to prevent this problem.

All these devices measure the total respirable dust in the air. Currently there is no device that looks at the speciation of the dust in real time. Traditional analysis for silica content requires the gravimetric filter to be processed in a laboratory. Recently NIOSH in the USA have developed a technique that allows the filters to be analysed on the mine site (Miller, et al, (2017). This in turn enables feedback to the mine and miners for the next shift rather than having wait weeks for the laboratory report. This immediacy of response greatly improves the mines capacity to identify potential problems and implement solutions before the exposure becomes excessive.

OCCUPATIONAL EXPOSURE STANDARD

Perhaps the biggest question raised by the research so far is what is the cause of the CWP and thus what should be the exposure standard(s). Currently medical experts are careful to talk in terms of coalmine dust rather than coal dust. This is because there may be components of the dust other than coal that could be causing the CMDLD, such as silica, and bioavailable iron. Recent research from the USA, where there are currently over 1000 new cases of CWP reported annually, indicate the potential contribution of non coal dust to the exposure (figure 3). Many of these components have much lower occupational exposure limits than coal dust (silica is currently 0.1 mg/m^3). It is possible that the cases of CWP reported in Queensland are not due to coal dust but silica or other components. It is important to identify the source so that the correct pathogen is controlled and exposure standards are not unnecessarily reduced, which would create an associated financial burden on mines.

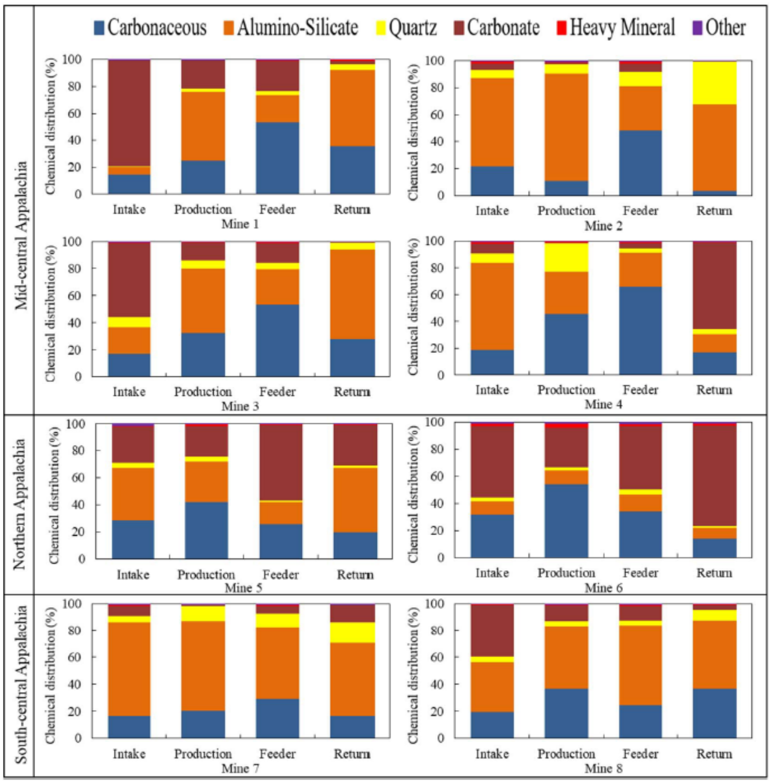

Fig. 2. Average particle mineralogy distributions for each mine by sampling location category.

Figure 3: Respirable coal dust composition in East USA (Johann-Essex et al, 2017)

RESEARCH NEEDS

ACARP has already commissioned new research to begin this year (2018) investigating the potential causes of Queensland CMDLD in terms of the active species responsible. This knowledge is vital before attempting to set any new occupational exposure standards especially if the exposure standard applies not only to CWP prevention but also all other CMDLD.

Work has begun to undertake a detailed analysis of the existing exposure data fromQueensland and NSW to see if there are any insights that the data can offer in terms of control effectiveness and the risk profiles for different worker groups.

Recent cases of CWP have emerged in the open cut coal industry and concern is now also spreading to the quarrying sector, tunnelling and metalliferous sectors, which do not have the centralised compulsory medical system that exists for underground coal nor, in many cases, the monitoring regimes.

There is a need to develop real time fixed point monitoring devices that are capable of monitoring the effectiveness of controls and reporting when the controls are not effective. This would require the issues relating to water droplets to be resolved as well as making devices robust enough to survive the underground coal working environment.

A number of the controls currently applied need to be optimised for effectiveness and tailored to the particular situation where they are applied i.e. water spray droplet size and energy in comparison to the target dust particles.

Automation and segregation of the worker from the dusty environment have delivered major benefits but there is still work to be done in ensuring high levels of availability of the automation systems while delivering the production targets.

CONCLUSIONS

- The research project is currently undertaking factoral analysis of respirable dust exposure data from NSW and Queensland in an attempt to gain better insights into the nature of the problem and potential control strategies.
- The literature review delving into monitoring techniques, control technology and the epidemiology of coal mine dust exposure is still in progress.
- Trials comparing various real time devices are currently in progress.
- A final report is due in May of 2018 and the findings will be publicised at the NSW and Queensland Mining Industry Safety and Health conferences.

REFERENCES

Coal Services, 2017. Standing Dust Committee Information Bulletin, April 2017, Coal Services, NSW.

DNRM, 2017a. Mine dust lung diseases https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/accidents-incidents/mine-dust-lung-diseases [Accessed 18 December 2017].

DNRM, 2017b. Recognised Standard 14 – Monitoring respirable dust in coal mines, Department of Natural Resources and Mines, Brisbane, Queensland.

DNRM, 2017c. Recognised Standard 15 – Underground respirable dust control, Department of Natural Resources and Mines, Brisbane,Queensland

DNRM, 2017d. Presentation at Dust Forum on Recognised Standard 14p Dust Monitoring, July 25-26, Central Queensland, Department of Natural Resources and Mines, Brisbane,Queensland.

Miller, A, Drake, P, Murphy, N, Nollb, J and Volkwein J, 2017. *Evaluating portable infrared spectrometers for measuring the silica content of coal dust*, paper on NIOSH website https://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/episf.pdf [Accessed 18 December 2017].

Johann-Essexa, V, Kelesa, C ,Rezaeeb, M, Scaggs-Wittea, M, and Sarver, E, 2017. *Respirable coal mine dust characteristics in samples collected in central and northern Appalachia*, International Journal of Coal Geology, 182, pp85-93.

Sim, M, Glass, D, Hoy, R, Roberts, M, Thompson, B, Cohen, R, Go, L, Almberg, K and Deponte, K, 2016. Review of Respiratory Component of the Coal Mine Workers' Health Scheme for the Queensland Department of Natural Resources and Mines, Monash University, Melbourne, Victoria.

Volkwein, J, 2017. *Dust Monitoring – State of the Art.* Presentation to the dust workshop at the Mine Ventilation Conference, Brisbane August 27, 2017.