NSW GOVERNMENT

NSW Resources Regulator

TARGETED ASSESSMENT PROGRAM

DIESEL EXHAUST EMISSIONS IN UNDERGROUND COAL MINES

August 2019

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Document control

Published by NSW Resources Regulator

Title: Diesel exhaust emissions in underground coal mines

First published: August 2019

Authorised by: Chief Inspector of Mines

CM9 reference: DOC19/637155

AMENDMENT SCHEDULE		
Date	Version	Amendment
August 2019	1	First published

Contents

Executive summary

This report summarises the findings of the targeted assessment program undertaken relating to the hazard of worker exposure to diesel exhaust emissions in underground coal mines. This program began in October 2017 and 19 mines have been assessed.

The results of this assessment program demonstrated that although all sites have acknowledged the criticality of maintaining sufficient ventilation to dilute exhaust gases, the implementation and maintenance of the associated controls did not appear to be systematically implemented at a number of sites. This poor maintenance of controls was also demonstrated in the management of filter systems fitted to mobile plant to reduce airborne diesel particulate matter. Both matters resulting in a number of work health and safety notices being issued to address these concerns.

Documenting the risk control measures within safety management plans did not always include all risk controls identified in risk assessments and where the risk controls were addressed in multiple documents, conflicting information was often provided. The components of the safety management system should be easily understood by all people who may be required to use it. This includes communicating all risk control measures and the provision of consistent information.

Adequate delivery of specific information to workers on the health effects of exposure to diesel exhaust emissions and the risk controls employed at the mine could not always be verified when workers were interviewed. Trained and competent workers are frequently identified as a risk control measure, however monitoring and reviewing the effectiveness of this control is often overlooked within safety management systems.

Monitoring programs for diesel exhaust emissions were focussed on diesel particulate matter and did not consider diesel exhaust gases, including nitrogen dioxide (NO2), carbon monoxide (CO) and carbon dioxide (CO2). This led to a failure of mine operators to determine the baseline for worker exposure to these gases.

The findings of this targeted assessment program are examined later in this report and details of compliance actions, good practices and additional references are also provided.

Mine operators are encouraged to review this report and evaluate their management of diesel exhaust emissions in their work place.

Background

The targeted assessment program (TAP) provides a planned, intelligence-driven and proactive approach to assessing how effective an operation is when it comes to controlling critical risk. The TAPs apply the following principles:

- a focus on managing prescribed 'principal hazards' from the WHS (MPS) Regulation
- evaluation of the effectiveness of control measures implemented through an organisation's safety management system
- consideration of the operation's risk profile and the targeting of operations deemed to be highest risk.

The objective of the risk profiling is to identify the inherent hazards and the hazard burdens that exist at individual operations in each mining sector in NSW. The information is then used to develop the operational assessment and inspection plans that inform the program.

Each TAP is undertaken by a team of inspectors from various disciplines, who undertake a thorough assessment of the control measures associated with the relevant hazard and their implementation.

Scope

The scope of the targeted assessment included two elements:

- a desktop assessment of:
  - compliance against legislation with respect to the management of risks to health and safety associated with worker exposure to diesel exhaust emissions at the mine
  - controls the mine utilises to prevent and mitigate the risks to health and safety associated with worker exposure to diesel exhaust emissions
  - means the mine utilises to monitor the effectiveness of those controls
- a workplace assessment of the implementation of those controls.

Process

The process for undertaking a TAP generally involves four stages.

1. Preliminary team meetings and the preparation of documents.

2. Information and assessment requirements are discussed and supplied to the relevant mine.
3. Execution of an on-site assessment involving:
    - a site desktop assessment of all relevant plans and processes
    - a discussion with the mine management team on the legislative compliance of the relevant plans
    - the inspection of relevant site operations.
4. Discussion and feedback to the mine management team on the findings and actions that need to be taken by the operators in response.

Worker exposure to diesel exhaust emissions in underground coal mines

Diesel exhaust emissions were classified as probably carcinogenic to humans in 1998. The International Agency for Research on Cancer reclassified whole diesel exhaust as a carcinogen to humans in June 2012. This change had implications for the mining industry. The Australian Institute of Occupational Hygienists recommends a worker exposure limit of 0.1mg/m3, measured as elemental carbon (EC). At this exposure level, the irritant effect of exposure is markedly reduced, and the risk of cancer may also be reduced.

The Regulator issued the Safety Bulletin SB 13-03 Diesel emissions in mines in June 2013, which provides guidance on the steps mines should take to control diesel emissions. MDG29 Guideline for the management of diesel pollutants in underground mines provides industry with guidance on how to manage worker exposure to diesel exhaust emissions.

The Work Health and Safety (Mines and Petroleum Sites) Regulation 2014, requires an underground mine operator to ensure that the concentration of diesel emissions in the air, in the areas where people work or travel, is as low as is reasonably practicable. The Regulation also requires the operator to manage risks and implement a range of control measures including:

- implementing a mechanical engineering control plan identifying measures for managing the risks to health and safety from the use of diesel engine systems and the creation of pollutants (clause 26(4))
- implementing a health control plan identifying measures for eliminating or minimising the exposure of workers to airborne and other contaminants (clause 26(3)

- implementing a principal hazard management plan for air quality or dust or other airborne contaminants (clause 24)
- implementing a ventilation control plan to provide for the management of all aspects of ventilation at the mine (clause 62)
- implementing air quality, monitoring and ventilation arrangements to ensure that the concentration of any airborne contaminant is as low as reasonably practicable (clauses 38-42, 54-64)
- managing exhaust emissions through regular sampling and analysis that is measured against baseline comparisons, using good quality fuel and lubricants, using filters and catalysts to treat emissions, training of operators, and maintenance of plant and equipment (clause 53).

In managing worker exposure to diesel exhaust emissions, operators of underground coal mines must:

- sample and analyse exhaust emissions to monitor and control pollutants from diesel engines (clause 75)
- undertake certain actions if air quality or safety standards are not met, such as withdrawing workers from a place of risk and preventing re-entry (clause 76)
- use only registered diesel engine systems in the underground mine (clause 177)
- ensure that the air, in the areas in which people work or travel has a concentration of diesel emissions (including diesel particulate matter) that is as low as is reasonably practicable (clause 55).

The targeted assessment program relating to diesel exhaust emissions in underground mines focused on how the mines prevent worker exposure to harmful diesel exhaust emissions. Key categories assessed were:

- identification, assessment and risk controls for diesel exhaust emissions hazards
- preventative controls (controlling emissions at the source)
- mitigating controls (controlling exposure to airborne emissions)
- monitoring (worker exposure)
- verification of the effectiveness of controls.

Additional information and guidance on managing risks associated with worker exposure to diesel exhaust emissions may be available from the published guidance stated at Appendix A.

Assessment findings

- General findings can be used to inform all aspects of an operation's safety management and provide valuable information and insight across all sectors and operation types.
- Specific findings should be used to inform and improve safety management systems to address this principal hazard.
- Areas of good practice observed during targeted assessments that may provide guidance for all mines.

General findings

Safety management system

Issue: The principal hazard management plans did not always describe all of the control measures that were identified in the risk assessments to manage the risks associated with diesel exhaust emissions.

Response: A principal hazard management plan must describe all control measures to be implemented to manage risks to health and safety associated with the principal hazard and set out the reasons for adopting or rejecting each control measure considered. [1]

Issue: Conflicting information was often provided within the safety management system documentation. For example, nominated ventilation quantities, required for mobile diesel equipment to operate in underground areas of the mine, were often not consistent between ventilation control plans and mechanical engineering control plans.

Response: The safety management system is a holistic system that may encompass many documented plans, standards and procedures. However, the components of the safety management system should be easily understandable by all people who use it. This includes the provision of consistent

[1] Clause 24(3) WHS (M&PS) Regulation

information. Mine operators should ensure an integrated approach between health, ventilation and engineering control plans.[2]

Worker information, training and instruction

Issue: At some mines, the adequate provision of specific information to workers on the health effects of exposure to diesel exhaust emissions and the risk controls employed at the mine could not be verified when workers were interviewed.

Response: Mine operators must ensure that workers are provided with suitable and adequate information, training and instruction in relation to hazards associated with the work being carried out by the worker and the implementation of control measures.[3] Additional refresher training should also be considered to maintain workers' knowledge on the hazards and associated risk control measures.

Monitoring and review of risk control measures

Issue: To manage mobile diesel equipment movements underground, mines used diesel tag boards or control room operator logs that rely substantially on human factors to implement the risk control. However, mines were not always able to produce evidence of audits or verifications of the implementation and effectiveness of the risk control.

Response: Mine operators must ensure that the safety management system for the mine includes performance standards for measuring the effectiveness of all aspects of the safety management system and must have a system for auditing the effectiveness of the safety management system against the performance standards.[4] Mine operators must review and, as necessary, revise control measures to maintain, so far as is reasonably practicable, a work environment that is without risks to health or safety.[5]

[2] Clause 24(2) WHS (M&PS) Regulation

[3] Clause 39 WHS Regulation and clause 104 WHS (M&PS) Regulation

[4] Clause 15 WHS (M&PS) Regulation

[5] Clause 37 WHS Regulation

Critical controls

Issue: Although some mines are implementing a critical control identification and management process, it was identified that some did not have a clearly documented plan for implementation and integration into the existing safety management system and did not have clearly defined criteria for critical control selection.

Response: The International Council on Mining & Metals (ICMM) provides guidance on the implementation of critical control management systems. This guidance advises that 'a successful CCM process will have monitoring and reporting components embedded into 'business as usual' operations, this includes integrating scheduled verification activities and reporting into current maintenance and inspection systems'.[6]

Additionally, there should be a fundamental understanding of the critical control approach at all levels of the organisation and an iterative process of review.

In relation to selection of critical controls, mines should ensure that criteria are clearly defined to ensure a credible and sustainable focus on those controls having greatest impact in managing risks. The ICMM provides a definition for critical control that may provide guidance in the selection of site critical controls.[7]

Specific findings

Monitoring for diesel exhaust emissions

Issue: Mines relied entirely on external service providers to develop, implement and manage monitoring programs for diesel exhaust emissions and were unable to demonstrate active oversight of programs or produce a formal documented agreement outlining the roles and responsibilities of each party.

Response: In managing risks to health and safety, it is recommended that mine operators develop a formal agreement with the service provider that clearly outlines roles and responsibilities of each party. The agreement should demonstrate how the air monitoring program manages the risks through

[6] Critical Control Management Implementation Guide, International Council on Mining & Metals, 2015, p50
[7] Critical Control Management Implementation Guide, International Council on Mining & Metals, 2015, p53

a site risk-based program that considers all work areas and tasks undertaken at the mine and includes all workers who are subject to the hazard.[8]

It is recommended that mine operators provide training to key site personnel in basic occupational hygiene to enable closer oversight of air monitoring programs administered by external service providers.

Issue: Monitoring programs for diesel exhaust emissions were focussed on monitoring for diesel particulate matter (DPM) and did not consider diesel exhaust gases including nitrogen dioxide (NO_2), carbon monoxide (CO) and carbon dioxide (CO_2).

Response: In undertaking air monitoring for diesel exhaust emissions, mine operators should determine a baseline for worker exposure to NO_2, CO and CO_2 and ensure that these gases are included in air monitoring programs.

It is recommended that monthly ventilation surveys and gas monitoring by mining supervisors with hand-held gas monitors include measuring for CO, CO_2 and NO_2 in areas where diesel equipment operates.

Air monitoring programs should determine the cumulative effect of worker exposure to NO_2, CO, and CO_2 and should be adjusted based on shift length, including extended shifts.

Issue: Test gases for the span testing of hand-held gas detectors were observed to have expired use-by dates and mines did not have a system to ensure equipment was fit for use.

Response: The effectiveness of equipment required to ensure a safe work place should not be compromised and mine operators must ensure that portable gas detectors remain fit for use. The safety management system must include performance standards for measuring the effectiveness of all aspects of the safety management.[9]

[8] Clause 9 WHS (M&PS) Regulation

[9] Clause 15, WHS (M&PS) Regulation, Clause 74 WHS (M&PS) Regulation

Ventilation control to manage diesel exhaust emissions

Issue: Some mines managed the operation of diesel equipment based on total ventilation quantity available in the panel, rather than ventilation quantity measured at the specific location where the diesel equipment was operating. A specific example included one mine using ventilation quantity measured in the return airway of a multi-intake panel to manage diesel equipment access to the panel.

Response: Mine operators must ensure that diesel equipment is only operated in areas with sufficient ventilation quantity as prescribed in clause 71(3) of the WHS (M&PS) Regulation. Mine operators should review SB17-07 Minimum air quantities for diesel engines in underground coal mines for further guidance.

Issue: Most mines did not include underground diesel workshops and refuelling areas in regular ventilation measurements undertaken by mining supervisors to ensure that ventilation quantity was sufficient for the operation of mobile diesel equipment in these areas.

Response: Mine operators should ensure that ventilation quantity in underground diesel workshops and refuelling areas is measured regularly to ensure there is sufficient ventilation quantity available to maintain levels of contamination as low as reasonably practicable.[10]

Issue: Some mines conducted weekly general body testing for diesel exhaust emissions in areas of high ventilation quantity not representative of areas where the diesel equipment normally operates. Additionally, pass or fail criteria was not adjusted accordingly.

Response:

Mine operators should consider undertaking general body gas testing with a ventilation quantity consistent with the lowest ventilation quantity at areas where the machine may operate to provide assurance that diesel exhaust emissions are being managed to a level as low as reasonably practicable when operating in those areas[11].

Mine operators should also ensure that persons conducting general body gas testing are not exposed to diesel exhaust emissions. Further guidance in relation to undertaking general body gas testing is available in published guidance, MDG29 Guideline for the management of diesel engine pollutants in underground environments.

[10] Clause 55, WHS (M&PS) Regulation
[11] Section 5.5.1.1, MDG29 Guideline for the management of diesel engine pollutants in underground environments

Issue: It was observed that some mines failed to foresee and manage risks associated with uncontrolled air recirculation. It was noted that some ventilation control plans and auxiliary fan documentation did not include information in relation to identifying and rectifying air recirculation and interviews with mining officials identified an absence of periodic refresher training in relation to ventilation management post their initial competency assessment.

Response: Mine operators must ensure that ventilation circuits at the mine do not allow uncontrolled recirculation of air and that any auxiliary fan or scrubber fan used at the mine is located and operated in such a manner as to prevent uncontrolled recirculation of air through the fan.[12]

When ensuring the control measures are maintained, mine operators should consider the training and instruction provided to the workforce in relation to the identification and rectification of uncontrolled recirculation.[13]

Diesel particulate filters

Issue: The effectiveness of diesel particulate filters (DPF) on mobile diesel equipment was often compromised by the use of incompatible filters or unmanaged modifications to filter housings. This resulted in poor sealing allowing exhaust gases to bypass the particulate filters.

Response: Control measures designed to eliminate or minimise risks to health and safety must be maintained to remain effective.[14] This includes managing any modifications or component changes.

For guidance on this issue mine operators should review SB 18-03 Diesel particulate filter seals critical for effective control of diesel particulate matter.

Areas of good practice

Inspectors identified areas of good practice during the targeted assessments including:

- One mine has established a permanent underground diesel test station with the testing process managed by programmable logic controller (PLC). A unique vehicle identifier is entered into the test station screen enabling the PLC to set the regulator to the air quantity required for testing, based on item registration. The screen provides prompts to the operator

[12] Clause 59 WHS (M&PS) Regulation
[13] Clause 39 WHS Regulation and clause 104 WHS (M&PS) Regulation
[14] Clause 37 WHS Regulation

in relation to engine rpm while gas analysers record emissions. The PLC compares this to statutory limits to provide a pass/fail result for the vehicle, displayed to the operator to enable real-time decision making, and disseminated to the diesel fleet coordinator for ongoing management.

- In managing diesel equipment underground, one mine has developed and implemented an electronic tag system to enable live tracking of vehicles. The process involves fitting vehicles with identifying electronic tags that are detected by sensors placed throughout the mine as the vehicle passes, providing real-time notification to the control room of the general location of the vehicle. At the time of assessment, several mines were in the process of developing or trialling the use of an electronic tag system to manage diesel equipment access to panels.
- One mine had engaged a group occupational hygienist to provide technical expertise for the development and oversight of the mine air monitoring program undertaken by a third-party contractor.

Compliance

Targeted assessments provide an account of the issues observed at sites at a point in time. Some of the findings resulted in notices being issued, including notices of concern under section 23 of the WHS (MPS) Act, improvement notices under section 191 of the WHS Act and prohibition notices under section 195 of the WHS Act.

The matters addressed by the notices reflect the findings of the inspectors. The findings are summarised in the table below.

Notice	In relation to
Prohibition notices, s 195	■ Operation of diesel equipment in areas with insufficient ventilation quantity, as prescribed in clause 71(3) of WHS (M&PS) Regulation. ■ Operation of diesel equipment with missing DPF seals, potentially compromising the integrity of the OEM control measure to reduce particulate matter being liberated into the mine atmosphere.
Improvement notices,	■ Diesel particulate matter (DPM) identified as a risk to workers in safety management system documents; however, no DPM monitoring program was implemented at the mine.

s 191	■ No baseline exposure established for diesel exhaust emissions, including DPM and diesel exhaust gases. ■ Inaccurate ventilation measurements by mining officials and stated lack of refresher training for mining officials in site ventilation management. ■ DPF housing and sealing issues, including unapproved modifications without appropriate management of change and incorrect and/or modified DPF fitted inconsistent with machine registration and OEM approval drawings. ■ Poor condition of underground travel roads.
Notices of concern, s 23	■ Used diesel particulate filters disposed of unbagged in site waste. ■ Underground diesel workshop not included in regular ventilation measurements taken by mining supervisors. ■ Failure to demonstrate integration of DEE risk assessments into mine safety management system documentation including failure to consider DEE in the Air Quality, Dust and other Airborne Contaminants Principal Hazard Management Plan.

Where to now

The targeted assessment program has identified many common issues around the approach taken by the sites to manage the hazard of worker exposure to diesel exhaust emissions. It also highlighted broader issues that are common across mine sites associated with the process of developing, implementing and reviewing risk assessments, management plans and procedures.

The Regulator expects that all underground mines will review their procedures and practices in consideration of the findings of this report.

The requirement for principal hazard management plans to comply with legislative requirements and reduce risk to as low as reasonably practicable apply at all types of mining operations.

Issued by

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Further information

Please contact the NSW Resources Regulator for more information on targeted assessment programs, the findings outlined in this report or other mine safety information.

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Appendix A Legislative requirements and guidance

This appendix provides a list of legislative requirements and published guidance referred to in the findings of this report as identified in the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 and Work Health and Safety Regulation 2017.

Legislation, section/clause	Legislative requirements
WHS (M&PS) Regulation, clause 9	Management of risks to health and safety
WHS (M&PS) Regulation, clause 10	Review of control measures
WHS (M&PS) Regulation, clause 13	Duty to establish and implement safety management system
WHS (M&PS) Regulation, clause 15	Performance standards and audit
WHS (M&PS) Regulation, clause 54	Air quality—airborne contaminants
WHS (M&PS) Regulation, clause 55	Air quality—minimum standards for ventilated air
WHS (M&PS) Regulation, Clause 59	Ventilation system—further requirements
WHS (M&PS) Regulation,	Duty to provide information, training and instruction

clause 104	
WHS Regulation, clause 38	Review of control measures
WHS Regulation, clause 39	Provision of information, training and instruction

The following published guidance material may assist mine operators to manage risks associated with worker exposure to diesel exhaust emissions;

NSW Code of practice: Mechanical engineering control plan (NSW Resources Regulator)

MDG29 Guideline for the management of diesel engine pollutants in underground environments (NSW Resources Regulator)

SB 13-03 Diesel emissions in mines (NSW Resources Regulator)

SB17-07 Minimum air quantities for diesel engines in underground coal mines (NSW Resources Regulator)

SB 18-03 Diesel particulate filter seals critical for effective control of diesel particulate matter (NSW Resources Regulator)

Critical control management (International Council on Mining and Metals (ICMM))