MINING INDUSTRY
OCCUPATIONAL
SAFETY & HEALTH

MINERALS COUNCIL
SOUTH AFRICA

THE IMPACT OF DIESEL PARTICULATE FILTERS ON NOISE REDUCTION

DIESEL PARTICULATE FILTERS
CASE STUDY

"Eland Platinum Mine uses a hybrid mining method, which means that the stoping is done by conventional means such as the use of hand-held machines to drill the face."

FULL DESCRIPTION OF THE RISK ADDRESSED

Eland Platinum Mine uses a hybrid mining method, which means that the stoping is done by conventional means such as the use of hand-held machines to drill the face. The ore from the face is then removed by means of scrapers and winches, down the centre gully directly onto the strike conveyors, which eventually end up on the conveyor decline. On the other hand, the development mining method is fully mechanised. Ore is drilled by handheld drilling machines or drill rigs, and then loaded by the LHDs and tipped at the tail end of the conveyor. The ore is then scraped from the tail end of the conveyor onto a vibrating feeder, feeding the conveyor belt.

The following noise sources are identified within the mine's operational process:

- TMMs (UVs, LHDs, drill rigs, bobcats)
- Rock drills
- Electrical motors driving equipment such as industrial fans, pumps, generators and conveyor belts
- Industrial fans which include axial and centrifugal motors
- Compressed air operated pumps resulting in high velocity gas flow noise
- Engineering services (grinding, hammering and drilling)
- Machinery noise as a result of mechanical impact or resonance (e.g. winch during scrapping)

OVERVIEW

Mining company

Northam Platinum

Commodity

Platinum

Operation/Mine

Eland Platinum Mine

Health and safety case study

The impact of diesel particulate filters on noise reduction

Number of employees affected

±3000 employees

Stakeholders consulted

Safety, Health, Environment Risk and Quality (SHERQ), Engineering, Procurement, Health and Safety Committees

Occupations affected/benefited

LHD and UV operators including all underground employees interacting with the TMM

Noise risk management is crucial to protect the health and safety of employees and also ensure we comply with regulatory requirements. The following key steps and strategies have been taken by our operation with the aim of mitigating noise exposures:

- Identifying and quantifying all noise sources, which is conducted in line with the requirements of section 11 of the Mine Health and Safety Act (MHSA)
- Furthermore, to ensure compliance with the requirements of sections 11(2) and 11(3) of the MHSA, Eland Platinum Mine has as far as reasonably practicable, taken the following steps:
  - Eliminate the risk
  - Control the risk at the source
  - Minimise the risk
  - Insofar as the risk remains, provide personal protective equipment (PPE) and institute a hearing conservation programme

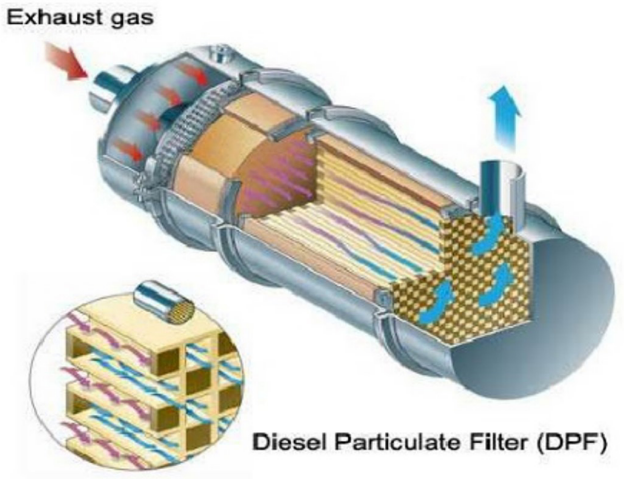
Anglo American Platinum – Modikwa

FINDINGS AND LESSONS LEARNED FROM THE IMPLEMENTATION AND INCORPORATION OF THE GUIDANCE NOTE

Due to the emission levels from diesel exhaust machines, the mine embarked on a project of installing retrofit diesel particulate filters on all utility vehicles (UVs) and load haul dumpers (LHDs). Diesel particulate filters (DPFs) are exhaust aftertreatment devices that significantly reduce emissions from diesel fuelled vehicles and equipment. DPFs typically use a porous ceramic or cordierite substrate or metallic filter, to physically trap particulate matter (PM) and remove it from the exhaust stream.

Description of DPF used: A SMF CRT 8.0m2 filter with 3" ceramic DOC Deutz DPF, Radial-axial

Retrofit DPF installed on LHDs and UVs



While the primary function of DPFs was to reduce harmful DPM emissions, it seemed to also yield a positive impact on the overall noise levels of the machines as an unintended consequence.

Subsequent to this observation the Hygiene Department, with assistance from the Engineering Department, conducted an investigation with the purpose of assessing the efficacy of the retrofit DPF in reducing noise emissions on LHDs and UVs. The outcome of the exercise manifested favorable results for most of the equipment that was part of the investigation. As noted, trackless mobile machines (TMMs) are one of the main sources of noise underground.

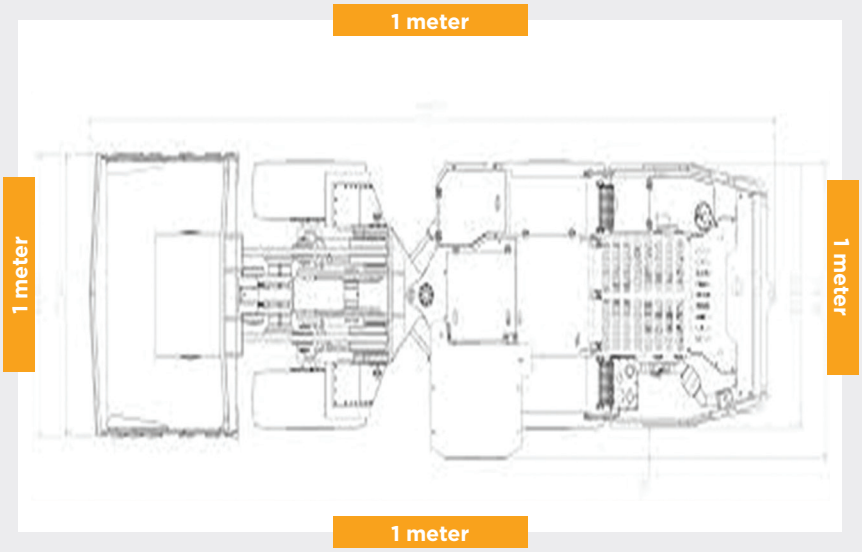
Two sets of noise measurements were taken, which include before and after DPF installation. The measurements were taken in a controlled environment to eliminate any external confounders. The noise measurements were conducted according to the method stipulated in SANS 10083:2021 and the Minerals Council Guidance Note for Noise Measurement of Equipment. The measured equipment was all the same make and model.

Kumba Iron Ore – Sishen

For the LHD it was a 5.5LP while for the UVs it was a UV42, with the same engine type (Four Stroke Air Cooled Deuts BF6L914, with a power output of 84kW at 2300 r/min).

Four measurements were taken, one measurement 1m away on each side of a single piece of equipment as depicted in the diagram.

A log average was applied to obtain the overall noise level emitted by the respective equipment. Noise measurement results are depicted in the table below:



Load haul dumper (LHD)

Summary of DPF impact on **PEAK** noise measurements					
Equipment type	**Model**	**REVV count**	**dB(A) pre-installation of DFF**	**dB(A) post installation of DPF**	**Total dB(A) reduction**
UV	AARD UV42	2500rpm	106.0dB(A)	101.1dB(A)	**4.9**dB(A)
UV	AARD UV42	2500rpm	108.1dB(A)	103.9dB(A)	**4.2**dB(A)
LHD	AARD 5.5 LP	2300rpm	109.8dB(A)	103.0dB(A)	**6.8**dB(A)
LHD	AARD 5.5 LP	2300rpm	106.9dB(A)	102.2dB(A)	**4.7**dB(A)

Summary of DPF impact on **LAeq** noise measurements					
Equipment type	**Model**	**REVV count**	**dB(A) pre-installation of DFF**	**dB(A) post installation of DPF**	**Total dB(A) reduction**
UV	AARD UV42	2500rpm	97.8dB(A)	94.2dB(A)	**3.6**dB(A)
UV	AARD UV42	2500rpm	96.9dB(A)	93.6dB(A)	**3.1**dB(A)
LHD	AARD 5.5 LP	2300rpm	97.6dB(A)	94.9dB(A)	**2.7**dB(A)
LHD	AARD 5.5 LP	2300rpm	96.7dB(A)	93.5dB(A)	**3.2**dB(A)

Due to the nature of the underground mining environment with various noise sources operating simultaneously, personal noise levels after DPF installation still ranged above 85dBA even though there was a reduction following the DPF installation in some of the activity areas. All operators are however issued with custom molded HPD which attenuates the noise levels by 25 decibels.

Hamony – Bambanani

BENEFITS AND IMPROVEMENTS REPORTED BY AFFECTED STAKEHOLDERS

Based on the results obtained it is evident that the installation of DPFs had a beneficial impact on noise reduction at Eland Mine. TMMs with an initial noise level of ≥105dB(A) showed a significant noise reduction of ≥10dBA, while TMMs with an initial reading of ≤105dBA showed a noise reduction of approximately 3dBA.

Considering the prevalence of noise induced hearing loss (NIHL) in the mining industry, the implementation of DPF has played a crucial role in the efforts to conserve hearing within the Eland operation and also ensure that they are on track with achieving the milestone target of 107dBA.

The Eland operation Occupational Hygiene Department also interviewed the TMM workshop employees and the operators:

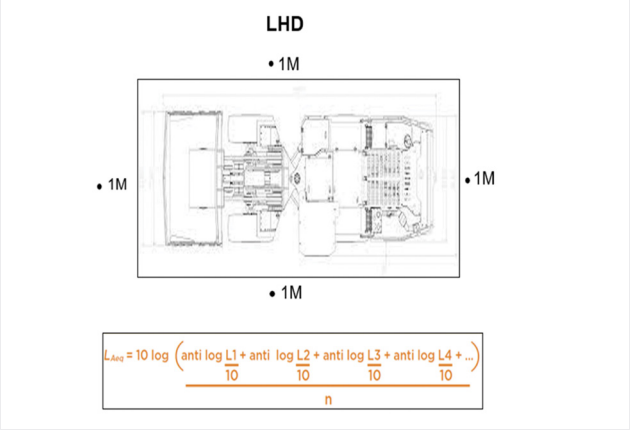
- The general employees welcomed the initiative due to the impact it has on both noise and DPM emissions.
- The Engineering Department mentioned that there is a significant difference in the noise reduction during their routine maintenance, especially when testing the machines during high revs
- The operators mentioned it is difficult to notice the noise reduction since they are constantly wearing hearing protection devices

It is important to note that the effectiveness of DPF in noise reduction deteriorates over time if not maintained regularly, and in some equipment, the noise was recorded at higher decibels than the initial noise measurement. Eland mine has embarked on various initiatives to ensure that we maintain the maximum effectiveness following the instillation of the DPM filters. A proactive approach has been taken, which includes the following:

1. **Continuous noise monitoring programme:** The Occupational Hygiene Department takes noise measurements on a regular basis to ensure deterioration in effectiveness is flagged to the Engineering Department.
2. **TMM maintenance schedule:** The Engineering Department has reduced the planned maintenance to every second week, instead of the recommended 1,000hrs by the OEM. The maintenance plan includes cleaning of DPFs to remove any residue inside the filter. Cleaning is done by spraying high-pressure water inside the filters. This also prolongs the DPF lifespan.

The Occupational Hygiene Department received enormous support from the Procurement Committee (comprised of HODs from Engineering, SHERQ, HR and Engineering), which also played a vital role in the outcome of the project, by providing financial and human resources. Other stakeholders that took part in the project include the Engineering TMM team, the OEM who was mainly responsible for the fitment of the DPF, and the MOSH Noise Team who ensured that measurements were taken correctly.

PHOTOGRAPHS



GLOSSARY

- **MOSH** Mining Industry Occupational Safety and Health
- **NIHL** Noise Induced Hearing Loss
- **dB(A)** A-weighted decibel
- **LHD** Load haul dumper
- **UV** Utility vehicle
- **TMM** Trackless mobile machinery
- **SANS** South African National Standard
- **HPD** Hearing protection device
- **DPM** Diesel particulate matter
- **DPF** Diesel particulate filter
- **MHSA** Mine Health and Safety Act
- **OEM** Original equipment manufacturer
- **HEG** Homogenous Exposure Group
- **HOD** Head of Department
- **SHERQ** Safety, Health, Environment, Risk and Quality
- **PPE** Personal protective equipment

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