MINING INDUSTRY
OCCUPATIONAL
SAFETY & HEALTH

MINERALS COUNCIL
SOUTH AFRICA

CASE STUDY:

ALTERNATIVE POWER SOURCES

IN NOISE RISK MANAGEMENT

Gold Fields – South Deep

FULL DESCRIPTION OF THE RISK ADDRESSED

Assmang Limited, jointly owned by African Rainbow Minerals (ARM) and Assore, operates as a key player in South Africa's mining sector with a strong presence across manganese and iron ore divisions. The company's strategic operations are geographically spread, supported by extensive rail linkages that connect production sites to national and international markets.

The Black Rock Mining Operations (BRMO), situated in the Northern Cape, Hotazel, forms the cornerstone of the manganese division. It employs over 2,400 permanent staff and 1,200 contractors, operating three underground shafts Nchwaning 2, Nchwaning 3, and Gloria. With an estimated ore reserve of 226 million tonnes for the Nchwaning and Gloria mines, the operation has a projected life of 42 years. The mine is fully mechanized, utilizing the bord and pillar method to ensure efficient and sustainable extraction, and as such due to the nature of the mining operations, Occupational Noise is a significant risk as a result of Trackless Mobile Machinery (TMM) activities.

Through its digital strategy that is centred on leveraging digital integration and advanced systems to drive performance excellence and achieve its long-term vision, the mine adopted the use of intelligent machines. Battery Electric Vehicles (BEVs) were designed to enhance sustainability, efficiency, and worker well-being. The initiative focused originally on decarbonization, ventilation cost reduction and reduction of the Diesel Particulate Matter (DPM) emissions. A positive unintended outcome was the significant reduced noise exposure, which was documented subsequently.

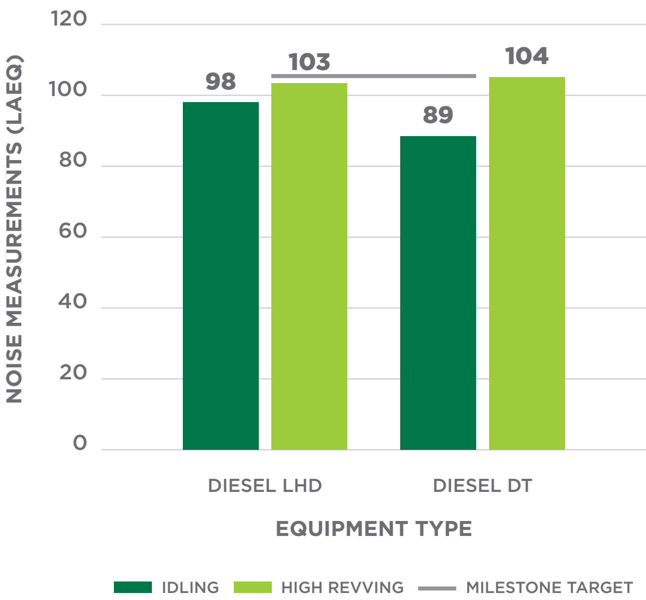
OVERVIEW

- **Mining Company** – Assmang Limited
- **Commodity** – Manganese Ore
- **Operation/Mine** – Black Rock Mining Operations
- **Health and Safety Success Story** – The application of alternative power sources in Noise Risk Management
- **Number of Employees affected by H&S Success Story** – 859 Employees
- **Stakeholders Consulted** – SHERQ, Engineering, Procurement, Health, and Safety Committee
- **Occupations Affected/Benefited** – LHD & UV Operators, including all underground employees interacting with the TMM

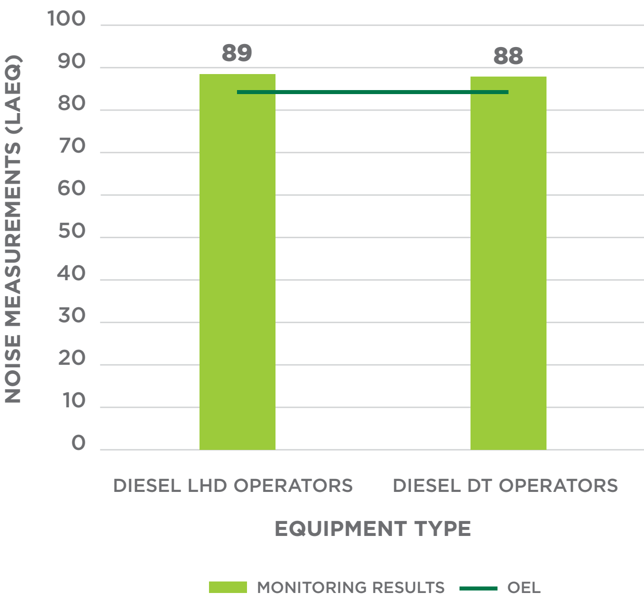
FINDINGS AND LESSONS LEARNED FROM THE IMPLEMENTATION AND INCORPORATION OF THE GUIDANCE NOTE

The original noise risk profile for BRMO's diesel equipment highlights significant occupational noise exposure risks. The noise emission profile shows that diesel Load Haul and Dumper (LHD) equipment records levels of 98 dBA when idling, and up to 103 dB(A) during high revving operations. Diesel Dump Trucks (DT) reach 89 dB(A) at idling, and 104 dB(A) during high revving. The personal monitoring results confirm that operator exposures remain high, with diesel LHD and DT operators averaging 89 dB(A) and 88 dB(A) respectively, exceeding the occupational exposure limit (OEL) of 85 dBA. Refer to graphs below for more information.

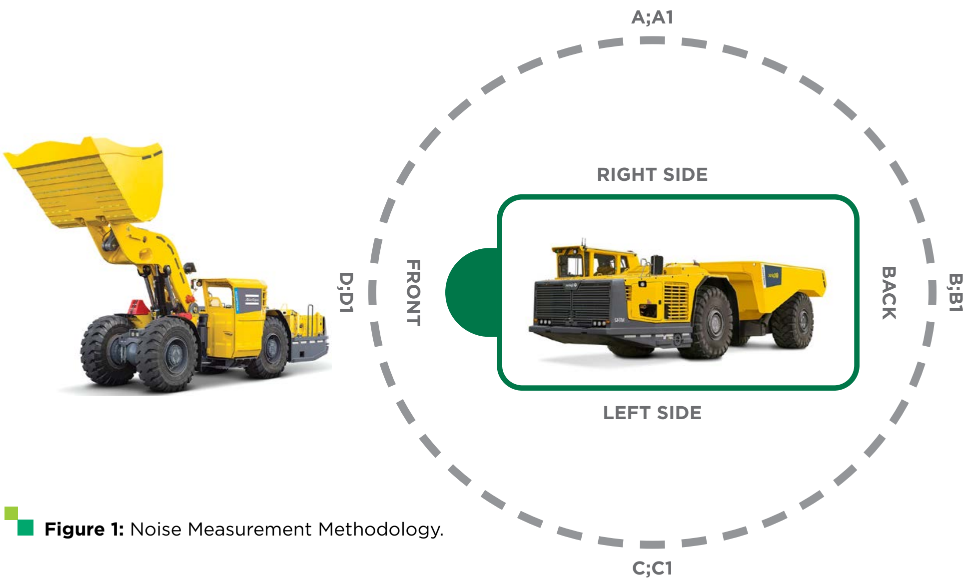
DIESEL EQUIPMENT NOISE EMISSION PROFILE



PERSONAL MONITORING RESULTS PROFILE



The introduction of the BEVs at the mine resulted in significant noise reduction, representing the mine's commitment to enhancing a safe working environment. To quantify the effect of the BEVs on noise reduction, the MOSH Noise Team in collaboration with the mine's Occupational Hygiene and Engineering departments visited an underground section where this equipment operates to quantify the new profiles. The measurements were conducted in line with the Noise Measurements Guidance Note, please refer to the image below for the measurement methodology applied during the verification visit.

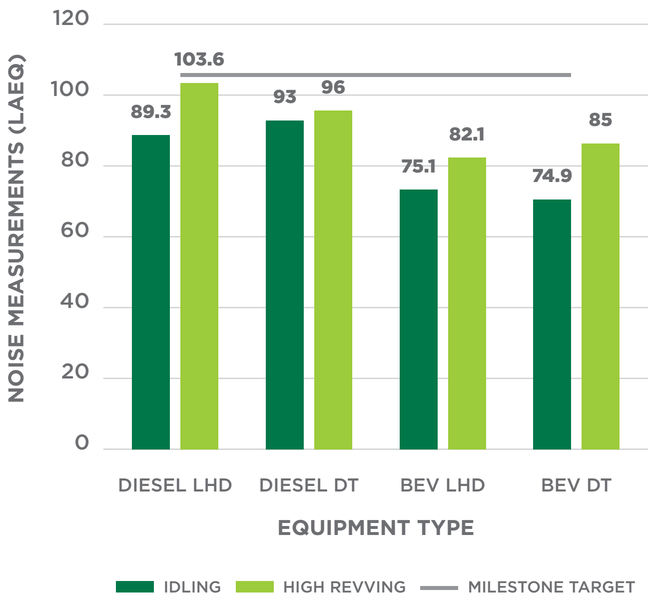


Noise measurements were conducted in accordance with the Noise ***Measurements Guidance Note***. In this context, the letters A-D refer to idling conditions, while A1-D1 correspond to full-load conditions. Safety requirements were duly considered, particularly with respect to maintaining appropriate safe distances.

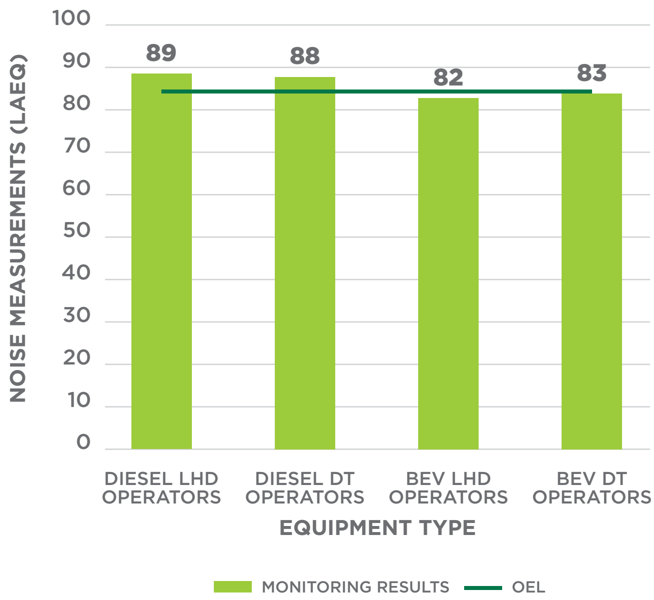
Figure 1: Noise Measurement Methodology.

The results from the verification visit demonstrated a significant improvement compared to diesel-powered equipment. The noise emission profile shows that the BEV LHDs and DTs produced noise measurements of 76.1 dB (A) (LHD) and 74.9 dB (A) (DT), well below the 2024 milestone target of 104 dB (A). Similarly, the personal monitoring results reflect a reduction in operator exposure, with BEV LHD and DT operators registering average exposures of 82 dBA and 83 dBA compared to 89 dBA for their diesel counterparts. The slightly higher personal noise measurements can be attributed to the fact that operators are multiskilled and may operate both battery-electric and diesel-powered equipment within a single shift. Despite this influence, the results demonstrate that the introduction of BEVs has yielded a significant positive impact through noise reduction. This improvement contributes meaningfully toward achieving the industry Noise Milestones and enhancing overall employee health and well-being. Please refer to the graphs below for further details.

DIESEL EQUIPMENT NOISE EMISSION PROFILE



PERSONAL MONITORING RESULTS PROFILE



The quantification of noise reduction following the introduction of Battery Electric Vehicles (BEVs) demonstrates a significant improvement compared to diesel-powered equipment. The noise emission profile shows that diesel LHDs and drill trucks produced peak levels of 103.6 dB(A) and 96 dB(A) respectively, while BEV equivalents recorded substantially lower levels at 76.1 dB(A) (LHD) and 74.9 dB(A) (DT), well below the milestone target of 104 dBA and OEL of 85 dBA. Similarly, the personal monitoring results reflect a reduction in operator exposure, with BEV LHD and DT operators registering average exposures of 82 dB(A) and 83 dB(A) compared to 89 dBA for their diesel counterparts. These results confirm that BEV deployment not only reduces noise emissions at the source but also lowers personal noise exposure, thereby contributing meaningfully towards achieving industry NIHL milestones and improving the overall occupational health and safety environment.

Implats - Impala Rustenburg operations

BENEFITS AND IMPROVEMENTS REPORTED BY AFFECTED STAKEHOLDERS

The implementation of BEVs at BRMO has delivered a wide range of benefits that extend beyond the mine's initial strategy. There has been a significant reduction in noise exposure, lowering the risk of occupational noise-induced hearing loss and improving the overall health and comfort of operators. Throughout this process, employees have reported safer working places, and enhanced communication due to reduced noise levels, improved productivity, with fewer breakdowns and sustainable mining operations. The mine management is pleased to see the operation and key stakeholders adopting innovative technologies that align with health and safety, environmental, and productivity goals, while bringing them closer to achieving the milestone and regulatory targets.

The adoption of alternative power sources, such as BEVs, represents a transformative step in advancing noise risk management within the mining industry. Traditional diesel-powered equipment has long been associated with excessive noise emissions, exposing operators to levels that frequently exceed occupational exposure limits and heightening the risk of Noise-Induced Hearing Loss (NIHL). By contrast, BEVs and other alternative energy technologies drastically reduce noise at the source, directly lowering personal exposures and aligning operational practices with industry and international best practices.

The ventilation demands for this case mine was unique because of the DPM focus. It is however important to note that battery-operated equipment, particularly Battery Electric Vehicles (BEVs), introduce unique fire risks in mining due to thermal runaway, which can produce flammable gases and sustain fires if not managed correctly, necessitating special mine ventilation and fire suppression systems. The ventilation planning must account for the hazardous gases vented during a battery fire and ensure sufficient air to dilute and remove them, while suppression systems should be specifically designed for battery fires. For Assmang Limited, the cost comparison between the infrastructure and ventilation layout required to dilute and manage the DPM fumes, versus the infrastructure required to manage the potential fire risk, showed that the former was more significant. Consequently, it made business sense to invest in the BEV's.

Beyond noise control, the integration of alternative power contributes to a holistic improvement in the occupational environment, minimizing diesel particulate matter, reducing ventilation demands, lowering operational costs, and enhancing overall productivity. This multifaceted impact underscores that alternative power solutions are not only an environmental or efficiency initiative but also a critical component of sustainable occupational health strategies. In this way, alternative power sources establish themselves as a cornerstone for modern mines seeking to balance productivity with employee health, regulatory compliance, and long-term sustainability.

Figure 2: Battery Electric Vehicles (LHD and UV)

Figure 3: Battery Electric Vehicles (LHD and UV) loading of Ore

Figure 4: Employee lining up Battery Electric Vehicles for charging

GLOSSARY LIST

BEVs	Battery Electric Vehicles
MOSH	Mining Industry Occupational Safety and Health
NIHL	Noise Induced Hearing Loss
OEL	Occupational Exposure Level
dB(A)	A-weighted decibel
LHD	Load Haul Dumper
DT	Dump Truck
TMM	Trackless Moving Machinery
DPM	Diesel Particulate Matter
HOD	Head of Department
SHERQ	Safety Health Environment Quality

MCMining – Vele