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An Analysis of the Various Factors that Affect the Control of Occupational Noise in Underground Coal Mines

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Abstract
The uncontrolled noise generated by mining operations can have detrimental effects on the environment. It can lead to the pollution of air and water, affecting the health and well-being of those around them. Occupational noise is a pervasive hazard in underground coal mining, posing serious health risks to miners, particularly hearing loss and other physiological stress effects. This paper investigates the sources of noise in underground coal mining operations, evaluates the impacts on workers, and reviews existing and emerging noise control measures. Through a combination of literature review, field study data, and analysis of engineering and administrative controls, the paper proposes a multifaceted strategy to mitigate noise exposure. The findings support the implementation of noise monitoring, advanced machine maintenance, acoustic treatments.

Keywords: Occupational Noise, Sound.

1. Introduction

Occupational noise in underground coal mining is recognized as one of the most significant health and safety challenges in the industry. The confined nature of underground environments amplifies the effects of noise, making it more harmful and difficult to control. Mining operations often involve high-decibel equipment such as continuous miners, roof bolters, shuttle cars, load haul dumper, and ventilation systems. Prolonged exposure to these noise levels can result in Noise-Induced Hearing Loss (NIHL), psychological stress, reduced work efficiency, and increased accident risk.
The aim of this research is to explore the sources, impacts, and control strategies for occupational noise in underground coal mines, with an emphasis on feasible and sustainable interventions.

2. Sources of Occupational Noise in Underground Coal Mining

Key sources include:

- **Continuous Miners**: Generate noise levels ranging from 90–110 dB(A).
- **Roof Bolters**: Mechanical drilling creates impulsive noise exceeding 100 dB(A).
- **Shuttle Cars and Conveyor Belts**: Operate at levels between 85–95 dB(A).
- **Ventilation Fans and Air Compressors**: Create continuous background noise.
- **Explosives and Blasting Activities**: Cause transient but extreme noise spikes.

Each of these contributes cumulatively to the daily noise dose experienced by workers, often surpassing the permissible exposure limits set by regulatory bodies like the Mine Safety and Health Administration (MSHA) and the Occupational Safety and Health Administration (OSHA).

Typical Noise Levels in Mining Activities

STATION	Sound Pressure Level (dBA)
Compressor house (between two compressors)	89-90
Main belt conveyor (beside the engine)	83-84
Monorail house	93-94
Central water drainage pumping station	78-79
Double ended ranging drum shearer	94-95
Transfer point of face armoured conveyor	91-92
Transfer point of belt conveyor	78-79
Noise measurements from open pits	
85 tonnes truck (dumping in progress)	99-100
85 tonnes truck (full speed, window closed)	83-84
Dozing operation (inside cab)	95-96
Pneumatic drilling machine (window closed)	91-92
Marion dragline (inside cab, window closed)	72-73
Marion dragline (5 m away)	81-82
10 yd^3 excavator (inside cab, window closed)	73-74
10 yd^3 excavator (inside cab, window open)	83-84
Noise measurements from coal preparation plants	
Rotary breaker	91-92
Belt conveyor for run-off mine coal	83-84
+18-50 mm sorting screens for coal	94-95
+18-50 mm sorting screens for tailing	97-98
+18-50 mm screens for run-off mine coal	95-96
-18 mm jigging system	92-93
Sheltered dumping station	92-93
Controlling panel room	73-74
Roberts & Schaffer heavy media cyclone system	90-91
Hand sorting conveyor	85-86
Noise measurements from manufacturing workshop	
Circular saw (1 m away)	97-98
Line saw (1 m away)	98-99
Planing machine (1 m away)	98-99
Guillotine machine (1 m away)	96-97
Pipe-cutting machine (1 m away)	97-98
Battering-ram (1 m away)	96-97
Grinding machine (1 m away)	87-88
Noise measurements from maintenance workshop	
Engine test hall (by the engine)	102-103
Engine test personal cab	77-78
Noise measurements from timber yard	
Small line saw (sawing in progress)	90-91
Big line saw (sawing in progress)	77-78

3. Noise Measurement by Instruments

Developments and latest research in the field of electronics, digital technology and computer science have led to the availability of very reliable and user-friendly instruments for noise survey in mining industry. Following instruments will be used to conduct field study to collect data from selected mines. Instruments available in mines will be used for this purpose.

- Sound Level Meter
- Noise Dose Meter
- Dose Bades
- Sound Level Calibrator

4. Health Effects of Noise Exposure

- **Hearing Loss**: NIHL is the most prevalent occupational disease in mining.
- **Stress and Fatigue**: High noise levels correlate with increased stress hormones and decreased cognitive performance.
- **Cardiovascular Issues**: Chronic noise exposure is associated with elevated blood pressure and heart disease risk.
- **Communication Interference**: Hinders effective communication and increases accident likelihood.

According to MSHA data, over 70% of miners are exposed to noise levels exceeding 85 dB(A), the action level for hearing conservation programs.

The time frame of exposure, noise intensity, age of the employees, and physical condition of the workers (presence of other illnesses, etc.) are the characteristics that are effective for hearing loss caused by noise. Most noise-related effects have no known treatment. However, the only way to prevent health harm is to prevent exposure to excessive noise

5. Noise Control Methods

5.1 Engineering Controls

- **Machine Design Improvements**: Low-noise cutting heads, dampers, and isolation mounts.
- **Acoustic Enclosures and Barriers**: Shielding high-noise equipment.
- **Damping Treatments**: Use of vibration-absorbing materials.
- **Mufflers and Silencers**: Applied to diesel engines and ventilation systems.

5.2 Administrative Controls

- **Shift Rotations**: Limit time spent near high-noise equipment.
- **Training and Awareness Programs**: Educate workers on noise risks and PPE usage.
- **Scheduling of Noisy Tasks**: Conduct during periods of minimal occupancy.

5.3 Personal Protective Equipment (PPE)

- **Earplugs and Earmuffs**: Standard PPE with varying noise reduction ratings (NRRs).
- **Smart Hearing Protection**: Devices that allow communication while reducing harmful frequencies.

5.4 Monitoring and Evaluation

- **Noise Dosimetry**: Personal monitors track daily exposure.
- **Sound Level Meters**: Spot measurements for compliance checking.
- **Hearing Conservation Programs**: Regular audiometric testing and follow-up.

6. Discussion

Despite the availability of effective noise control strategies, adoption in underground coal mining remains inconsistent due to economic, operational, and logistical barriers. Engineering controls, while effective, often require upfront investment that deters companies operating on thin margins. Administrative measures and PPE are more widely adopted but are less effective when used in isolation.

An integrated approach is necessary, involving:

- Strong regulatory enforcement
- Incentives for adopting quieter technology
- Worker participation in hearing conservation programs
- Ongoing research into low-noise equipment designs

7. Conclusion

Occupational noise in underground coal mining continues to pose significant risks to worker health and safety. Effective control requires a combination of engineering solutions, administrative strategies, personal protection, and continuous monitoring. With technological advancements and regulatory support, it is possible to create quieter and safer mining environments, protecting miners from the irreversible damage of noise-induced hearing loss and associated health risks.

8. References

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