Compendium of Research Project Summaries on Physical Hazards - 1998 to 2014

MHSC

Mine Health and Safety Council

CONTENTS

FOREWORD

The Mine Health and Safety Council (MHSC) is a public entity that is mandated, in terms of the Mine Health and Safety Act (MHSA), to advise the Minister of Mineral Resources on research programmes, regulations, standards, policies, procedures focused on minimising the occu-pational health and safety (OHS) risk at mines. The Council is also tasked with promoting a culture of health and safety in the mining industry

The MHSC office executes the operational deliverables of the Council, including the provision of secretarial support to the Council and all its committees, managing occupational health and safety research programmes, finances, communications and promotions, and liaising with other statutory bodies on matters relating to occupational health and safety at mines.

MHSC provides a platform for stakeholder engagements on OHS matters. In the South African Mining Industry (SAMI) it has been established that more deaths are still reported as a result of occupational diseases. Hence the mining sector has increasingly been giving more attention to health matters which was also as a result of the promulgation and implementation of the Mine Health and Safety Act as amended.

The role of the MHSC in the SAMI is to oversee research. One such research area is termed as the Research Thrust area 7: Physical Hazards.

Research Thrust area 7 focuses on identifying research that will improve the health of mine workers through the identification of implementable controls for the prevention of injuries and or diseases caused by exposure to physical agents. These includeexcessive noise, vibration, temperature extremes (hot / cold environments), illumination (poor/excessive lighting), ionizing or non-ionizing radiation and ergonomics (awkward posture/heavy lifting etc).

As the MHSC, we are committed to promote OHS in the Mining Industry, including research that will lead to the prevention of injuries and or diseases caused by exposure to physical agents. This publication contains synopses of work already completed in this thrust area.

Thabo Dube

Chief Executive Officer

Mine Health and Safety Council

December 2017

1. RECOMMENDATIONS ON SETTING ILLUMINATION AND VISIBILITY STANDARDS IN SOUTH AFRICAN COAL MINES

By CSIR research, Ref: GAP 804
1998

SUMMARY:

A review of the current illumination standards and guidelines used in coal mining industries globally was conducted to assess their applicability to conditions in South African coal mines. Thereafter, a literature review was undertaken to identify factors that must be considered in order to ensure a safe visual working environment. The primary output of this project is a set of recommendations based on what is currently accepted as 'best practice', both within South Africa and internationally. The recommendations are based on comprehensive underground observations of current visibility and lighting conditions and were presented to industry representatives for comment, prior to finalisation.

The objective of the recommendations is to assist in the identification of potential hazards that can result from poor visual environments across a comprehensive range of the operational situations most frequently encountered in coal mines. Recommendations are made for improving the visual environment in order to reduce the risks identified and guidance is included on the provision, siting and maintenance of lighting equipment. The recommendations focus on three main areas:

1. *Static Locations*: areas of the mine that are of a long-term fixed nature and hence it is likely to be practical to recommend the installation of comprehensive, permanent lighting fixtures and other aids to improve the visual environment.
2. *Dynamic Locations*: primarily production areas, which are likely to move on an almost daily basis. Hence, it is less practical to provide fixed lighting installations.
3. *Mobile Machines*: a broad sample of typical mining machines is covered and the visual environment of both the operators and the workers is considered.

Within the above areas, the underground observations identified the major tasks undertaken, their critical visual requirements and the associated potential visual limitations and potential hazards. Recommendations are made on:

- potential improvements to illumination/ visibility, for example, improving reflectance of walls in static locations, painting obstructions in highly contrasting colours, upgrading headlights/rear lights on mobile machines, providing portable light units where mine area lighting is poor;
- potential improvements to sight lines, for example, modifications to canopies, provision of improved wing/side mirrors, provision of height-adjustable seating;
- additional considerations which could compensate for limitations in the visual environment, for example, provision of high visibility clothing, provision of audible warning devices, provision of clear advance warnings of hazardous roadway conditions.

CONCLUSION:

This document provides a source of information with recommendations that will allow direct and effective action to be taken at both corporate and individual colliery level to improve the visual working environment. This should in turn lead to improved safety and a reduction in the number of accidents arising from poor visual environments and lighting standards. It is important to bear in mind that the recommendations are not prescriptive and that each situation must be subjected to a specific risk assessment. The recommendations must be used as a guide to good practice and the information is presented in a form that is designed to act as an aid to all members of the coal mining community when conducting such risk assessments for specific situations.

2. A COMPREHENSIVE ERGONOMICS STRATEGY FOR THE SOUTH AFRICAN MINING INDUSTRY

By de Koker T.H., Schutte P.C., Ergotech Ergonomics consultants, Ref: GEN 603, 1999

SUMMARY:

This research report discusses the development of a comprehensive ergonomics strategy for the South African mining industry. The objective of the strategy is to introduce and implement ergonomics in the mining industry to improve occupational health and safety in compliance with the Mine Health and Safety Act (No. 29 of 1996), worker morale and well-being as well as productivity, efficiency and effectiveness on South African mines.

As a first phase in the development of the strategy, an extensive literature survey was conducted to gather relevant information on ergonomics strategies and other ergonomics implementation approaches, particularly in mining industries. From the literature survey and personal communication with ergonomists in various overseas countries, it became evident that a holistic ergonomics strategy, specifically for a mining industry, has not yet been developed or implemented in any country.

In view of the absence of a generic strategy, a formal strategy development process was followed to develop a draft ergonomics strategy for the South African mining industry. A representative sample of role players in the local mining industry was then consulted to determine the feasibility of the proposed strategy. Feedback from these role players was drawn upon to refine the proposed strategy where after proposals were formulated for the practical implementation of the strategy. Role players were again consulted to assess the feasibility of the implementation proposals.

The strategy to implement ergonomics in the mining industry will involve four groups of role players, namely the state, employers, employees and manufactures/suppliers of mining equipment, on the basis of participatory ergonomics. The specific involvement proposed for role players entailed reviewing of existing legislation addressing ergonomics and the drafting of an ergonomics implementation plan. In the case of the state, the establishment of formal ergonomics programmes on mines by employers, the active participation and involvement in the ergonomics programmes by employees, and the use of ergonomics design guidelines and specifications suitable for the local user population and mining conditions by manufacturers/suppliers of mining equipment has been proposed.

Successful implementation of the strategy will depend on the effective introduction of the science of ergonomics and it is therefore of cardinal importance to raise the general level of awareness among all role players. This can be achieved through general information and promotional programmes to introduce ergonomics to all involved.

Education and training in ergonomics will also be required to facilitate the active participation of all employees in the ergonomics programmes on mines. Costs to implement the ergonomics strategy should be regarded as an investment with long-term benefits. There will also be benefits that could not be expressed in monetary terms such as improved health, safety, comfort and human well-being, which are actually the main aims of implementing ergonomics in the local mining industry.

CONCLUSION:

The ultimate goal of ergonomics is to improve and maintain the health and safety and well-being of the individual worker. Simultaneously, it is likely that the well-being of the organisation will also be improved and maintained, which is of particular relevance in a challenging economic climate where management is required to use existing resources optimally. The strategy developed in this study will contribute significantly to the implementation of ergonomics in the South African mining industry.

3. QUANTIFICATION OF NOISE SOURCES IN MECHANICAL BOARD AND PILLAR COAL MINING

By Heyns P.S., Stander C.J.,Scheffer C. and Du Plooy N.F., Research Enterprises at University of Pretoria, Ref:COL 714, 2001

SUMMARY:

Research Enterprises at University of Pretoria was commissioned to provide the mining industry with a consistent set of noise data, based on a common measurement protocol, on representative continuous miners, road headers and load haul dumpers.

Measurements were conducted and documented in accordance with a test protocol based on procedures outlined in GEN420, in accordance with BS 7025. A total of ten machines were tested on surface. To gain improved understanding of the differences between surface and underground noise levels, another five tests were conducted underground.

From the tests, it was found that the noise levels on continuous miners are very high. In one case 115 dB(A) was recorded. The conveyor chain seems to be the major offender in terms of noise generation on continuous miners. This is particularly so on the surface level. Once the machine is at the coalface, it seems as if the conveyor chain noise may be significantly dampened by the presence of coal on the chain. Under these circumstances, the scrubber contribution becomes comparatively more important, and it seems as if most of the development effort should be focused on these two components.

In one case, very significant attenuation of conveyor chain noise was accomplished underground, even though the chain was not covered with coal. This should be investigated further to establish the consistency of these results and to identify the mechanism involved in the attenuation, so that it may be exploited in other cases.

Another contributor to the noise is the cutting process itself. There seems to be enough evidence that although there are some conflicting results, this mechanism is less important than the convey or chain and scrubber mechanisms. Hydraulic noise is the least important of the noise generating mechanisms.

CONCLUSION:

In order to reduce continuous miner noise levels, it is clear that immediate efforts will have to be focused on conveyor chain and scrubber development.

Noise reductions of the order of 10 dB needs to be obtained. Such reductions are very significant and will require fundamental redesign of the components involved. These changes will compromise the performance and productivity of these systems.

Noise levels caused by load haul dumpers are lower than for continuous miners (bearing in mind that load haul dumpers were only tested under maximum engine speed but no load conditions), but still high. Essentially, engine noise must be attenuated. Due to performance, productivity and cost implications, the changes required to reduce noise levels will never be implemented spontaneously and firm targets and associated penalties for not attaining these targets will need to be introduced to provide the impetus required to make real progress in this regard. Procedures to test for conformance will also have to be implemented .

Once these targets are set, individual manufacturers of conveyor chains and scrubber fans will be forced to critically consider their designs and improve or optimise these designs. This will prompt more detailed experimental investigations. It is an objective of the research that the present work will provide a very useful basis for such investigations as well as for the setting of conformance tests.

4. DESIGN AND DEVELOPMENT OF A QUIET, SELF-THRUSTING BLAST HOLE DRILLING SYSTEM

By Ottermann R.W., von Wielligh A.J., Burger N.J.L., de Wet P.R., RE @UP, University of Pretoria, Ref:GAP 642, 2001

SUMMARY:

Noise is a generic hazard common to all commodities and, which affects all operations within the mining industry in particular. More people are exposed to the risk of noise-induced hearing impairment than to any other occupational hazard within this context. Pneumatic percussion drills are a major contributor to noise-induced hearing impairment of miners. The design and development of a quiet, self-thrusting blast hole drilling system is necessary to reduce this risk of hearing impairment. As impetus for this study, such a drilling system was developed during this project, which was then tested and demonstrated. Based on this, the study presents findings and recommendations.

The primary output of this project is a quiet, ergonomically reliable blast hole drilling system, which is used to drill suitable blast holes by workers. The objective of such a system was safety and reliability with reduced hearing loss and higher productivity.

After a problem survey was conducted, a functional analysis was done, from which a specification was created. Although the current regulations state that a worker may be exposed to a maximum equivalent noise level of 85 dBA for 8 hours per day, it was calculated and decided that an appropriate design level for the sound power level for the “quiet” rock drill would be 90 dBA as workers do not drill the full 8 hours. Different concepts were generated and evaluated.

The preferred concept was presented , approved, designed and an experimental development model (XDM) was built and surface tested. A design review was done and five prototype quiet rock drills were manufactured. These rock drills were tested on surface as well as underground. A marked reduction of sound levels was achieved with the quiet rock drill. The quiet rock drill consists of a standard Seco S215 pneumatic rock drill encapsulated in a composite material tube. The tube is pushed onto the rock face by a pneumatic cylinder and is sealed at the rock face by means of a flexible material.

A lead screw mechanism, powered by a geared air motor, thrusts the drill forward. The exhaust air, dust, water and rock shavings as well as oil and grease are removed from the tube via an exhaust pipe a distance away where the air and water is dumped.

CONCLUSION:

A quiet, self-thrusting blast hole drilling system was developed and demonstrated during the project. The system has shown that it will reduce hearing loss and increase productivity as operators can operate more than one system. A considerable reduction in sound levels was achieved with comparable drilling speeds to standard pneumatic drills. However, sound levels of below 90 dBA were not achieved directly adjacent to the quiet rock drill, the sound levels measured on surface are below 90 dBA a distance of 1 to 2m away from the drill. As the operator will only be close to the drill for a very short period of time, while for the majority of the time he will be further than 2m away, this may not pose a problem.

Recommendations:
It is envisaged that the sound levels of below 90 dBA, measured underground, will be achieved with an improved revised design.

The tests of the quiet rock drill identified certain shortcomings including the weight and manoeuvrability, which will have to be addressed during further development of the drill. For the further development of the drill the following is recommended:

- Conduct a design review to address shortcomings of drill, i.e. reduce weight, reduce noise levels etc. (See paragraph 9.2).
- Test the drill.
- Amend the drill or build new drills until the required performance is achieved.
- Conduct underground operational evaluations.
- Conduct reliability tests.
- Finalise design

As a tendency exists for the introduction of drill rigs in mines it is also recommended that the quiet rock drill be incorporated in drill rigs. A drill rig with the quiet rock drill will have to be designed, built, tested and evaluated. The use of the quiet rock drill in a drill rig will solve the problem of manoeuvring, as size and weight will not be a problem on a rig.

5. THE ROLE OF ILLUMINATION IN REDUCING RISK TO HEALTH AND SAFETY IN SOUTH AFRICAN GOLD AND PLATINUM MINES

By Rushworth A.M., Talbot C.F., von Glehn F.H., Lomas R.M. and Franz R.M., Bluhm Burton Engineering, Ref: GAP 804, 2001

SUMMARY:

A review of current standards, research and developments relevant to illumination and visibility in gold and platinum mines was undertaken to update and supplement corresponding information elicited for coal mines by COL 451. COL 451 produced general guidance and recommendations for a wide range of underground coal mining locations and activities. The current project used the same proven research approach and methodology.

It was found that poor design of visual environments can induce:

- Errors caused by an inability to see properly
- Confusion, illusions and disorientation
- Visual discomfort and headaches.

The review provided an indication of the impact that poor standards of illumination and visibility have on safety and performance, and identified a range of factors that must be considered to ensure a safe visual working environment.

The primary output of GAP 804 is a self-contained set of recommendations for the gold and platinum sectors based on:

- Accepted ‘best practice’, both within South Africa and internationally; and
- Comprehensive underground observations of current visibility and lighting conditions.

The recommendations are intended to assist in the identification of potential hazards that can

result from poor visual environments across a comprehensive range of operational situations most frequently encountered in gold and platinum mines.
Recommendations are made for improving the

visual environment to reduce identified risks, and guidance is included on the selection, siting and maintenance of lighting equipment. The recommendations were presented and discussed at a SIMRAC
their appropriateness, practicality and relevance to the industry.

The recommendations focus on three main areas:

- Static Locations: areas of a long-term or fixed nature suitable for permanent lighting fixtures.
- Dynamic Locations: changing areas of the mine, suitable for only temporary or semi-portable lighting.
- Mobile Machines: consideration is given to the visual requirements of both the operator and other workers.

Within the above areas, the underground observations identified the major tasks undertaken, their critical visual requirements, and the associated potential visual limitations and potential hazards.

Recommendations are made with regard to:

- Potential improvements to illumination/ visibility.
- Potential improvements to sight lines.
- Additional considerations which could compensate for limitations in the visual environment.

The report provides a source of information that is designed to allow direct and effective action to be taken at both corporate and individual mine level to improve the visual working environment. This should, in turn, lead to improved safety and a reduction in the number of accidents which could arise from poor visual environments and standards of lighting. It is important to bear in mind that the recommendations are not prescriptive, and that each situation must be subjected to a specific risk assessment. The recommendations should be seen as guidance for best practice.

As such, the information is presented in a form intended to serve as an aid to all members of the gold and platinum mining community when conducting such risk assessments for specific situations.

CONCLUSION:

Although 'insufficient illumination/visibility' is rarely cited as the primary cause of an accident, a number of accidents, for example, slip/trip/fall incidents and machine collisions, may well have been prevented if sufficient lighting had been provided.

6. BODY COOLING SYSTEMS

By Schutte P.C., de Klerk C. and Matesa J, CSIR Mining Technology, ref: SIM 020702, 2002

SUMMARY:

The project reviewed body-cooling garments commercially available in South Africa, with reference to design, principle of operation, functional performance, and their potential for practical application in the South African mining industry. Current research and development activities in the field of personal body cooling systems, locally and internationally, were also covered.

There are basically three categories of body-cooling system: circulating air systems, liquid-conditioned garments and phase-change garments. In the South African mining industry, body-cooling garments are used by Mines Rescue Services during some of their activities, and by certain mines when emergency work has to be done in abnormally hot temperatures.

At present, not one of the body-cooling garments at present commercially available in South Africa fully meets the requirements of the mining industry or those of Mines Rescue Services. The major driving force behind the research and development of body-cooling systems at an international level is the military application of this technology.

It is, however, unlikely that any new developments and technologies in the field of

body cooling will be commercially available for industrial application in the near future.

Despite the fact that considerable effort is being directed towards the development of suitable combinations of chemicals to be used in cool packs and towards smaller cooler and pump configurations, many of the ideas are still in a conceptual phase. Newly developed products will have potential for application in mining.

There is general consensus that body-cooling systems have a role to play in the management of heat stress on mines, and will do so in the future. However, as far as the exact application of body-cooling garments is concerned, there are two schools of thought. One school of thought is that, during routine mining operations, body-cooling garments should only be employed during emergency work in abnormally hot environments. The other school of thought is that body-cooling garments should be available for day-to-day use during routine mining operations, even at relatively moderate environmental temperatures. The proponents of this view are of the opinion that body-cooling garments have the potential to contain body core temperature in the range in which there is minimum effect on cognitive and physiological performance, and that individuals with suspect heat tolerance are also afforded protection.

CONCLUSION:

Body-cooling systems will continue to play an important role in the strategy to protect rescue brigadesmen during their operations, and Mines Rescue Services need a purpose-designed body-cooling system to meet their specific requirements.

Recommendations:

In view of the expressed need for personal body-cooling garments in the mining industry, it is recommended that the industry's specific design and operational requirements be conveyed to the major manufacturers and suppliers of these systems.

Body-cooling garments should be considered as standard protective gear during emergency work in abnormally hot environments. However, it could be argued that commercially available body-cooling garments do not fully meet the operational requirements of the mining industry, the amount of protection afforded by these garments should, nevertheless, be regarded as 'crucial' rather than 'negligible'.
Recommendations on action levels and permissible exposure times with body cooling garments are contained in Annexure 10 of the 'Guideline for the compilation of a mandatory Code of Practice for an Occupational Health Programme on Thermal Stress' issued by the Chief Inspector of Mines, Department of Minerals and Energy.

7. DEVELOP FEASIBLE METHODOLOGIES TO AID ESCAPE IN POOR VISIBILITY IN UNDERGROUND MINING ENVIRONMENTS

By Schutte P.C., de Klerk C. and Matesa J., CSIR Mining Technology, Ref: SIM 020702, 2014

SUMMARY:

This research project aimed to redefine and review the "user" requirements in providing underground mine workers with a safe escape in poor visibility conditions. With those requirements at the forefront, the project will evaluate the shortcomings of current solutions in the industry and recommend incremental improvements and conceptual solutions for development.

As part of the objectives of the study, the following questions were addressed in order to determine the root causes of the problem:

- What are the existing systems and methods available to mines to assist workers with escape in poor visibility underground environments?
- What are the shortcomings of the existing systems?
- How can these shortcomings be addressed?
- How can alternative solutions be prioritised?
- How well does the highest priority proposed solution address the problem?

CONCLUSION:

The following objectives were achieved in addressing the above questions:

- Identification of all available systems that assist miners with escape in poor visibility underground environments;
- Determination of the shortcomings of the existing systems;
- Development of alternative solutions;
- Selection of better alternatives; and
- Evaluation of alternative solutions.

NOTES:

MHSC

Mine Health and Safety Council

T: 011 655 1797 | **F:**011 656 1578

145 Western Service Road
Western Wood Office Park
B7 Maple Place
Woodmead

www.mhsc.org.za