Safety In Mines Research Advisory Committee Project Summary

Project Title: **HEALTH704**	Evaluation of Newly Developed Real-time and Gravimetric Dust-Monitoring Instruments for Personal Dust Sampling For South African Mines

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Summary

Monitoring of dust in the mines is an important task in terms of Section 12.2 and 12.3 of the Mine Health and Safety Act (MHSA) of 1996 and therefore requires reliable dust measuring instruments. Information on routine worker dust-exposure levels using reliable dust monitors can assist both workers' and operators' awareness of the need to protect their occupational respiratory health. However, uncertainty regarding the accuracy of measurement of dust monitoring instruments weakens the validity of efforts aimed at monitoring and determining workers' personal exposures. Against this background, the search for an improved or alternative instrument that will be able to measure dust-exposure levels more accurately and more reliably is continuing. In order to be able to ascertain the magnitude and range of dust levels and to react in accordance with the MHSA (1996) when an unhealthy dust exposure level occurs, a real-time personal monitoring instrument for mineworkers is undoubtedly required.

The specific objectives of the project were as follows:

- To evaluate the newly available, real-time and respirable dust gravimetric monitoring instruments for personal exposure assessment in order to determine whether they withstand the harsh environmental conditions (heat, humidity and working area) in the South African mining industry.
- To evaluate six different instruments for monitoring the respirable dust fraction, both in the laboratory and in typical underground mine conditions, viz. in coal, gold, platinum and diamond mines.
- To compare the performance of the identified instruments in terms of accuracy, the option for quartz or elemental analysis, intrinsic safety issues, and practical implications such as portability, ease of use and the ergonomics surrounding wearability of the instruments underground.

In order to achieve the set objectives, an initial worldwide literature review was carried out on the availability of newly developed instruments and their use as personal samplers. The findings of the literature review are discussed in Section 2.9 of the main report. Based on these findings, six dust monitors were selected for evaluation. They were: (1) a locally manufactured gravimetric sampler, (2) the Dorr-Oliver 10 mm sampler, (3) the National Institute of Occupational Safety and Health respirable dust dosimeter (RDD) tube, (4) the Institute of Occupational Medicine (IOM) sampler, (5) the Personal Data Ram (PDR) and (6) the Split-2 dust monitor. All the instruments were operated according to the new Comite' European de Normalization /International Standards Organization /American Conference of Governmental Industrial Hygienists (CEN/ISO/ACGIH) size-selective curve and the South African (SA) sampler was used as a reference sampler.

Laboratory evaluation of the instruments was carried out in the Polley dust duct. Side-by-side comparison of the identified instruments with the SA gravimetric sampler indicated that there was a significant difference in the measured dust levels between them and the SA sampler, except for the PDR real-time dust monitor. Based on the criteria set for the selection of a suitable instrument and statistical analysis of the laboratory data, it was found that the PDR is potentially the best real-time personal dust monitor for underground applications.

Field evaluation of the instruments as personal dust-monitoring instruments, side by side in the breathing zone, was carried out in gold, platinum, coal and diamond mines. In all, eleven weeks were spent underground in these mines. It was not the intention of this study to exclude or recommend any particular type of dust-monitoring instrument for industrial use, but rather to evaluate their comparative performance, under broadly the same conditions.

Conclusions

The following overall conclusions were drawn from this study:

- The portable real-time dust monitor (PDR) proved to have the highest potential as a personal dust monitor for exposure assessment. Nevertheless, all the real-time instruments can be used for engineering control or for a quick estimation of dust levels, but using a real-time monitoring instrument as a stand-alone unit for compliance is not recommended.
- The RDD real-time dust monitor was easy to use and wear as a personal sampler under extremely harsh environmental conditions such as in hard rock mines. However, in view of the poor relationship between pressure drop and mass of dust collected on the filter, the RDD needs further fine-tuning. Further, the RDD is not recommended for use in an environment where diesel particulate matter (DPM) and moisture is present. Also, there is no confirmed procedure for evaluating the quartz content of the RDD foam dust sample.
- From both the laboratory and field studies, it was recognized that when two samplers (the SA sampler and the Dorr-Oliver sampler) were operated according to the ACGIH/ISO/CEN size–selective curve, there was a significant difference in the measured respirable dust concentrations. From this it can be inferred that either the SA sampler overestimates or the Dorr-Oliver sampler underestimates the "true" concentration.
- The identified instruments were successfully evaluated and the project has led to technical knowledge and to know-how on the practicality of providing information on the use of personal samplers in some of the harsh conditions underground.

Recommendations

The following recommendations are made based on the extensive laboratory and field study:

- This study recommends further development of the PDR real-time monitoring unit for usage in SA. Modifying the PDR unit by adding a micro-size-selective device operating at low air flow rate, improving the battery life, intrinsic safety and ergonomics design will likely to turn the monitor into a unique real-time compliance instrument for personal dust monitoring specially suited to South African mining conditions.
- In order to clarify the significant differences in measured respirable dust levels between two size-selective devices, the detailed penetration characteristics (aspiration efficiency) of the SA sampler for the size fractions of respirable dust is required. This would further assist in ascertaining the SA cyclone as a "reference sampler" which will operate according to the new size-selective curve.
- Finally, the study highlights the lack of basic state-of-the-art infrastructure for applied aerosol research for the local mining industry. What is lacking in this field at present is a well-established state-of-the-art infrastructure for aerosol sampler testing to cater for the needs of the local mining and allied industry. Therefore, as a national priority, this would lift South Africa's capacity in dust research and the region. This should be the strategic aim of the Advisory Committee for the future of Dust Measurement and Control research.