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**EVALUATION OF THE TEOM CONTINUOUS**

**RESPIRABLE DUST MONITOR FOR USE**

**IN AUSTRALIAN COAL MINES**

**REPORT OF STAGE I**

**APRIL 1998**

## Introduction

The aim of this project is to evaluate the Tapered Element Oscillating Microbalance (TEOM) continuous respirable dust monitor (CDM) for use in Australian Coal Mines. The project has two stages, these being an initial technical evaluation of the CDM and secondly an operational evaluation under Australian Mining condition. Progress to Stage II of the project was considered subject to an appropriate outcome of the Stage I technical evaluation.

This interim report details the results of Stage I and makes recommendations as to how Stage II could be progressed, at a significant cost reduction on the original proposal.

## Project Team

The key researchers for this project were:

Mr Denis Glover: Joint Coal Board (Project Manager)  
Mr Brian Davies: Australian Environmental Health Services Pty Ltd

## Outline of Stage I

The concept of Stage I was for the key researchers (Messrs Glover & Davies) to visit the United States and inspect the CDM as it was undergoing final acceptance trials in US Coal Mines. Following discussions with the CDM project manager in the US, Dr Bruce Cantrell of the National Institute of Occupational Safety & Health (NIOSH) it was agreed that the following visits would be beneficial.

- Rupprecht & Patashnick Inc (CDM Manufacturer)
- NIOSH - Pittsburgh Research Centre
- Mine Safety & Health Administration (MSHA) Technical Support Centre - Pittsburgh
- Underground Coal Mines

As a result of these discussions and inspections, it was anticipated that the key researchers would be well placed to technically evaluate the CDM and thus make a recommendation to the JCB Health & Safety Trust regarding Stage II of the project.

To this end, Messrs Glover & Davies visited the United States in early March 1998. The results of that visit are detailed below.

## Technical Evaluation & Discussions

Following discussions with R & P Inc personnel, the following observations can be made:

- The TEOM principal is well proven technology and is currently being recommended by the US EPA as the basis of PM10 & PM2.5 atmospheric dust measurements.
- Previous experiences with machine mounted dust monitoring equipment in respect to interference from vibration do not appear to be an issue with the CDM.

- The readout of the instrument provides both an instantaneous display and a full shift rolling time weighted average which allows operators to control their full shift exposure.
- The issue of moisture (a common problem with previous instruments of this nature) has been resolved by maintaining the sampling head at 50°C. This ensures that droplets do not form on the TEOM and thus are not recorded as dust particles.
- The current instrument box is made of aluminium which would need to be substituted with a more appropriate material before use in Australian underground mines.
- Current development work includes the break up of the system into modular units which could then be included in the IS housing of a longwall shearer. This would result in only the sensor being exposed to the elements (damage, water, etc).
- Current designs conform to the recently promulgated ISO/CEN dust sampling convention (ISO 7708/1995) thus making direct comparisons with overseas results possible.
- A personal sampling device based on the same technology is possible, however, in the absence of a substantial order further miniaturisation of the CDM to a portable (personal) unit is stalled.

In summary, both researchers considered the technology to be excellent with many of the problems that have previously plagued direct reading dust instruments overcome. In addition, the TEOM provided a direct means of measuring dust as against previous devices which were based on some effect associated with dust, eg  $\beta$  absorption, reflected light (Tindall effect) all of which can be subject to significant interferences.

Discussions with personnel at the Pittsburgh Research Centre of NIOSH resulted in the following:

- In terms of validation of the CDM, the project was not as far developed as anticipated from the literature and personal communication. Little work has been performed on establishing the relationship between the CDM readout and actual exposures on the production faces. This is a key element of the successful use of the CDM and must be established if the CDM is to be of practical use.
- Due to a political dispute (over the development of a personal unit) between NIOSH, MSHA and mine owners, trial instruments are being removed from mines for the immediate future. Consequently, inspection of a unit on a working section of an underground mine was not possible.
- Most trials to date have been on continuous miners with only one longwall unit being trialed.
- Ten (10) instruments have been produced, however only 4 or 5 units will be used in the trial phase due to the lack of suitable mine sites for installation of the CDM.
- NIOSH expressed an interest in establishing a collaborative arrangement whereby NIOSH supplies one of the spare CDM units at no cost to the research team (Glover & Davies). In return, the research team would be expected to undertake a 14-28 day validation trial

and share the results with NIOSH. These figures would be included in the overall US statistical appraisal of the instrument.

At the same time NIOSH would consider providing a number of ISO curve (ie ISO7708/1995) calibrated vertical impactors for comparison with the current Australian Sampling techniques (AS 2985-1987). Given the current world move to the ISO curve, this would be valuable information for the Australian mining industry.

In summary, the researchers were disappointed as to the lack of progress on the validation of the instrument. At present, no effective relationship has been established in relation to the CDM output and the actual exposures of workers on the face.

The unsolicited offer of an instrument at no cost to conduct trials in Australia appears generous and worthy of consideration.

Discussions with the Division Chief of MSHA Technical Support in Pittsburgh revealed the following:

- All dust samples for both coal and metalliferous mines are now processed in Pittsburgh.
- The introduction of single sample compliance dust sampling has resulted in a significant increase in the number of inspector samples processed in Pittsburgh.
- No formal response has been made by MSHA in respect to the NIOSH proposal of a 0.9 mg/m<sup>3</sup> respirable coal dust standard.
- Given that MSHA is a joint venture partner with NIOSH in the development of the CDM, those present could not foresee any major issues in regard to a NIOSH/JCB Health & Safety Trust Collaborative arrangement.

In summary, MSHA is currently absorbing the restructuring of dust monitoring into its Pittsburgh facility after the closure of some other offices. No objections were presented by MSHA officers present to a collaborative arrangement between NIOSH and Australia in respect to the CDM.

### **Conclusions**

As a result of a technical evaluation of the TEOM continuous dust monitor, the following conclusions can be made.

- The TEOM technology as developed by R & P Inc appears to be excellent and may well be the basis of all dust monitoring in the future, especially if a miniature personal monitoring device is developed.
- Technical evaluation of the CDM in the US is not as advanced as was expected, giving rise to serious concerns in respect to the purchase at this stage of an instrument for trials in Australia.
- The offer of a spare CDM unit by NIOSH appears to be very generous, given that they only seek validation data in return. A re-evaluation of costs associated with adjusting

Stage II of the original project to incorporate a loan CDM from NIOSH and the required validation trials, would reduce the cost of Stage II of the project from \$165,450 to approximately \$30-50,000 with no loss in the information gained in the exercise.

### **Recommendation**

The researchers recommend to the Trustees that a collaborative research arrangement be explored with the National Institute of Occupational Safety and Health of the USA to trial a continuous dust monitor in Australia. Subject to a successful outcome of these negotiations, that the research protocol and funding of Stage II of the project be amended accordingly.

If an acceptable collaborative arrangement cannot be negotiated with NIOSH, the project should be terminated until suitable validation data from the US warrants reconsideration of the project.

**REVISED COSTS (Based on 28 monitoring days)**

Travel costs of mine sites and accommodation	\$ 4,600.00
Airfares - NIOSH Technical Expert	\$ 3,500.00
Salaries/fees of Researchers	\$ 9,040.00
JCB Dust Monitoring Section	\$22,400.00
Consumables	\$ 450.00
Technology Transfer	\$ 400.00
Approval Costs of CDM	\$ 500.00
Transport from USA	\$ 2,000.00
Local R & p Agent Technical Assistance	<u>\$ 2,000.00</u>
	\$44,890.00
Data Processing to US format	<u>\$ 1,200.00</u>
	<u>\$46,090.00</u>



**JCB Health**

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**CORRIMAL**  
8 December, 1999

Ms Sharon Buckley  
Secretary  
Health & Safety Trust  
SYDNEY

Dear Sharon

I have recently been advised that the US National Institute of Occupational Safety and Health (NIOSH) has decided not to provide additional funds towards the future development of the Continuous Dust Monitor (machine mounted version). This outcome arose from an internal report which concluded the following:

- The machine-mounted continuous dust monitor cannot be used to accurately represent worker exposure to respirable dust.
- The instrument's accuracy could not be determined by in-mine testing; however, the shift-to-shift variability of the device is approximately similar to personal samplers.
- For the test program to be considered mineworthy, the reliability of the machine-mounted continuous dust monitor must be significantly improved.

Given this situation, it is apparent that the instrument scheduled for delivery to Australia will not eventuate. Therefore, it is the recommendation of the researchers that Stage 2 of this project be terminated.

It is interesting to note that the focus has switched in the US to the incorporation of the continuous dust monitor technology into a personal sampling device. If this in fact occurs such a device would be very useful to the coal industry and may well require evaluation.

Yours sincerely

**DENIS GLOVER**  
Project Co-Ordinator