

Safety in Mines Research Advisory Committee

FINAL REPORT

SIMRAC Silicosis Control Programme - Phase 1

Chamber of Mines of South Africa

**Dr. David W. Stanton
Dr. Charles Mbekeni**

Department of Minerals and Energy

Mr Doug Rowe

***Safety in Mines Research Advisory Committee Project
Support Services***

Prof. Mary H. Ross

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EXECUTIVE SUMMARY

In 2002 SIMRAC established a long-term project to eliminate silicosis in the South African Mining industry (SIM 02-06-03). Phase 1 of this project was to scope the Phase 2 research required to work towards eliminating silicosis and included two regional workshops on silicosis elimination and a National Workshop.

Research efforts aimed at the elimination of silicosis in the SA mining industry will be long term and will require considerable funding and resources. Collaboration will be required from a broad range of personnel in the industry including management, health and safety personnel, human resources, employees, government and trade unions.

The primary objective should be reducing dust at source by means of improved engineering control. This will require the identification of the best practices to control the various dust sources underground and on the surface. Those responsible for dust control need to be fully aware of the engineering controls required to reduce dust generation to minimise exposure.

To properly monitor and evaluate the progress in dust control the industry needs to ensure that reliable and valid dust exposure and medical surveillance data are collected and reported. The analysis of this data should provide a better understanding of the health risk associated with silicosis and exposure to silica dust.

Current awareness and education programmes for employees on silicosis control will have to be considerably enhanced and appropriate refresher training implemented.

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1. INTRODUCTION

It is now a century since the Commission on Miners Phthisis reported in 1903 on the hazards of airborne dust. Since that time a considerable amount of work has been conducted in South Africa on aerosol physics, airborne dust measurement and control and the epidemiology and pathology of silicosis.

Despite all this work over a century we still have a high prevalence of silicosis in the South African mining industry.

In recent times the dust measurement and control research facilities in South Africa have been allowed to run down and we now have very little expertise in this field. We are in a situation where there is no competent research facility to conduct research on the measurement and control of airborne dust.

There is no independent assessment of respirable dust exposures in the South African mining industry and no quality control scheme in place for quartz analysis or reference laboratory for quartz analysis. Serious question marks exist today on the validity of the mining industry respirable dust exposure data.

Despite under-reporting of respirable dust exposures by the mining industry, the NCOH analysis of the DME dust exposure database indicates many industry exposure results in excess of the DME OEL of 0.1 mg/m^3 for respirable quartz.

A considerable amount of work is required by the mining industry to reduce dust exposures and to eventually eliminate silicosis.

A number of studies, including HEALTH 606, indicate that there is still a risk of silicosis from long working lifetime exposures to airborne respirable quartz below the DME OEL of 0.1 mg/m^3 .

1.1 HISTORICAL BACKGROUND 1902 - 1980's

The PhD thesis by I.J. Donsky (1993), *A History of Silicosis on the Witwatersrand Gold Mines, 1910-1946* states that the problem of silicosis could be categorised into successive time slots of:

- ? Ignorance (Before 1902)
- ? Awareness (1902)
- ? Investigation (1902 onwards)
- ? Control and Prevention (1911-1919)

Between the 1920's and 1940's preventative controls were being carefully monitored, but the emphasis had shifted more towards compensation for silicosis sufferers, and the question of prevention played a minor role towards the silicosis problem.

Another way to categorise dust control efforts is:

- ? The work of the early Commissions of Enquiry (Weldon, 1903 and Krause 1910), the work of the Chamber of Mines Dust Committee established in 1914, the work of the Miners' Phthisis Prevention Committee 1912-1919 and subsequent legislation

- ? The establishment of the Mine Ventilation Society of South Africa in 1944, the efforts of D.G. Beadle and colleagues at the Corner House Laboratories in the 1950's and 1960's, the further work by the Chamber Research Organisation (COMRO)
- ? The ILO international programme on *The Prevention and Suppression of Dust in Mining, Tunnelling and Quarrying* in the 1950's - 1970's, the ILO publication 'A Guide to the Prevention and Suppression of Dust in Mining, Quarrying and Tunnelling' (Geneva 1965) and the anti dust campaign efforts by the Chamber in the 1960's
- ? The 1990's - criticism of the SA mining efforts with regard to dust control by the Leon Commission (1995), Benjamin and Greef Committee (1997), SIMRAC Report SIMRISK 401 (1997), the PhD thesis by Anna Trapido (Wits 2000), and by Prof. Neil White (2001) in the SIMRAC Occupational Health Handbook
- ? 1995 - Establishment of the ILO/WHO International Programme on the Global Elimination of Silicosis
- ? The Mine Health and Safety Act (1996) and occupational hygiene regulations published under this act (2002), improved efforts by mining houses to address dust

1.1.1 Commissions of Enquiry and Early Legislation

It is not until the Government Mining Engineer of the Transvaal Mines Department in his annual report for the period up to June 1902, introduced the subject of occupational health of workmen that any appreciation seems to have been given to health. In his report first mention is made of "miners phthisis" as a disease " which seems to be peculiar to men employed in rock drill work". Careful enquiry at this time elicited the fact that out of the 1,177 rock drill men employed on the Rand prior to the Anglo-Boer War, 225 or 16.75 per cent. were known to have died from miners' phthisis. The actual number may have been greater.

Weldon 1902-1903

In 1902 the Governor of the Transvaal appointed a Commission to enquire into and report upon the prevalence and causes of the disease known as "miners phthisis" and to make recommendations as to the preventative and curative measures which should be adopted. One result of their enquiry was that: Although the incidence of the disease appears to be more marked in miners who have been working with rock drills for some years, yet it is also found to prevail amongst miners who have never worked them. The Weldon Miners Phthisis Commission of 1902-03 recommended that it would be urgently necessary to:

1. Prevent the discharge of the minute, hard, angular particles of dust already referred to into the mine atmosphere, and which are largely produced by blasting and rock drill operations;
2. Supply the working places throughout the mine with air in sufficient quantities and in such a manner as to render harmless and sweep away all vitiated atmosphere;
3. Maintain underground workings in every mine in a clean condition, and to provide for this purpose, a suitable sanitary system;

4. Provide change houses, suitably warmed and within reasonable distance from each shaft, where the miners can dry and change their clothes; and
5. Avoid the use of low flash point lubricants in the air cylinders of compressors, and to provide that the air intake be outside the engine house, so as to ensure a pure supply.

With regard to the "Use of Water Sprays to Allay Dust", they stated that, "Analysis made of mine air has shown that the use of water, both in the form of sprays and jets, is most efficacious in allaying the dust produced by various mining operations".

It was realised that there was a need for specific legislation to enforce the use of any recognised means for the prevention of silicosis. Act No. 54 of 1903, and the Mines and Works Regulations promulgated thereunder, was the first step in a long series of legislative measures to control the conduct of mines in the use of the best preventive measures, identified by continuous research into the cause and prevention of miners' phthisis.

The 1903 Regulations, contained four regulations on ventilation (Chapter VI), and one reference, Chapter IX, Regulation 97(8), that the ganger shall be responsible that no person enters the working place "until the fumes caused by the explosives shall have been sufficiently dissipated".

Krause Commission 1907-1910

Preventive Measures

In 1907, the Government of the Transvaal appointed a Commission known as the "Mining Regulations Commission" to report on the working of the Mines, Works and Machinery Regulations, with special reference to (amongst other things) ventilation and the better protection of the health and safety of persons working in mines.

The Krause Commission (1910) considered it very clear that efforts must be directed to:

- (1) the prevention of dust inhalation;
- (2) the prevention or removal of noxious fumes resulting from explosives; and
- (3) the prevention of tuberculosis.

(1) The Prevention of Dust Inhalation.

The rock-driller is far more exposed to dust than any other miner. This dust is produced (a) by drilling dry holes and (b) by blasting. In *dry* working places it is raised again after its subsidence (a) by the air escaping from the rock-drills and (b) by the lashing or shovelling of broken rock which is not wet. Holes drilled from above downwards are usually kept filled with water, and, as work progresses, exude only *mud*; 'backholes' or holes drilled from below upwards, will obviously not retain water, and unless a jet or spray be played upon them, give off a continuous stream of fine dust. The chief occasions of dust inhalation are therefore (a) when the escaping air from the rock-drills raises the dust from the floor and sides of dry working places; (b) in drilling backholes; (c) on returning to the working face after blasting before the dust has had time to subside; and (d) in lashing without keeping the rock thoroughly wet.

As a result of the recommendations of this Commission the following additions to the Mining Regulations were gazetted on 24th December, 1908:

Prevention of Dust.

(5) Every place where development work is carried on and where the natural strata are not wet, and every dry and dusty stope shall be adequately supplied at all times with suitable clean water. Such supply shall be continuous, and shall be sufficient for effectively damping the broken ground and for allaying the dust caused by drilling operations.

(6) Blasting shall be so arranged that men working in other places shall be exposed as little as practicable to dust and smoke.

(7) All plant, material, and other things necessary to enable the above rules to be carried out shall be provided and maintained in working order.

146. (ii) The manager or miner in charge of workmen shall be responsible that the following provisions be observed: -

(1) No person shall, in the drilling of holes, use any percussion machine drill unless a water-jet or spray or other means equally efficient is provided and used so as to prevent the escape into the air of dust caused by the drilling.

(2) No person shall, in any part of a mine, remove any broken rock or ground if such rock or ground is in a dusty condition until it has been effectively damped so as to prevent the escape of dust into the air during removal.

(3) No person shall, after firing has taken place, whether by electricity or in any other manner, enter the place in which such firing has occurred until the fumes caused by the explosion shall have been sufficiently dissipated, unless such person is wearing an effective respirator or other apparatus to prevent the inhaling of fumes or dust.

1.1.2 Miners' Phthisis Prevention Committee 1912-1919

This Committee conducted extensive investigations into improved methods of dust measurement and dust control. The General Report of the Miners' Phthisis Prevention Committee (1916) made a number of recommendations for the amendment of the Mining Regulations, and these were substantially incorporated in the amendments promulgated during the year 1917. In the early part of 1911 there were eleven Mining Regulations dealing with precautions to prevent miners' phthisis and to ensure good ventilation; by 1918 there were sixty- three such regulations.

One of the amendments provided for the appointment of mine officials whose special duty was to examine and report to the manager on conditions in the mines which have a bearing on health, and particularly with reference to miners' phthisis. It became evident that many of these officials had an insufficient knowledge of their duties and it was therefore considered necessary to compile an abstract of the Regulations specifying their duties, containing all the Regulations referring to the prevention of miners' phthisis. The Committee prepared such an abstract and the Chamber undertook its publication.

Pamphlet For Dust Officials - Foreword (1919)

"The appointment of dust officials, with duties as specified in Regulation 161 (10), has as its broad object the greater efficiency and better control of the measures taken for the diminution and suppression of miners' phthisis. It is expected of such an official that he should promptly discover and have remedied as soon as possible any condition in the mine which is conducive to the disease, such as the existence of dusty conditions, a deficiency of the water supply, defective ventilation, or exposure of men to dust and fumes from blasting."

The Regulations contained in this pamphlet are an abstract from the Mines and Works Regulations, and include all the Regulations which fall within the sphere of duty of the dust official. If any person is found to be contravening any of these regulations, the dust official should point out the fact to him, and, if necessary, the attention of the shift boss or of a higher official should be also directed to the matter.

Some of these Regulations refer to permanent arrangements, such as those affecting the water supply, the condition of the water used, the wetting of the drives, the efficiency and adequacy of the ventilation, the suitable splitting of air currents, the conditions of fans, air-doors, and ventilating pipes, and the exposure of men to dust and fumes from blasting. When any of these are defective, immediate steps should be taken to have the matter put right.

The dust official should also periodically inspect the crusher-stations and ore-sampling rooms on the mine, and satisfy himself that proper measures are taken for the suppression of dust, and that the fans, sprays, and other appliances for the purpose are in proper order and are being utilized.

"Mines employing more than 1000 persons below, one or more competent persons to be appointed, whose principle duty to be to examine and report to the manager on all matters relating to dust conditions and ventilation.

161. (10) In every mine included in the list of mines framed under section two of Act No. 19 of 1912, the manager shall, when the total number of persons employed underground on any one shift exceeds one thousand persons, appoint one or more competent persons whose principle duty it shall be to examine and report to the manager on-

- (a) all matters relating to the mine's water supply, its quality, distribution, and use;
- (b) the condition of the necessary appliances for using water at each working place and elsewhere;
- (c) the dust sampling of the mine;
- (d) the conditions of the mine relating to ventilation and health.

The manager shall by letter notify the Inspector of mines of the person or persons so appointed from time to time, and the reports made by them shall be open to the inspection of the Inspector."

1.1.3 Education and Training

Mine Ventilation/ Dust Control

The need for competent, trained persons to be employed in the ventilation departments of gold mines was recognised at an early stage in the exploitation of the Witwatersrand gold fields and training schemes were introduced to satisfy this need. In June 1916, the Chamber issued a book entitled "Dust and Miners Phthisis". One objective of this book, which contained details on dust prevention and measurement, was to ensure that samplers used a standard method when determining the dust content of air. After publication of this book, a series of lectures to mine dust samplers was commenced in September 1916, at the South African School of Mines and Technology. The lectures were given by J.S. Cellier, Professor of Mining at the School, and ended in January 1917. The training of ventilation officials had commenced.

The Government Mining Engineer in 1919, and again in 1923, expressed his concern at the lack of competent mine dust inspectors and requested the industry to make improvements in the station and training of these officials. The mining industry through the Chamber informed the Government Mining Engineer that it would satisfy itself that men employed as dust officials would be adequately educated in the subject of ventilation and arranged for a course of lectures for mine dust inspectors to be held at the University of the Witwatersrand between August and November 1923. The subjects covered included underground hygiene, phthisis prevention and ventilation. The lecturers were Dr. Mavrogordato and Professor Watermeyer, and at the end of the course an examination was held.

On completion of these lectures a system of monthly meetings of mine dust inspectors commenced. These meetings served as forums to educate ventilation officials and were to continue until 1927 when JP Rees commenced his duties as Ventilation Officer to the Chamber. Rees had been engaged previously on the staff of Birmingham University, U.K. and, as one of his first duties, he organised a series of lectures to be given to mine ventilation officials. The first series of lectures commenced in January 1928, and the last of these lectures was given in October 1947. Examples of the calculations given in these lectures were collated in book form by Rees and published in 1950. At the completion of each lecture series, an examination was held and certificates were issued to successful candidates.

J. Lawrie of the Chamber's Dust and Ventilation Laboratory visited mines in 1938 to advise mine staff on the treatment and counting of konimeter slides. This may have been the first instance of "on the job training" in mine ventilation.

The methods of examination and training of ventilation officials were reviewed during 1947 and 1948 and a new system of examinations and lectures was introduced during 1949. Examination now included a practical and written examination for an elementary certificate in dust prevention and mine ventilation and, once candidates had successfully completed these papers, they could progress to the advanced certificate. These lectures were to continue until 1966. The examinations were known as the Chamber Elementary and Advanced Examinations in Mine Ventilation. The Department of Mining at the Witwatersrand Technical College introduced a National Diploma in Mine Ventilation course in 1949 (evening classes) to assist persons studying for the above Chamber examinations. DG Beadle wrote a correspondence course in ventilation for use by the College, which was introduced in 1959. The Chamber sponsored the writing of the book but responsibility and credit were given to the MVS.

In 1964, a Chamber committee of ventilation engineers and training officers reviewed the system of training ventilation officials. As a result of the recommendations of this committee, a system of centralised courses under the direction of a Ventilation Consultant and a Ventilation Training Officer commenced in 1966.

In recent years, the occupational hygiene content of the Chamber examinations has been expanded by the MVS who took over the examinations in 2002.

In March 2003, Dust control courses were held in Cape Town and Johannesburg under the WHO/ILO Joint Effort on Occupational Health and Safety in Africa. The courses were based on the WHO *Hazard Prevention and Control in the Work Environment: Airborne Dust* document and were presented by members of the Swedish Institute for Working Life (SIWL) and the Finish Institute of Occupational Health (FIOH). A key component of the course was the use of the PIMEX (Picture and Measurement of Exposure) system whereby video clips are played back on a portable computer showing worker activity and airborne pollutant exposure. The system can be considered a key tool to assist in the control of exposure to airborne dust.

1.1.4 Publications

Starting with the 1916 publication "Dust and Miners Phthisis", the Chamber has published several publications on airborne dust measurement and control. Others include "Quality of mine air: dust content and cooling power (1947), "Ventilation Calculations" (1950), "Quality of mine air" (1965, 1968), "Routine mine ventilation measurements" (1972), Measurements in mine ventilation control" (1982, 1988), "Intermediate Workbook for the certificate in mine environmental control" (1997) and "Workbook for the certificate in mine environmental control" (1997). The textbook "The Ventilation of South African Gold Mines" was sponsored by the Chamber and published under the Mine Ventilation Society in 1974. Mr. J.H.J Burrows, Chamber, was the editor. Other MVS publications include: Mine Ventilation Notes for Beginners (Afrikaans 1971 English version 1972), Environmental Engineering in South African Gold Mines (the so-called Black Book, first published in 1982), Le Roux's notes on mine environmental control (1990) and The Mine Ventilation Practitioner's Data Book (1992). The Chamber has also assisted with the costs of publishing MVS textbooks. An annual grant to assist with the publication of the Mine Ventilation Society Bulletin was made by the Chamber in 1956 and in 1957, the Bulletin changed its name to the Journal of the Mine Ventilation Society of South Africa. This journal has included numerous articles on airborne dust measurement and control.

The Mine Ventilation Society of South Africa (MVS) is currently doing a major revision of one of the engineering manuals, which includes chapters on airborne dust and dust control.

1.1.5 Anti-Dust Campaigns

A major anti-dust campaign was initiated in 1965 through the Chamber Anti-Dust campaign Sub-Committee and some 29,600 copies of 23 different posters were printed. Some 10,000 pamphlets on dust were printed in English and 18,000 in Afrikaans. In 1966, lecturers from various mine-training centres attended Randfontein Estates for a one-week course to be trained on presenting lectures on dust control. The film ***Dust is Dangerous*** was produced in colour and various recall materials were issued to remind those who have seen the film of its message. The film was launched in 1966 at the Chamber Sports Club and the anti-dust lecturers attended a meeting before the preview to be briefed on the use of the film and its associated follow-up materials. Those invited to the launch were:

Gold Producers' Committee
Collieries Committee
Technical Advisory Committee
Collieries Technical Committee
Anti-Dust Campaign Sub-Committee
Sub-Committee of Group Ventilation Engineers
Sub-Committee of Group Training Officers.

In addition, invitations were sent to the Government Mining Engineer, District Inspectors of Mines, the Superintendent of the Government Miners' Training Schools, the Head of the Collieries Training School and the anti-dust lecturers.

Prize money was awarded for anti-dust slogans and various follow-up materials were purchased for use in conjunction with the film:

- ? Scotchlite stickers, slogan slips, banners, ashtrays with figure of Stoffel Waterman, book matches, gramophone records and key cases. The gramophone records were for use by lecturers and to be played at shaft-heads, in change houses etc.
- ? A film was also made of an anti-dust lecture given in Fanakalo by an instructor team leader. Regular publicity was provided in The Reef magazine including articles on dust and a painting competition for children of mine employees.
- ? All lecturers were provided with copies of the ILO publication 'A Guide to the Prevention and Suppression of Dust in Mining, Quarrying and Tunnelling ' (Geneva 1965).

In 1965, arrangements were made for an Anti-dust campaign on Collieries and the Sub-committee was expanded to include representatives of the collieries.

The Sub-committee of Group Ventilation Engineers had been asked to advise the Anti-Dust Campaign Sub-Committee of any internal mine anti-dust competitions or campaigns that came to its notice. Details were provided of the propaganda campaign and competition based on dust counts in mine overseer's sections, which had been introduced at West Driefontein by the Ventilation Officer. The campaign included Newsletters and Prizes. A floating shield was presented monthly to the Mine Overseer with the lowest monthly dust count. In addition, he was presented with a beer mug. At the end of each month, pamphlets recording the average dust counts taken during the month in each Mine Overseer's section was distributed to management and Mine Overseers. Information on the campaign was circulated to all managers for information and West Driefontein was commended on its campaign.

1.1.6 Audiovisual Resources

The Film Catalogue of the Chamber Mine Safety Division includes several 16-mm films on dust control:

Dust is Dangerous Colour 13 minutes.

The film shows by means of animated drawings how minute particles of silica damage lungs. The cartoon character, Stoffel Waterman, then shows the various methods used to reduce the dust hazards.

Pas op lo tayises Colour

Fanakalo version of 'Dust is Dangerous'

Pas op lo tuli Colour 36 minutes

The film is a record of an anti-dust lecture given in Fanakalo by an instructor team leader.

The Miner and Dust

Part 1 10 minutes

Part 2 10 minutes

The purpose of the film is to show the miner some of the anti-dust measures, which are under his direct control and with which he comes in contact. Produced by the Department of Mineral and Energy Affairs.

Die Mynwerker en Stofbestryding

Afrikaans version of 'The Miner and Dust'

Dust suppression in continuous miners. 20 minutes

Produced for the Research Organisation of the Chamber of Mines, it discusses sources of dust in the continuous mines and methods of suppressing this dust, i.e. effective coal cutting, water sprays and proper ventilation.

Language: English, Afrikaans and Fanakalo on one tape.

1.2 International Efforts on Dust Control

With the concerns around airborne dust, the Chamber held an international competition in 1903 with prizes for the best method of allaying dust caused by machine drilling.

The Chamber assisted with a number of International Conferences in South Africa on pneumoconiosis. The landmark International Labour Office (ILO) Conference on Silicosis held in Johannesburg in 1930 was sponsored by the Chamber who also provided the staff to support the ILO Conference secretariat. This conference dealt predominantly with the medical aspects of silicosis.

Following the formation of the Pneumoconiosis Research Unit (PRU) in 1956, scientists from many countries were invited to Johannesburg to advise the PRU research team on the best evolution of their research projects. This resulted in the second International Conference on Pneumoconiosis held in South Africa in 1959. The Conference Rapporteurs on Dust/ Engineering were from the mining industry (Mr. D.G. Beadle) and the Chamber (Mr. P.H. Kitto, Director, Dust and Ventilation Laboratory). Several papers were presented on dust measurement and control, including papers on "Sources of Dust and Methods of Prevention", "Sources of Dust in Mines and Methods of Prevention at Source", "Behaviour of Mine Dust after Formation", "Methods of Controlling Dust after it has been Formed", and "Methods of Lessening Exposure to Dust".

Modern principles of dust sampling for hazard assessment are founded on three main recommendations adopted at the 1959 Conference in Johannesburg, which have remained largely unchanged to the present day:

- (i) measurement of the respirable dust fraction
- (ii) gravimetric assessment of the collected dust
- (iii) long period sampling to give average dust levels over a shift.

The third International Conference on Pneumoconiosis was held in Johannesburg in 1969. P.H. Kitto from the Chamber was responsible for the Dust Physics sessions and chaired the Symposium on the Engineering Aspects of Pneumoconiosis.

The first International Conference on Mine Ventilation held in Johannesburg in 1975 was organised by the Mine Ventilation Society of South Africa with Chamber sponsorship. Mr. J Burrows, Chamber, was Chairman of the Organising Committee. The aim was to enable ventilation engineers, mining engineers, academics, government representatives and others to gather together and to discuss their problems and to find solutions. An International Committee was established with Burrows as the Chairman with the primary assignment of arranging similar congresses every four years. The second International Mine Ventilation Congress was held in Reno, Nevada, USA in 1979. The 5th International Mine Ventilation Congress was again hosted in South Africa in 1992.

1.2.1 ILO

In the 1950's, the ILO established an international programme on *The Prevention and Suppression of Dust in Mining, Tunnelling and Quarrying*. The First International Report 1952-1954 (1957) had contributions from 18 Countries, including South Africa, and for the Sixth International Report 1973 – 1977 (1982), 77 countries contributed. South Africa contributed to the 1st, 2nd and 3rd Reports of 1957, 1961, 1965. This work led to the ILO publication 'A Guide to the Prevention and Suppression of Dust in Mining, Quarrying and Tunnelling' (Geneva 1965).

Information that was required to be reported by Countries to the ILO included:

Introduction

1. Minerals Worked
2. Pneumoconiosis Statistics
 - 2.1 Machinery and procedures for the compilation of statistics of pneumoconiosis, especially silicosis
 - 2.2 Actual statistics of pneumoconiosis, and especially silicosis, showing for each year covered by the report
 - (a) numbers of persons exposed to risk
 - (b) total number of pneumoconiotics
 - (c) new cases of pneumoconiosis
 - (d) deaths from pneumoconiosis
 - (e) other statistics of pneumoconiosis if possible classified by
 - (i) place of employment
 - (ii) type of work
 - (iii) duration of exposure to risk

Part 1 Legislation, Administration, Research

1. Legislation
 - Types of laws, regulations, instructions, codes of practice, etc.
2. Administration
 - 2.1 Names and scope of jurisdiction of competent authorities
 - 2.2 Reports and other publications
3. Research
 - 3.1 Names and Functions of Research Institutions
 - 3.2 Progress in research
 - 3.3 Publications

Part II Dust Prevention and Suppression Practices

1. Introduction
2. Water: Supply, Wetting agents
3. Methods of Operation and Working
4. Roof control, mine supports, measures against ground pressure
5. Drilling
6. Breaking Down Mineral: Shotfiring (blasting) Substitutes
7. Extraction of Mineral: General, Water Infusion, Coalcutting and coalgetting machines, Pneumatic Picks
8. Loading, transport and unloading of mineral and dead rock
 - 8.1 General
 - 8.2 Loading, transfer and unloading

- 8.3 Tubs, mine cars, etc
- 8.4 Scrapers
- 8.5 Conveyors
- 8.6 Chutes
- 9. Deposited dust
- 10. Airborne dust: General, Sprays, mist and fog
 - Precipitation, extraction and filtration
- 11. Ventilation: General, Main, Auxiliary
- 12. Preparation of coal, ores and other minerals
- 13. Travelling on underground roadways
 - 13.1 On Foot
 - 13.2 Mechanical transport
- 14. Personal Protective equipment
 - 14.1 Design
 - 14.2 Testing
 - 14.3 Use
 - 14.4 Maintenance
- 15. Supervision of operations and equipment for dust prevention
 - 15.1 Supervision of operations
 - 15.2 Supervision and maintenance of equipment
- 16. Education and Training of personnel
 - 16.1 Supervisory staff
 - 16.2 Workers
 - 16.3 Apprentices, learners
- 17. Special Problems: Temperature and Humidity, Pressure, Other
- 18. Other matters

Part III Airborne Dust Sampling, Measurement and Analysis

- 1. General
- 2. Sampling (Methods and Instruments)
- 3. Counting and Measurement
- 4. Analysis
- 5. Recording of Results

Appendix: Bibliography

List of official reports, important books, pamphlets, research reports, studies, articles etc., published during the period covered by the national report.

1.2.2 Global Elimination of Silicosis: ILO/WHO International Programme

The ILO/WHO Global Programme on Elimination of Silicosis was established in 1995. The objective is that every country develop its own national silicosis elimination programme, and ILO/WHO offers participating countries and institutes a knowledge base and support to ensure systematic programme development for surveillance and preventive activities. The Programme incorporates a feasible prevention strategy designed on a thorough knowledge of local conditions and the national situation, proven safety measures, and opportunities for innovations.

The immediate objective of the ILO/WHO International Programme is to promote the development of National Programmes on Elimination of Silicosis to reduce significantly the incidence rate of silicosis by the year 2010.

The development objective of the ILO/WHO International Programme is to establish wide international cooperation to eliminate silicosis as an occupational health problem by the year 2030.

The preventive strategy is based on the primary prevention approach, i.e. control of silica hazard at source (introduction of dust control measures, use of appropriate technologies, ventilation and local exhaust, process enclosure, wet techniques, substitution of less hazardous agents for silica, etc.). The secondary prevention should include the surveillance of the working environment to assess the efficiency of the dust control measures; exposure evaluation to assess the health risks for workers; surveillance of the workers' health for early detection of the disease. Implementation of the strategy is undertaken jointly by the ILO and WHO, including the Occupational Health Programme in the WHO Headquarters, the WHO Regional Offices, and the global Network of 65 WHO Collaborating Centres in Occupational Health.

Silicosis can be prevented

Many countries have succeeded in reducing the incidence of silicosis through implementation of basic preventive measures. Exposure control is the only effective means of prevention of silicosis. Workplace exposures must be monitored regularly and processes changed when harmful levels of dust are present. There is current international debate on these exposure levels.

- ? At the national level, laws and regulations; enforcement of occupational exposure limits and technical standards; governmental advisory services; an effective system of inspection; a well-organized reporting system; and a national action programme involving governmental agencies, industry and trade unions; are the necessary elements of a sound infrastructure, which is required to combat silicosis successfully.
- ? At the enterprise level, application of appropriate technologies to avoid the formation of silica-containing dust; use of engineering methods of dust control; compliance with prescribed exposure limits and technical standards; surveillance of the work environment to assess effectiveness of preventive measures; surveillance of workers health to detect early development of silicosis; use of personal protective equipment (as a temporary measure); and health education, information and training are imperative. The cooperation between the employers and workers is a prerequisite for successful action.

South African National Programme on Silicosis Elimination

At the time of this report, a South African National Programme on Silicosis Elimination does not exist although many elements of such a programme are already in place and discussions have taken place in 2003 between the Departments of Labour, Health and Minerals and Energy. Presentations were made in Brazil at ICOH 2003 on South African Efforts to address silicosis by Professor David Rees, NCOH, Department of Health, and Dr. Sophia Kisting, UCT.

1.2.3 International Occupational Hygiene Association (IOHA)

The International Occupational Hygiene Association is working with the WHO Collaborating Centres in Occupational Health Network to develop a variety of information resources on silicosis prevention. The next meeting of the WHO Collaborating Centres in Occupational Health will be at the 6th International Scientific Conference of IOHA in South Africa 19-23 September 2005 at which silicosis sessions will be held. The Chamber has sponsored the initial announcement for this Conference and Dr. DW Stanton, Chamber, is Chairman of the Conference Organising Committee.

1.3 Dust Exposures in South Africa 1990's

1.3.1 Report of the Commission of Inquiry into Safety and Health in the Mining Industry (Leon 1995)

"4.6.5 As a result of his own work, on the basis of dust measurements made between 1956 and 1960, Beadle concluded that there was little evidence of a decline in dust levels between 1938 and 1969. As a result of the work done by Du Toit and the unpublished review by King the Commission is of the opinion that dust levels have remained roughly the same over a period of about 50 years. This constitutes a priori evidence that the absence of a downward trend in the official figures for certification is correctly interpreted as a failure to control dust related disease.

4.6.6 It is not the role of the Commission to re-examine all the available evidence, but to form an opinion on the basis of the evidence submitted to it. No evidence was submitted to show that dust levels had decreased. It is a matter for concern that there is undue reliance on data which is now nearly 40 years old, and that the results of the many thousands of dust measurements which have been made in recent years have not been analysed and published in a form which makes it possible for experts in the field to describe the trends accurately, nor is it possible without access to the raw data to determine whether current sampling strategies and methods used to measure dust levels succeed in identifying the highest exposures accurately."

The closing submission of the National Union of Mineworkers to the Leon Commission stated with regard to **Respirable Dust** that *An Expert Task Force on Industrial Hygiene Should Be Established to Investigate and Monitor the Respirable Dust Hazard in Underground Mining.*

1.3.2 Report of the Committee of Inquiry into a National Health And Safety Council in South Africa (Benjamin and Greef 1997 p165)

"It is now generally acknowledged that the ODMW Act's compensation system contributed significantly to the poor control of health hazards in the mining industry as noted by the Leon Commission. First, the extremely low levels of compensation paid to black mineworkers under the ODMW Act prior to 1994, and the correspondingly low compensation assessment paid by mines, meant that the compensation system contained no financial incentive for employers to tackle dust problems in the mines.

The cost of the compensation system to employers is further reduced by the fact that the State covers the cost of administering this compensation system. Second, larger mines were permitted to monitor dust levels to determine their compensation levies. In the case of small mines, the state performed this function. The method of measurement adopted (gravimetric sampling) did not provide any meaningful feedback to control hazardous dust levels effectively. The result was a system in which more was spent on determining air quality indices for mines for the purpose of calculating contributions and on anatomical pathology than on either controlling and rectifying hazardous conditions or on compensating workers. This approach has been criticised by the Department of Health, the Leon Commission and the mining employers and trade unions."

1.3.3 An Analysis of the Burden of Occupational Lung Disease in a Random Sample of Former Gold Mineworkers in the Libode District of the Eastern Cape (Anna Trapido (2000) PhD Thesis)

Chapter 5 Dust and Occupational Diseases in the South African Gold Mining Industry

P87

"TLV standards have been criticised for several reasons. First, section 4.14.1 of the regulations of the Mine Health and Safety Act, Act 29, 1996, which was brought forward from the Minerals Act, Act 50, 1991, which was in turn, brought forward from the Mines and Works Act, Act 27, 1956 (variously amended), restricts underground risk work to 48 hours per week plus 60 minutes daily travelling time rather than 40 hours on which the TLV is based.

Secondly, TLV international standards are based on a normal respiration rate rather than on the increased respiration rate that is associated with extremes of depth (and associated heat) of the South African gold mines. The depth and heat is likely to cause an increase in the ventilation requirements of South African gold mineworkers for any given work load. And places them at a further disadvantage vis a vis other hard rock miners working at lesser depth. Consequently, the TLV formula fails to adequately protect South African mineworkers."

Conclusion (p107)

"This chapter has shown that there is a high silica content in the reef formation of the Witwatersrand gold fields and that there are high prevalences and incidences of occupational lung diseases which result from the inhalation of silica dust. This chapter makes it clear that while South Africa has had a gold mining industry for over a century and whereas legislated dust management mechanisms and regulations have been in place for most of that time, the prevalence of silicosis, tuberculosis and COPD presented above, indicate that neither past nor present practices are safe."

"Previous legislation has been criticised for its artificial separation of occupational hygiene surveillance from the surveillance of occupational disease. This has led to a culture within the South African Mining Industry which has concentrated on monitoring dust levels rather than monitoring disease prevalence and finding engineering solutions to reduce dust levels."

1.3.4 SIMRAC Occupational Health Handbook 2001

Chapter 5: Occupational Lung Disease - Prof. Neil White

"Beadle believed that there was little evidence of any improvement in dust exposure levels in the years between 1938 and 1969. This finding still has relevance. In 1995 the Leon Commission concluded that there had been little significant change in dust exposure in South African gold mines for fifty years. In 1999 the National Centre for Occupational Health published data based on 26 000 underground dust measurements in 48 South African Gold mines from 1995 - 1997. Only 8 (17%) of these mines had all of their estimated time weighted average (TWA) measurements for respirable quartz below the DME's standard of 0.1 mg/m^3 . Of the remainder, 21 mines (43%) had a high proportion of dust measurements in the range $0.1 - 0.4 \text{ mg/m}^3$, whilst 19 (40%) had most of their measurements above 0.4 mg/m^3 ."

1.4 SIMRAC Research

Several SIMRAC projects have addressed exposure-response assessment, dust measurement and dust suppression.

SIMRISK 401 (1997)

Exposure data for airborne dust in South African mines is presented in SIMRAC Report SIMRISK 401 and includes data from the DME dust exposure database. It was stated that despite the availability of a comprehensive airborne dust database, there is considerable uncertainty on the exposure of mineworkers to dust. The reliability of the sampling equipment used and the strategies used by mines for dust monitoring have been called into serious question with a strong suspicion that dust levels may be substantially under-reported.

Note: A limited amount of exposure data from the DME dust database has been published in recent annual reports of the DME.

GAP 440 (1997)

Respiratory Effects of Exposure to Crystalline Silica

Dr Eva Hnidzo and collaborators reviewed the evidence from previous studies of the exposure-response relationship and also reported on two additional studies of silica exposure related to pulmonary tuberculosis and chronic obstructive lung disease.

The results of a cohort study of the incidence of pulmonary tuberculosis (PTB) in white gold miners, followed for 25 years from 1970 to 1995, have important implications for medical surveillance and compensation practices for miners exposed to silica dust since:

- ? The risk of PTB is increased in miners with silicosis;
- ? The risk of PTB displays a dose-response trend with cumulative silica dust exposure in the absence of silicosis;
- ? PTB was diagnosed on average 7.6 years after cessation of silica dust exposure; and
- ? Of the PTB cases who had silicosis, 90% had x-ray evidence of silicosis before PTB was diagnosed.

Another cohort of white gold miners was restudied for a 20 year period beyond cessation of exposure to dust. It was discovered that 50% of miners who developed radiological silicosis did so after exposure to dust had ceased - a finding which should lead to renewed efforts to reduce silica exposure and a review of medical surveillance in ex-miners.

The results of a comparative study of autopsy findings and in life disability from chronic obstructive airways disease (COAD) showed a severity linked relationship between emphysema diagnosed post mortem and in life airflow impairment and difficulty in breathing (dyspnoea). Bronchitis of varying severity was associated with only mild airflow impairment. Tobacco smoking was associated with all the COAD outcomes.

HEALTH 606 (2003)

Silicosis prevalence and exposure response relationships in older black mineworkers on a South African goldmine.

The setting was a goldmine in the Free State where a sample of 520 mineworkers underwent medical examinations, including a questionnaire and chest x-ray. Amongst these 520 men, 85 different occupations were represented. Cumulative dust exposures were calculated for each individual by incorporating all jobs worked by an individual on the mine and a time weighted average (TWA) respirable dust and quartz concentration assigned to each job. The assumption was made that current dust concentrations are a reasonable proxy for average dust concentrations experienced in those jobs over the previous three decades, and similarly for average quartz fractions. All the workers in the sample were reported to have worked at an average exposure to quartz below the current OEL of 0.1 mg/m^3 .

The report conclusions were that:

- ? Using ILO profusion =1/0 as the definition of silicosis, the prevalence was 23.9 percent. Using the ILO profusion =1/1 as the cut point, the prevalence of silicosis was 18.3 percent.
- ? Almost one in five of these older, longer service black mineworkers had developed silicosis, despite having worked for an average of 22 years with average quartz concentrations under the OEL.
- ? Allowing for the fact that the sample in this study was chosen to represent older mineworkers, if one extrapolates these results to the goldmining industry in general, they confirm the existence of a significant epidemic of silicosis in the industry.
- ? The findings support the conclusion of Hnizdo and Sluis-Cremer ten years ago in 1993 as well as international practice, that a reduction of the OEL from 0.1 mg/m^3 is indicated to substantially reduce the risk of silicosis. Both that study and the current one suggest that a reduction to at least 0.05 mg/m^3 will be necessary to substantially reduce the risk of silicosis.

2 OBJECTIVES FOR SIM 02-06-03 PHASE 1

In 2002, SIMRAC established a long-term project to eliminate silicosis in the South African Mining industry (SIM 02-06-03). The objectives of Phase 1 were to:

- ? Establish control targets and define scope of research programme for Phase 2 on the basis of regional workshops and a national workshop
- ? Document best practice for evaluating current practice in measurement and analysis; and
- ? Develop the Phase 2 proposal for essential research to establish current practice and evaluate interventive measures.

3 METHODS

3.1 Regional Silicosis Elimination Workshops

It was agreed through the MOHAC Research sub-committee that an approach would be made to the Mine Ventilation Society of South Africa to hold through their various branches workshops on silicosis elimination. The workshops were to be open to anyone with an interest in silicosis elimination. A presentation to the MVS was made on the 12th July 2002 and shortly after this the MVS agreed to organise through their branches workshops on Silicosis elimination. A workshop was held by the MVS Western Branch on the 19th November 2002 at the Kloof Country Club (Kloof Gold Mine) and the MVS Collieries Branch on the 5th February 2003 at the SACE Recreation Club, Near Witbank. Over sixty persons attended the MVS Western Branch Workshop and some thirty people attended the MVS Collieries Branch Workshop. The latter meeting was held at short notice but the recommendations were then sent to a wider audience for comment and input.

The workshop programmes were similar with the first half of the workshop consisting of an update on efforts to date to address silicosis followed by workshop sessions covering environmental engineering/dust control, dust measurement and reporting, medical surveillance, compensation and reporting, human resources, training and management. The recommendations from the two Regional Workshops are provided in Annexure A.

3.2 National Workshop

The National Workshop was held at the Devonshire Hotel, Braamfontein, Johannesburg, on the 19-20 March 2003. Approximately ninety persons attended the National Workshop. The recommendations prepared by the facilitators are included in Appendix B.

Following the National Workshop a special meeting of MOHAC was held at SIMPROSS when the Regional and National Workshop recommendations were reviewed and the recommendations made for the research to be conducted in Phase 2 of the SIMRAC Project on Silicosis Elimination. Following the MOHAC meeting draft documents were prepared at the Chamber of Mines by Bruce Doyle, Ralph McIntyre, and Ronald Motlhamme, DME and David W Stanton, Chamber, to reflect the MOHAC recommendations. The draft documents were then worked on at SIMPROSS by Mary Ross, SIMPROSS, and David W Stanton and distributed for comment to MOHAC. The documents were tabled at the MOHAC meeting on the 8th May 2003 when members were given further time to provide any further corrections to the recommendations. No amendments were received.

3.3 26th International Congress of the ICOH

The ILO and WHO organised silicosis sessions at the 26th International Congress of the International Commission on Occupational Health (ICOH) held in February 2003 in Brazil. Various countries reported to the Congress on their efforts to control silicosis. Two project team members attended the Congress to participate in the silicosis sessions, meet the members involved in the international effort and obtain information on international activities in eliminating silicosis. The information is summarised in Appendix C of this report.

4 RECOMMENDATIONS AND SIM 03-06-03

4.1 Workshop Content and Recommendations

The recommendations from the regional workshops are in Appendix A and the recommendations from the National workshop in Appendix B.

Presentations and discussions on silicosis elimination were made at six meetings around the country of the Aggregate and Sand Producers Association of South Africa (ASPASA) in February 2003. ASPASA members felt they would like to be supported by a programme similar to that available from the National Industrial Sand Association (NISA) in the USA. This includes educational material on dust control in the form of videos, brochures plus technical support. Another important issue raised was environmental pollution by dust.

4.2 Website

In addition, information on, recommendations from, and the presentations made at the workshops have been published on the Internet at the following website:

<http://silicosis.sheafrica.info>

This is a subdomain of the ILO/WHO Joint Effort on Occupational Health and Safety in Africa website "www.sheafrica.info".

The PowerPoint presentations were converted to Flash by the software POWERConverter for posting on the web in a smaller file size and streaming media format. PDF files also created with six (6) slides per page.

A compilation of all the papers from Day 1 and Day 2 of the National Workshop are available as PDF files (Six slides per page) via the National Silicosis Elimination Workshop page:

http://silicosis.sheafrica.info/national_workshop.htm

The website also includes links to the WHO Global Elimination of Silicosis programme website and links to silicosis information from around the world.

4.3 Phase 2 : SIMRAC Silicosis Control Programme

Phase 2 of the project, Sim 03-06-03, is to research the containment/elimination of silicosis in the South African mining industry as identified in regional and national workshops. This phase has been scoped as three components identified as separate research areas during the workshop process of Phase 1:

- ? Part A Dust Measurements and Reporting
- ? Part B: Environmental Engineering/ Dust Control
- ? Part C: Human Resources Training and Management

Each of these components has been further subdivided into the research to be conducted over the five year duration of Phase 2.

Phase 2: Part A Dust Measurements and Reporting

Motivation

SIMRAC is a partner in the WHO/ILO initiative for the global elimination of silicosis. Since its establishment in 1994, SIMRAC has funded projects in dust measurement and control, but silica exposure, with related silicosis and tuberculosis, remains a priority challenge for the mining industry. It is essential to evaluate the existing practice in relation to control requirements, set exposure reduction targets and established best practice to meet these targets for silica exposure. In addition, new technologies for preventing or allaying dust pollution should be reviewed and research conducted, if necessary. This project is to research the containment/elimination of silicosis in the South African mining industry as identified in regional and national workshops.

Previous SIMRAC research and the lack of progress in eliminating silicosis highlighted the problem of measurement, analysis and reporting of respirable dust exposures. This includes the re-emphasis on high peak exposures which have not been measured and for which adequate measurement instrumentation has not been developed. SIMRAC has prioritised dust measurement and reporting as an area for research in the Silicosis Control Programme.

Primary outputs

- ? Evaluate the techniques used in South African mines for determination of exposure to respirable crystalline silica. This includes the sampling instrumentation; sampling strategies, sample analysis, quality assurance/control and reporting which will be compared with best practice.
- ? Review and assess techniques used in South African laboratories for respirable silica analysis on filter samples and the implementation of an international quality control check with standard samples on the laboratory analysis performance.
- ? Develop standard samples for instrument calibration for quartz analysis.
- ? Develop a manual of best practice for the assessment of exposure to respirable crystalline silica, including field survey work, laboratory analysis and reporting.
- ? Develop a manual of best practice to assess the engineering and other control measures in place to minimise exposure to crystalline silica.
- ? Review inspection/enforcement around the world with regard to silicosis prevention.
- ? Develop a manual of best practice for the inspectorate to assess worker exposure to respirable crystalline silica and the verification of mine data.

Year 1 - 3

- ? Assessment of current practice of measurement and analysis for respirable crystalline silica. *(Including collection characteristics of samplers operated according to the JHB criteria and the ISO/CEN criteria)*
- ? Characterisation of the particle size of airborne mine dust from various dust sources. Assessment of the crystalline silica content in the various size fractions. *(Link to filtration efficiency and general control techniques in Phase 2 Part B)*
- ? Implement International quality control testing and standardisation for crystalline silica on filter analysis.
- ? Comparison of South African practice with international best practice.
- ? Compile manuals on best practice:
 - ✍ to assess exposure to airborne respirable crystalline silica.

- ✍ for the inspectorate to assess the exposure of workers to airborne respirable crystalline silica and to verify mine dust exposure data.
- ? Further development and piloting of real-time respirable dust measurement instrument.

Year 4 - 5

- ? Compile manuals on best practice with which to assess the engineering and other control measures in place to minimise exposure to crystalline silica. (Linked to project on engineering controls).
- ? Further piloting and evaluation of real-time dust measurement instrument.

Scope

Requires the research team to obtain information on the current practice for the determination of exposure to respirable silica dust through visits to a selected sample of mines and to all laboratories in South Africa conducting quartz on filter analysis. Assessment of current practice in developed mining countries compared to South African practice. The compilation of best practice manuals, which would guide the mining industry to work towards the elimination of silicosis in the mining industry.

Estimated duration and cost (5 years, R8 000 000)

NB Includes budget for Health 704 Extension

Year 1 :	R1 500 000
Year 2 :	R2 500 000
Year 3 :	R2 000 000
Year 4 :	R1 000 000
Year 5 :	R1 000 000

Potential impact on significant health and safety risks

Very high potential impact by producing implementable best practice manuals for the assessment of respirable silica exposures. Real time monitoring capability.

Requirement for technology transfer

Assessment of effectiveness of legislation and current practices.
Best practice manuals to assess exposure to respirable crystalline silica.

Specialist Skills and Facilities

Occupational Hygiene
Laboratory quality control and crystalline silica on filter analysis techniques
Instrumentation and Electronics Engineering
Aerosol Physics

Phase 2 Part B: Environmental Engineering/ Dust Control**Motivation**

SIMRAC is a partner in the WHO/ILO initiative for the global elimination of silicosis. Since its establishment in 1994, SIMRAC has funded projects in dust measurement and control, but silica exposure, with related silicosis and tuberculosis, remains a priority challenge for the mining industry. It is essential to evaluate the existing practice in relation to control requirements, set exposure reduction targets and established best practice to meet these targets for silica exposure. In addition, new technologies for preventing or allaying dust pollution should be reviewed and research conducted, if necessary. This project is to research the containment/elimination of silicosis in the South African mining industry as identified in regional and a national workshop.

The most important intervention for any silicosis control programme is to eliminate or reduce dust at source and to prevent exposure. SIMRAC has targeted feasible or cost-effective environmental control engineering and dust control technology as a research priority area for the silicosis control programme.

Primary outputs

- ? Risk assessment to identify the priority dust sources and the applicable control technologies.
- ? Assess the filtration efficiency for respirable dust of the current filter media used for dust control.
- ? Compile internationally accepted best practice materials, including manuals, for dust control.

Year 1 - 2

- ? Assess and prioritise dust sources and determine the contribution of each source to the overall exposure. *(Incorporate use of PIMEX)*
- ? Review new technologies for breaking and moving rock with regards to potential for dust exposure minimisation.
- ? Identify and assess the different control technologies (existing and new) used for each identified dust source for a range of commodities and size of mine. *(Link to particle size distribution research in Part A of Phase 2)*
- ? Assess the filtration efficiency for respirable dust of the current filter media used for dust control. *(Link to assessment of crystalline silica content in various size fractions in Part A of Phase 2)*
- ? Comparison of results with international experience to determine best practice for controlling the various identified dust sources. *(To include dust control methods evaluation workshop with national and international experts)*
- ? Pilot and evaluate potentially cost effective dust control methods.
- ? Develop draft best practice manuals for South African mines including design component for new mines.
- ? National workshops on draft best practice manuals.

Year 3 - 5

- ? Design, pilot and evaluate comprehensive dust control programme.
- ? Determine worker exposures with best practice implemented.
- ? Finalise best practice materials, including manuals, to control exposures to respirable crystalline silica.

? Technology transfer of best practice materials.

Scope

Requires the research team to obtain information on current local and international practice for dust control through visits to selected sample of mines and communication with dust control experts. Assessment of current practice in developed mining countries compared to South African practice. Pilot potentially cost effective dust control methods. The implementation of the recommendations of the best practice manuals on pilot mines and the assessment of workers exposures. The compilation of best practice materials, including manuals, which would guide the mining industry to work towards the elimination of silicosis in the mining industry.

Estimated duration and cost (5 years, R11 000 000)

Year 1:	R2 500 000
Year 2:	R2 500 000
Year 3:	R2 000 000
Year 4:	R2 000 000
Year 5:	R2 000 000

Potential impact on significant health and safety risks

Extremely high potential impact by producing implementable best practice for the control of exposure to respirable crystalline silica.

Requirement for technology transfer

Assessment of effectiveness of legislation and current practices.

Best practice manuals specific to mining commodities for the control of exposure to respirable crystalline silica, covering surface and underground mines and mineral processing plants.

Specialist Skills and Facilities

Occupational Hygiene, Mechanical and Mining Engineering
Aerosol Physics and Dust Control Expertise
International Collaboration

SIM 03-06-03 SIMRAC Silicosis Control Programme – Phase 2

Phase 2 Part C: Human Resources Training and Management

Motivation

SIMRAC is a partner in the WHO/ILO initiative for the global elimination of silicosis. Since its establishment in 1994, SIMRAC has funded projects in dust measurement and control, but silica exposure, with related silicosis and tuberculosis, remains a priority challenge for the mining industry. It is essential to evaluate the existing practice in relation to control requirements, set exposure reduction targets and established best practice to meet these targets for silica exposure. In addition, new technologies for preventing or allaying dust pollution should be reviewed and research conducted, if necessary. This project is to research the containment/elimination of silicosis in the South African mining industry as identified in regional and a national workshop. Close collaboration is required with the dust measurement and dust control projects on silicosis elimination.

In the 1960's the South African mining industry held a leading position in research on dust exposure and control and also in education and training about dust. This needs to be re-established using current educational methods and technology, which have developed in the intervening years, to raise awareness about dust exposure and health effects. SIMRAC has targeted the area of human resources training/technology transfer as one of the priority areas for the Silicosis control programme.

Primary outputs

- ? Development and the evaluation of a range of training and educational material to promote the elimination of silicosis in the mining industry.
- ? Technology transfer using material of such a standard that it could be adopted internationally.

Year 1 - 2

- ? Review and evaluation of existing training and educational material, on airborne dust, locally and internationally.
- ? Assessment of end user awareness and solicit input.
- ? Develop training materials for:
 - ✍ Specialists responsible for dust control
 - ✍ Management
 - ✍ Trade unions / health and safety representatives.
 - ✍ Workers

Year 3 - 5

- ? Use pilot mines to evaluate training and educational material.
- ? Use feedback to update and finalise technology transfer material including material from the two parallel projects on dust measurement and control.
- ? Develop technology transfer to popularise the training and educational material and conduct regional technology transfer sessions.

Scope

Requires the research group to obtain and evaluate current local and international practice for dust minimisation campaigns. The development of the appropriate training and educational material for dust minimisation for a range of personnel. The training material will include booklets, manuals, posters, and multimedia software (such as PIMEX) which will illustrate *inter alia* the health effects, dust measurement and control.

Estimated duration and cost (5 years, R5 000 000)

Year 1:	R1 000 000
Year 2:	R1 000 000
Year 3:	R1 000 000
Year 4:	R1 000 000
Year 5:	R1 000 000

Potential impact on significant health and safety risks

Very high potential impact by producing implementable training and educational best practice for the minimisation of exposure to respirable silica.

Requirement for technology transfer

Assessment of effectiveness of legislation and current practices.
Best practice resources to control exposure to respirable crystalline silica, covering surface and underground mines and mineral processing plants.

Specialist Skills and Facilities

Occupational Hygiene and Engineering
International Collaboration
Adult Education Expertise
Multimedia Developers

APPENDIX A - RECOMENDATIONS FROM THE REGIONAL WORKSHOPS

MVS WESTERN BRANCH WORKSHOP 19 November 2002

Kloof Country Club (Kloof Gold Mine)

AIR MONITORING AND ENGINEERING CONTROL

1. What are we doing now? Is it working well?

CURRENTLY DOING	WORKS WELL?
CoP for airborne pollutants	? Time will tell
- Monitoring (Just doing it to comply with legislation and to meet minimum requirements) - Gravimetric monitoring	Old Regime – X New Regime - X
Fragmentation of the discipline – not controlled or communicated	X
Communication - Not disseminated (poor sharing of information between departments, e.g. hygiene and medicine) - Not two-way and there is no feedback -	X
Training - For the specialists - Empowerment (education) - Not broad enough	X
Planning - Original planning - Annual planning to ensure within original boundaries - Adherence - Maintenance	X
Filtration Systems - Dust control equipment not effective - Improved SABS std on Filter Efficiency Testing - Filter efficiency tests required	X
Quartz Analysis - Current methodology accurate - Quarterly or 6 monthly - Physiological reactivity	? ? ?
Multiskilling - Executing of an occupational function, e.g. stopes - Monitoring	X

2. What do we think we know, but are unsure of the results?

- PPE/RPE
 - o Not giving the most appropriate PPE to the workers
 - o Use of respirators
- Analysis of the samples
 - o Not getting similar results from parallel samples
- Total effects on the body
- All the sources of dust exposure
- Time of dust exposure
- Adverse effects of chemicals added to water for dust suppression
- Quartz Characteristics
 - o OEL for quartz
 - o Radiation effects
 - o Type of quartz activity
 - o Compounding factors (cocktails)
- Blasting procedures and exposures
- Best practices
- Efficiency and effectiveness of controls
 - o Dust filters (thought efficiency is in order, but unsure of effective size span)
 - o Footwall treatment (methods and effectiveness)
- Training
 - o Specialist
 - o Employees
 - o Basic training (physical)

3. What don't we know and need to research?

- Establish a training academy of excellence
 - o Refresher courses
 - o Theoretical knowledge and practical sessions
 - o Specialist training
 - o Best practices (updated)
 - o 'A' courses
- Communication
 - o Research information consolidated into a user friendly booklet and disseminated
 - o Ongoing best practices document managed and updated by a person with good knowledge and understanding of the industry
 - o Ongoing best practices document disseminated to all mines
- Influence of diesel particulates
 - o Influence of sampling accuracy
 - o Cross contamination effect
- Backfill
 - o Alternatives to prevent spillage
 - o Transportation of backfill
- Global research
- Instruments
 - o Real time for dust measurement
 - o Size distribution and silica content
- Effects of short-term high exposures

- Determination of practical size distribution
- Dust characteristics produced by different mining operations
 - o Mechanical side
 - o Chemical side
 - o Examples from platinum mining
 - o Dust suppression during blasting
- Predictive tests for toxicity of particles
- Suspended particles in water – how much of a contribution
- An industry forum
- Costing and effect of dust exposure on production
- Effectiveness of different controls
- Costing of different controls
 - o Engineering
 - o Admin
- Ergonomics

MEDICAL SURVEILLANCE

Three pertinent questions were raised at the workshop on medical surveillance. The questions were as follows:

- ? What are we doing now?
- ? What do we think we know, but are unsure of the results?
- ? Research Requirements

1. What are we doing now?

Medical surveillance is routinely performed on workers exposed to silica dust. However, members believe that:

- ? Medical surveillance is not conducted as well as it should
- ? The competency for reading chest x-rays is poor
- ? Chest x-rays are a blunt tool for medical surveillance

Reporting:

Currently, the industry reports cases of silicosis for compensation purposes. Members are of the opinion that the following reporting should be considered:

- National
 - Should we not also consider reporting cases of acute silicosis
 - E.g. 25 – 30 year olds (as notifiable accidents)
 - Acute silicosis (as notifiable accidents)
- Company level
 - Burden of the disease
 - Trends and related costs

Informing employees:

Employees must be familiar with all issues relating to prevention and healthcare promotion and compensation. Doctors do not necessarily have to perform this

function, but could facilitate the referral of employees to a service that provides education and training on such issues.

1. *Informing the worker:*
 - At an individual clinical level (doctor-patient relationship)
2. *Lobbying at company and national level:*
 - Making management aware of trends

2. What do we think we know, but are unsure of the results?

Extensiveness and severity of silicosis:

- The current workforce constitutes a highly select group
- Do we know what happens after employment?

National level:

- How many workers are exposed to silica?

Where are ex-miners going to be diagnosed?

- How do we communicate dust-disease to medical practitioners outside the field

3. Research Requirements

There is a need for more effective or sensitive diagnosis tools than X Ray?:

- Pre-silicosis marker?
- Metal content in skin?
- Something else?

It is important to understand the toxicity of different morphologies of silica?:

- Freshly fractured silica?
- Heated silica?
- Coated silica?

What can halt / slow the disease?

Why do 60% - 80% of people not get silicosis?:

- Marker for pre-disposition?
- Dose related?
- Genetics?

What are the long-term effects that are associated with short, sharp dose exposures (e.g. blasting)

What are the confounders?:

- Age?
- Smoking?
- Radiation?
- Fumes?

What co-factors enhance the toxic effects?:

- TB?

Factors that impact on the progression of the disease?:

- Genetic?

- Exposure?

Is there a need for prospective longitudinal study that can provide us with a better understanding of the dose-response relationship?

HR / TRAINING AND MANAGEMENT ISSUES

(Note all the points below refer to the training and awareness of Silicosis specifically)

- ? There is a training deficiency at all levels with a gravely insufficient focus on silicosis; there is a lack of knowledge on available learning materials.
- ? Programs are too superficial and do not give sufficient detail, employees are not fully aware of the nature of the danger and their rights surrounding this.
- ? Behaviour based training systems taking cognisance of the technical input need to be developed and implemented – programs must focus more on changing behaviour and attitudes as opposed to a superficial passing on of information. (Train the trainers!)
- ? Consolidate available learning materials and other SIMRAC research for the provision of a generic training package, which must be aligned with SAQA standards.
- ? Specialised training and education programmes need to be developed for different target populations.
- ? A system needs to be developed for other operational personnel to be involved in the evaluation of the effectiveness of training programmes – there must be a follow up system, the awareness must be continuously reinforced.
- ? Motivating factors for safe behaviour must be determined, are the motivating factors currently more in favour of non-safe behaviour?
- ? Establish a networking system for training providers across the industries.
- ? Develop a generic costing formula for non-conformance – Real time. Teams at the rock face and their managers must be personally accountable.
- ? What is the base line level of awareness on silicosis (Mine specific)

MVS COLLIERIES WORKSHOP 5 FEBRUARY 2003

SACE Recreation Club, near Witbank

DUST MEASUREMENT AND CONTROL

1. What are we doing now? Is it working well?

CURRENTLY DOING	Works well?
Suppression practices	
? Treated travelling surfaces (Dustaside)	? Yes
? Load/movement sensors on conveyor belts activating sprays	? Yes
? Maintenance of systems	? Can improve
? Service water treatment/filtration to provide clean water for dust suppression	? Yes
? Kloppersbos CM dust suppression systems	? Yes
? Wet-head dust suppression systems	? Time will tell

2. What do we think we know, but are unsure of the results?

Occupations with suspected/confirmed high exposure levels
? Loader operators (shuttle cars, haulers)
? Conventional mining – coal cutter operators
? Roofbolt operators/on-board roofbolt operators
? Stoneduster operators
Casual exposure of in-section workers to high stonedust concentrations
Properties of pollutants
? Effects of high exposure levels of stonedust
Contamination of air by ESCOM stack fall-out (areas in contamination plume)
Sampling strategy
? Information obtained from the employee sampled poor/uncertain/unreliable
? Awareness of persons sampled needs to be improved regarding the importance of adhering to sampling protocol (and understanding of the reasons why sampling is being done)
? Changes in sampling parameters (1.9 – 2.2 l/m and 7 – 10 µm) – how to relate old and new data.
? Above change resulting in order of magnitude increases in sample results
? Establishment of HEGs for silica exposure not possible with present system – results obtained from composite samples
New guideline (CoP Airborne pollutants) suggests sampling frequencies that do not fit into the turnaround times involved with silica analysis

3. Research requirements

Analysis for silica
? Shorter turnaround times (bulk required takes 4 – 12 months to accumulate) Cost factor (aim for >R200/sample)
Training/awareness material
? Development of generic material (video, poster, lesson plans, presentations) Contamination of air by ESCOM stack fall-out (areas in contamination plume)

MEDICAL RESEARCH OBJECTIVES

- ? Methods for the early detection of Silicosis to be researched.
- ? Reflect on the characteristics of the particle being inhaled size distribution, the effect and cause of coal workers pneumoconiosis. Correct fraction size to determine and measure the risk is required.
- ? Particles below 1 micron do not feature in the current gravimetric sample.
 - ? Diesel influence
 - ? Radon influence
- ? Silicosis exposure characterization for the various mining areas – gold, coal etc, allows for retrospective analysis.
- ? Alternative methods for diagnosing x-ray readings
- ? Methods to be researched to determine individual susceptibility to the exposure to silica, dose response, (fine line of self infliction to speed up the process smoking effects)
- ? Work practices administrative controls
- ? Determination at which rate silicosis reacts after being removed from the dust environment, rate at which the affliction accelerates after retirement.
- ? Synergy for various trade organizations e.g. (Columbus stainless) with SIMRAC.
- ? The effects of dust generated from the Opencast dumps / gold mine dumps on individuals living close proximity to these areas. Properties of silica dust fresh from the underground workings versus the dump dust.
- ? Methods to improve the awareness
 - ? Health education training
 - ? Means to filter research work to the employees
 - ? Various media such as video versus conferencing

APPENDIX B

NATIONAL SILICOSIS ELIMINATION WORKSHOP 19-20 MARCH 2003

Devonshire Hotel, Braamfontein, Johannesburg

DUST MEASUREMENT

Aspect of dust measurement	Is further action required?	Action required
Personal monitoring		
? Equipment		
✍ Pump	No	
✍ CIP10	Yes	De-regulate
? Methodology		
✍ DME directed method	Yes	- Carry out a comparative study between the DME method and a scientific based method to check the validity and practicality of the DME method - Do a comparison between sampling at 1,9 l/minute and 2,2 l/minute - Comparison between routine and periodic sampling
? Analysis		
✍ Accredited laboratories and their capacities	Yes	- Identification of accredited laboratories - What methodology is appropriate for analyzing quartz from hard rock mines?
? Quality assurance	Yes	- This to be linked and scoped into any study that seeks to establish validity
Engineering monitoring	Yes	- Characterization of dust in the industry as a whole - Guideline for Environmental Engineering sampling strategy
Reporting	Yes	- Guideline on reporting both to the DME and internally, covering control measures and corrective actions adopted - Linkage between occupational health and occupational medicine surveillance data base

ENVIROMENTAL ENGINEERING DUST CONTROL

Aspect of dust control	Is further action required?	Action required
Dust generation		
Rock breaking ? Vertical mechanical boring including slipping and lining ? Shaft sinking ? Drill and blast ? Multi-blasting ? Hydropower equipment ? Mining methods/ processes ? Crushing and tipping	Yes for all	Find ways to contain dust and pressure Procedures for face cleaning and preparation Performance specification for dust control for all types of drill Prioritize the dust generation capacity of each of these activities and design appropriate controls
Rock conveyance Horizontal transport ? Water jetting ? Scraping ? Trimming & tipping ? Conveyor belts ? Mechanical loaders ? Footwall & sidewall dust ? Trucking Vertical conveyance ? Station to station conveyance ? Ore passes ? Skips ? Backfill conveyance ? Mud pumping ? Piston effect ? Measuring flask system ? Shaft/station washing	Yes	Prioritize the dust generation capacity of each of these activities and design appropriate controls
Maintenance ? Truck busting/salvage ? Blowing over ? Barring down/make safe ? Watering down ? Water quality ? Dust suppression systems	Yes	Prioritize the dust generation capacity of each of these activities and design appropriate controls
Dust removal (U/G & surface) ? Filtration	Yes	? Assess the effectiveness of all filtration systems and recommend best practice ? Industry guideline on tip filtration systems ? Systems to quantify stack emissions
Planning and controlling	Yes	? Optimum design criteria
PPE	Yes	? Specifications for the appropriate PPE ? The ergonomics of PPE and personal preferences ? Training and awareness for the need and correct use of PPE
Training	Yes	? Awareness package strategy for specialists and promotional road shows to cover all employee categories. SIMRAC to provide strategy and ways to monitor its effect

MEDICAL SURVEILLANCE

- ▶ The need for a more sensitive screening tool – such as a bio-maker.
- ▶ The development of x-ray reading standards that can be used to diagnose TB in the presence of silicosis. The ILO standard films fall short in this respect.
- ▶ The need to quantify the risk of developing cardio-pulmonary TB following cumulative exposure to silica dust (in the absence of radiological silicosis).
- ▶ The need to look at TB chemoprophylaxis, taking stock of current research initiatives.
- ▶ Look at the incidence rates per exposure and per length of service.
- ▶ Look at the impact of short peak exposures on the development of silicosis.
- ▶ Look at factors that impact on the progression of the disease.
- ▶ Look at ways of improving the performance, recording, storing, analysing and reporting of medical surveillance.
- ▶ Look at challenges facing smaller operations.
- ▶ Consider behaviour research projects.
- ▶ Consider lung cancer and multiplicative exposures
- ▶ Consider a prospective study - for dose-response relationship
- ▶ Look at issues related to administrative control such as:
 - returning to a dusty area after an episode of TB
- ▶ What co-factors enhance the toxic effects?
- ▶ What can halt or slow the disease?
- ▶ What are the effects associated with short, sharp high dose exposures (e.g. blasting)?
- ▶ The need to understand the toxicity of different morphologies of silica.
 - ▶ Freshly fractured silica
 - ▶ Heated silica
 - ▶ Coated silica

APPENDIX C

Silicosis Sessions - 27th International Congress on Occupational Health (ICOH 2003), Iguassu Falls, Brazil 23-28 February 2003

Programme

SPS (Symposium) 36: Silicosis (1) Global Trends on Silicosis - Part 1

2:00 - 4:00 pm Tuesday 25 February 2003

Round Tables

- ? Global Trends on Silicosis - Gregory Wagner (NIOSH, USA)
- ? Reducing the Global Burden of Silica-Related Disease - Tee L. Guidotti (USA)
- ? Control of Silica Exposure Is it Possible - Berenice Goelzer (Brazil)
- ? PM Silica and Cancer: Evidences after 1996 - Ubiratan de Paula Santos (Brazil)

SPS 36: Silicosis (1) Global Trends on Silicosis - Part 2

4:20 - 6:30 pm Tuesday 25 February 2003

Experiences Gained

- ? Switzerland - Michel P. Guillemin (Switzerland)
- ? The United States - Gregory Wagner (USA)
- ? Sweden - P. Malmberg (Sweden)
- ? Japan - Naomi Hisanaga (Japan)
- ? Silica and Silicosis in Japan - Unresolved Issues - Ken Takahashi (Japan)

SPS 47: Silicosis (2) ILO/WHO Global Program on Elimination of Silicosis - Part 1

2:00 - 4:00 pm Wednesday 26 February 2003

National Programme Reports

- ? The ILO/WHO Global Program on Elimination of Silicosis - Igor Fedotov (ILO)
- ? National Program in Vietnam - Nguyen Khac Hai (Vietnam)
- ? National Program in Thailand - Wilawan Juengprasert (Thailand)
- ? National Program in India - H.N. Saiyed (India)
- ? National Program in China - T. Jin (China)
- ? National Program in South Africa - David Rees and Sophia Kisting (South Africa)

SPS 54: Silicosis (2) ILO/WHO Global Program on Elimination of Silicosis - Part 2

4:30 - 6:30 pm Wednesday 26 February 2003

National Programme Reports (cont.)

- ? National Program in Russia - Nikolai Izmerov (Russia)
- ? Report from Brazil - Eduardo Algrant (Brazil)

Panel Discussion

Future Development of the ILO/WHO Global Program on Elimination of Silicosis

Other Papers Presented on Silica/Silicosis

- ? Exposure Modelling for Quartz Exposures in Aluminium Foundries - Westberg, H.; Bellander, T (Sweden)
- ? A Birth of the 2000 ILO International Classification of Radiographs of Pneumoconiosis - Suganuma, N et al (Japan)
- ? Pneumoconiosis Prevalence in Coal Miners in Turkey - Cimrin, A.H. et al (Turkey)
- ? Prevalence of Silicosis in Quarry Workers, Rio de Janeiro, Brazil - Araújo, A. J. et al
- ? Prevalence of Respiratory Disease in Ukrainian Coal Miners - Vcohen, R.A. et al.
- ? Respirable Coal and Silica Dust Levels in Ukrainian Coal Mines - Cohen, R.A. et al
- ? Prevention and Control of Silicosis - Indian Experience - Saiyed, H.N. et al (India)
- ? Serum ACE, Serum Copper as a Biomarker of Silicosis and Silicotuberculosis - Karnik, A.B et al (India)

Report on Silicosis Workshops

Strategies of different participating countries

Elimination versus eradication

- ? Eradication, which would require complete elimination of silica exposure, is not feasible since the exposure to silica is an inherent result of the mining process, particularly in some mining commodities. With eradication, control becomes superfluous but surveillance and organisation have to be excellent.
- ? Elimination is the target of the WHO/ILO programme and entails reduction of new cases of silicosis to a near zero level. This has been achieved in some developed countries which do not have extensive mining operations but do include Switzerland where there were coal mines but of more note there have been extensive tunnelling activities akin to mining
- ? Control is the progressive reduction of new cases of silicosis until the "acceptable level" i.e. eradication level is reached

Beyond silicosis – silicosis is a part of a larger strategy

- ? ILO and Japan – silicosis is part of a wider work-related cancer strategy since the carcinogenic properties of silica assume a more important focus as silicosis per se decreases
- ? USA – silicosis is one disease within a wider comprehensive occupational lung disease programme
- ? India – silicosis eradication is linked with the National tuberculosis programme

Strategy elements – the national silicosis eradication programmes comprise a variety of elements which include the following:

- ? Participation in the ILO programme
- ? Target dates for outcomes
- ? National plan

- ? Co-operation, assistance and commitment of industry, govt, labour
- ? Surveillance systems
- ? Training programmes
- ? Technical counsel
- ? Technology transfer
- ? Awareness programmes
- ? Regulations and legal framework

Involvement of partners - within and outside the country

- ? Bolivia and India – pilot projects with individual industrial partners
- ? Thailand – participation of all 5 engineering schools at universities
- ? Sweden – retrained engineers to become inspectors, close involvement of govt, society, labour market and unions
- ? USA – NIOSH and OSHA websites and CDC information material
- ? India – developed market for precious stone cutting dust and relationship between association of stone cutters to introduce dust collecting system
- ? Vietnam – involvement of media for TV, posters, pamphlets campaign and national co-ordination board chaired by Minister of Health, international financial aid

Indicators used to prioritise Silicosis: problems and success

Sweden, Switzerland, Japan and the USA were put forward as success stories in the elimination of silicosis. These countries have excellent surveillance systems and have documented progress in terms of progressive decline in new cases and deaths. Other countries use a variety of indicators to prioritise silicosis and these reflect, to some extent, their success.

Brazil

- ? 53% prevalence in stone carvers despite wet processes
- ? 25% prevalence in quarry workers with more than 10 years exposure and drillers/basters > rock crushers > machine operators > office personnel

China (1997 figures provided)

- ? 10 million exposed;
- ? estimated prevalence of 1 million prevalence;
- ? accounts for 74% of reported occupational disease

Colombia

- ? 1.8 million workers at risk

India

- ? Prevalence of up to 50% in slate pencil workers

Japan

- ? 350 000 exposed workers; 7.5% prevalence
- ? Increase in cases due to change in definitions: 1500 new cases/ year

Sweden

- ? New cases 120 in 1960 0 in 2000

Switzerland

- ? 1993-1997 3 deaths i.e. < 1 death per year

Ukraine

- ? Apparent epidemic since reporting has been encouraged

USA

- ? >1.7 million still exposed and PEL to be reduced
- ? mortality from silicosis exceeds that from breast cancer
- ? after 1994 exposure levels decreased dramatically (*inspections introduced for drills and maintenance rather than dust measurements*)

Vietnam

- ? 14 –31% coal miners have silicosis

World wide artisanal and small scale mining (ASM)

- ? Silicosis identified as one of 5 major risks for 13 million people involved

Challenges and research needs for control

The challenges and barriers to control are both universal and country specific. They need to be identified by each country or industry and are clearly dependent on the systems and successes.

- ? WHO/ILO: adaptation of technology
- ? WHO/ILO and South Africa: need to make a strong business case for control
- ? WHO/ILO and USA: lack of will, commitment and effective action are barriers
- ? Brazil: need to research and develop new drilling/ blasting/ cutting techniques
- ? China: occupational health services – hygiene and medical surveillance etc
- ? Japan and South Africa: follow up of retired workers
- ? South Africa: universal definitions for indicators e.g. deaths *with* versus *from* silicosis, inadequate dust control, links with TB and HIV,
- ? Switzerland: valid measurement indicators, not dependent on weight of dust
- ? USA: engineering at dust source, dust suppression/ collection/ extraction

Three PowerPoint Presentations (S. Kisting, M. Ross and DW Stanton) on the Silicosis Sessions at ICOH 2003 are available in the papers Presented on Day 1 at the SIMRAC National Silicosis Elimination Workshop and are available via:

http://silicosis.sheafrica.info/national_workshop.htm

APPENDIX D

The World Health Organization (WHO)/ International Labour Organization (ILO) Joint Effort on Occupational Health and Safety in Africa:

Dust Control Courses

Introduction

Under the WHO/ILO Joint Effort on OHS in Africa, pilot dust control courses were held in Cape Town and Johannesburg, South Africa in March 2003. The courses were organised by Dr. Sophia Kisting, University of Cape Town and facilitated by staff from the National Institute for Working Life, Sweden (Gunnar Rosén, Ing-Marie Andersson, Lars-Erik Byström) and the Finish Institute of Occupational Health (Hannu Riipinen).

The pilot dust control courses are an excellent example in international collaboration. The National Institute for Working Life (NIWL), Sweden and the Finish Institute for Occupational Health (FIOH) sponsored the facilitators to run the courses in South Africa as well as for the development and preparation of the course materials. The University of Michigan, Fogarty International Center, Southern African Programme in Environmental and Occupational Health covered the cost of ten applicants from SADC member states other than South Africa. The WHO under the umbrella of the Africa Joint Effort provided support throughout for the coordination of the courses.

Mr Shafiek Hassan of the Peninsula Technikon, Cape Town, Professor David Rees of the National Centre for Occupational Health (NCOH), Johannesburg, and Professor Jonny Myers of the Occupational and Environmental Health Research Unit (OEHRU), School of Public Health, UCT kindly provided support and facilities for the workshops and public meetings.

The first two days of the courses were based on the WHO Prevention and Control Exchange (PACE) document on airborne dust published in 1999 to aid dust control and the reduction of dust related disease:

http://www.who.int/peh/Occupational_health/dust/dusttoc.htm

In addition, the PIMEX visualization method was used to demonstrate exposure and control measures on day three. The courses were aimed at achieving understanding of exposure in relation to the workplace process and focused on intervention with regards to problems such as silica dust, welding fumes, organic solvents, wood dust, organic dust etc in both formal and informal workplace settings. What the facilitators stressed throughout the courses was the central role that workers must play in the prevention of airborne dust exposure.

During their visit to South Africa the course facilitators obtained PIMEX material from local industries and incorporated into the course workshops and the four CD collection provided to course participants (The CD collection contained Word docs, PowerPoint presentations, Adobe PDF files and MPG video files).

PIMEX

In practical occupational health work, direct-reading instruments of various types are important aids in monitoring concentrations of air contaminants in workplaces. Rapid measuring instruments, sometimes small and battery-operated, make it possible to collect large amounts of data at different times and monitoring points. One problem that soon arises is how to relate this mass of data to factors at the workplace that can explain changes in the concentration of the contaminant being monitored. One common method is to transfer the information from the monitoring instrument to a printer or into some type of data logger, and in a subsequent operation correlate each concentration with an exact point in time. The accuracy of the following analysis is then completely dependent on the detail and accuracy of the notes on what was going on in the workplace at that time. Practical experience has shown that with this method it is not possible to capture more than a small fraction of the occurrences that affect the readings.

This was the state of affairs in 1984, when the staff at the NIWL began to explore the possibility of developing a more efficient way to store information about relevant occurrences at the workplace by using video filming as a complement to the direct-reading instruments. A year later this development work had resulted in a system which was soon dubbed PIMEX. The name PIMEX is an acronym from the words Picture Mix EXposure, and implies that the method is based on mixing pictures, in this case from a video camera, with data on a worker's exposure to some agent.

Different technical solutions for PIMEX has been developed by different research groups including PIMEX-PC from the NIWL, Sweden, FINN-PIMEX from VTT, Finland and Exposure Video Visualisation (PIMEX) from the Health and Safety Laboratory (HSL) in England.

PIMEX-PC

PIMEX-PC is based on the use of a standard PC and special software.

It has the following basic components:

- ✍ A direct-reading monitoring instrument, usually for air contaminants, which is placed in a small backpack to be worn by the studied worker (as in other systems).
- ✍ A video camera.
- ✍ A computer (laptop preferable).
- ✍ Software

The monitoring instrument is attached to a short tube in such a way that samples can be taken in the worker's breathing zone. For practical reasons, it is usually placed on the shoulder. Either a cable or a transmitter for wireless transmission of the signal (telemetry) is connected to the instrument's output to a recorder.

The video camera is usually placed on a tripod and aimed at the worker while the measurements are being made. If a wide-angle lens is used, it is usually not necessary to move the camera unless the worker moves around quite a bit. In these cases a cameraman is needed to keep the camera aimed at the worker.

The monitoring instruments used with the PIMEX method must have a short response time, preferably no longer than a second or two. The reason for this is that it has to be possible to relate a change in the monitoring values to the occurrence that caused the change. The response times typical for instruments based on semiconductors or electrochemical cells are therefore too long. If the monitoring value rises as a result of something that was shown on the video screen a minute and a half ago, the only result is confusion. The monitoring instrument has to be relatively small and lightweight, and preferably battery-operated, so that it can be carried in the backpack. One type of instrument that meets these requirements is the battery-powered photoionization instruments that can be used for most volatile organic compounds (VOC) and also for a number of inorganic gases. Another is light scattering instruments for aerosols. Both these types of instruments also have detection limits that are usually quite adequate for practical monitoring at workplaces. Together they can be used to (non-specifically) monitor more than half of the substances on the Swedish list of occupational exposure limits. The fact that these instruments do not make specific measurements is seldom much of a problem in practical work. Several other types of instruments can also be used, of course, though there are some limits. If the instrument is large or heavy or has to be plugged into a power outlet, it may be possible to use a longer hose from the worker's breathing zone to the instrument.

Telemetry for wireless transmission of the monitoring signal from the instrument to the video mixer is extremely helpful, since it allows the worker to move around relatively unencumbered by the monitoring device. Experience has shown, however, that in many cases it also works quite well to transfer the signal via a cable, especially if the studied worker is sitting at a work station or moves around very little: welding, spray painting in a booth, and laboratory work at a fume cupboard are a few examples.

The PIMEX-PC equipment can be handled by one properly trained person, but experience has shown, however, that it's usually much better to be two persons, especially if the worker moves around so that the camera can not be on a stationary mount, if telemetry is not used and a cable has to be attached to the worker, etc. Furthermore, PIMEX studies made at workplaces usually arouse so much curiosity among other workers in the vicinity that one person is kept busy providing a running commentary on what is going on. This kind of communication has a further value, since suggestions for improvement often arise in the group that stands around watching the video.

Uses of PIMEX

The uses of the PIMEX method can be roughly divided into three categories:

- ? Direct intervention at workplaces
- ? Production of training films
- ? Research

For direct intervention, PIMEX has three important advantages. By watching recorded material, the personnel involved develop a better understanding of the connection between the situation at the workplace and the exposure that arises. This knowledge is considerably more difficult to communicate when the monitoring results are presented in reports, tables or figures. Presentation is made even easier by the fact that the results can be viewed as the measurements are being made.

A second positive effect is that workers usually become more aware of occupational exposures. Seeing yourself on video along with information on how your exposure varies with working method etc. is usually quite a kick in the right direction.

Third, and perhaps most important, is the information that the ventilation expert, occupational hygienist etc. can get. The material makes it possible to study in detail the effects of various improvements introduced at the workplace - isolation of machines, ventilation modifications, new working methods etc. These three effects provide a very important basis for remedial measures.

Production of training films is an area of use that makes it possible to spread the knowledge gained at one workplace to a larger circle. The results of a successful (or unsuccessful) measure can be worth knowing about at other workplaces with the same or similar problems. This kind of training film can be produced with simple equipment. A video film can be edited by connecting two video cassette players. There are also a lot of possibilities to edit video with the help of relatively cheap programs for PC. A film made like this will not have the picture and sound quality of a professionally made one, but this is often offset by the quality of the message. Of course, if the training film is to be produced for wider distribution, an investment in professional quality picture, sound and direction may be worthwhile. The additional costs for this improvement in quality are often considerable, however.

As a tool for research, PIMEX provides many opportunities. The wealth of information that is found in a picture, combined with the monitoring data from one, two or possibly more instruments, can provide the basis for research on such topics as the connection between production parameters and exposure. The technique has also been used to assess the effects of various ventilation systems.

PIMEX has numerous areas of application. A few of them are listed below. The list covers more than air contaminants: the method has no such limits. Any instrument that provides a signal that can be processed by the video mixer can be connected to the equipment.

- Painting of furniture, organic solvents
- Wood dust in the furniture industry
- Screen printing, organic solvents
- Paint manufacturing, organic solvents
- Nitrous oxide exposure during surgery
- Smoking of sausage, carbon monoxide
- Production of flag poles, styrene
- Production of man made mineral fibres, dust and smoke
- Welding fumes
- Dust in ceramic production
- Styrene exposure in a boat-factory
- Electromagnetic field exposure
- Organic solvent, degreasing
- Gasoline exposure, car service
- Dust in a pharmaceutical factory
- Dust exposure, chimney sweeping
- Solvent exposure in a laboratory
- Ammonia on a farm
- Soldering fumes
- Laboratory studies of a ventilation system

Vibrations in a bus passing speed bumps
Solvent exposure, degreasing in an airplane factory
Wood dust in a furniture factory 1992
Quarry dust
Organic solvents, dust and work load (EMG) in a foundry
Organic solvents, dust and work load (EMG) in a paint factory
Organic solvents, dust and work load (EMG) in a rubber industry

Related techniques

With PIMEX-PC all the data stored on the computer is available for further analysis. Calculating average values over specified time intervals and production of various graphic presentations are a couple of examples.

Detailed exposure analysis is a method that has been developed from the PIMEX method. With access to the results of exposure monitoring in a computer file, combined with the video film, it is possible to separate the exposures for different tasks. This job is easily done (but it takes time) by noting the start and stop time for each task. The monitoring data can then be sorted according to task. Detailed information on the contribution made to total exposure by each task can be calculated by this kind of analysis.

Future Developments

The pilot dust control course material presented in South Africa by facilitators from the NIWL and FIOH will be developed for use by the WHO as training material on dust control.

Note: *This text is based on the dust control course announcements by Sophia Kisting, OEHRU, UCT, and an article on PIMEX by Gunnar Rosén and Ing-Marie Andersson, NIWL, Sweden.*

APENDIX E

Elimination of Silicosis in Sweden and Finland

In the publication OSH & Development (No. 4, May 2002), Gideon Gerhardsson makes a historical, technical and economic review of how silicosis has been eradicated in Swedish mining and industry. This paper is available on the Internet at the website of the Swedish Association for Occupational and Environmental Health & Development (UFA):

<http://www.ufa.org.se/OSH&D/OSH&D4/3silicos.html>

During the Dust Control courses in Cape Town and Johannesburg March 2003 there were two public meetings where the facilitators from Sweden and Finland discussed the interventions in Sweden and Finland with regards to the elimination of silicosis. In Johannesburg this was held at the NCOH 17h00 on Tuesday, 25 March 2003.

Copies of the PowerPoint presentations are available via:

<http://www.asosh.org/WorldLinks/TopicSpecific/silica.htm>