Description of coal associated diseases and coal dust concentrations in Mpumalanga coal mines.

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DECLARATION

I, Andreas Zacharias du Toit, declare that this research report is my own work. It is being submitted for the degree of Master of Public Health: (Occupational Hygiene) at the University of the Witwatersrand, Johannesburg and has not been submitted before for any degree or examination at this or any other University.

……………………………….

A. Z Du Toit

23rd day of June, 2010

ABSTRACT

Introduction

Coal mine workers are exposed to a mixture of dusts including coal dust and silica (as alpha quartz), in this respect the mixture of dusts is termed mixed coal dust.

The illnesses commonly associated with the inhalation of mixed coal dust are (1) coal workers' pneumoconiosis, (2) silicosis, and (3) chronic obstructive pulmonary disease.

Objectives

The main aim of this research report is to determine whether current dust levels in Mpumalanga coal mines were above generally recommended standards and to review information on the burden of coal associated diseases in the coal miners of Mpumalanga.

The objectives of this research project are (1) to describe the coal dust and silica concentrations as measured by personal breathing zone sampling in Mpumalanga coal mines over the period 2003 to 2006 and (2) to describe the burden of coal-associated diseases reported by autopsy examinations received from NIOH Pathology Department and in the SAMODD data base in Mpumalanga coal mines over the period 2002 to 2006.

Methods

Dust

Personal breathing zone sampling data were obtained from gravimetric sampling programmes established according to the DMR – SAMOHP from fifty three coal mines in the Mpumalanga region. During the time of the study, the sampling programme strategies were co-ordinated by a central laboratory services: “Colliery Environmental Control Services”. The raw data were obtained from this laboratory for the periods 2003 to 2006 in Microsoft excel spread sheet format.

Burden of disease

NIOH - PATHAUT

The annual reports of the NIOH on the autopsy data for the coal mining sector were obtained from the web site of NIOH. Sample data sheets were drawn up to extract only relevant information from the reports.

DMR - SAMODD

The DMR collects medical information from coal mines across South Africa, and this information was obtained from the local inspectorate. The data contained in the report were of all the mines in South Africa, a filter was applied in a Microsoft Excel spread sheet to extract the relevant information for Mpumalanga coal mines.

Results

Dust

There was a reduction in the recorded concentration of respirable dust levels in the collieries over the four year period 2003 to 2006. The average coal dust exposures fell from 1.9 mg/m^3 in 2003 to 1.3 mg/m^3 in 2006.

The Department of Mineral Resources places emphasis on the 90^{th} percentile and most of the sampling strategies are centred on this figure. Although the 90^{th} percentile decreased from 4.82 mg/m^3 to 3.02 mg/m^3 (i.e. 1.8 mg/m^3) over the four year period, this level is still unacceptable as it is above the required statutory limit of 2.0 mg/m^3.

Silica exposures also showed a reduction from an average of 0.047 mg/m^3 in 2003 to 0.034 mg/m^3 in 2006.

Disease burden:

PATHAUT

Pulmonary tuberculosis - the number of employees at autopsy with pulmonary tuberculosis (PTB) decreased from 12 in 2002 to 8 in 2006, but there is not enough information to establish a trend over the five year period.

Silicosis: - the number of employees at autopsy with silicosis was between 3 to 4 cases per year except in 2004 where there was an outlier of 11, but in general the cases stayed constant over the five year period. The rate of silicosis per 1000 autopsies however indicates an increase over the five year period as the rate increased from 37 to 52.

Emphysema: - the number of emphysema cases stayed fairly constant with 32 cases in 2002 and 30 cases in 2006, but with an increase in 2003 and 2004 to 42 and 43 respectively. The rate per 1000 autopsies increased from 294 in 2002 to 390 in 2006.

Coal workers' pneumoconiosis: - there was a decrease in coal workers' pneumoconiosis from 2002 to 2006 from 10 to 2 cases, but there were 11 and 15 cases in 2003 and 2004.

SAMODD

Coal workers' pneumoconiosis: - the total number of employees reported with Coal Workers Pneumoconiosis (CWP) decreased for the period 2003 to 2006, from 12 in 2003 to three in 2006.

Chronic obstructive pulmonary disease: - No useful information was available for this illness.

Silicosis: - One case was reported in 2002, and 2 cases in 2003 and 2004, no cases were reported for 2005.

Tuberculosis: - with initially only three cases in 2002, cases increased during 2003 to 2005 to 53, 44 and 50 respectively. A reduction was observed in 2006 to 13 cases.

Conclusion

- There may be an overall reduction in the dustiness of the coal mining industry in Mpumalanga province as the arithmetic mean of the samples collected decreased from 1.9 to 1.3 mg/m³ over the four year period 2003 to 2006.
- The level of exposures to silica might be lower because the exposures reduced from a mean of 0.047 in 2003 to a mean of 0.034 mg/m³ in 2006.
- The recorded data suggest a decline in CWP; this is in line with international data from the United Kingdom, USA, Australia, Germany, France and Belgium.
- Pulmonary tuberculosis - was constant over the five year period based on limited autopsy data, but the SAMODD data base indicates a decline for the year 2006 but overall shows an increase in the number of tuberculosis cases in Mpumalanga coal mines.
- Silicosis cases were fairly constant, but the rate per 1000 autopsies increased by 15/1000 over the five year period. The number of recorded cases from the DMR SAMODD is too few to make any useful deductions.
- Emphysema numbers were constant, but the rate per 1000 autopsies increased by 96/1000 over the five year period.
- No useful interpretation can be made from the data received from the DMR on chronic obstructive pulmonary disease.

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ABBREVIATIONS

ACGIH - American Conference of Governmental Industrial Hygienists

CEN – European Committee for Standardization (Comité Européen de Normalisation)

DME – Department of Minerals and Energy (Please note that this name changed during the time of preparation of this research report and although all the places in the report referring to this department has been changed to the DMR, some of the references are still DME due to historical information)

DMR – Department Mineral Resources (Previously DME)

HEG - Homogenous Exposure Group

IEC – International Electro technical Commission

ISO – International Standards Organisation

MHSI – Mine Health and Safety Inspectorate

NIOH - National Institute for Occupational Health (South Africa)

NIOSH - National Institute for Occupational Safety and Health (USA)

OEL - Occupational Exposure Limit

PATHAUT – Pathology Automation System

SAMOHP - South African Mines Occupational Hygiene Programme

SAMODD - South African Mines Occupational Diseases Data base

SANAS – South African National Accreditation System

SIMRAC - Safety in Mines Research Advisory Council

TWA - Time Weighted Average

1 CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction and literature review:

This chapter describes an overview of underground mixed coal dust, its liberation, measurement strategies, and a discussion of the illnesses the mixed coal dust is known to cause. This chapter also describes literature reviews done on international and local papers on the specific topic. The chapter closes with the objectives of this research report and the anticipated use of this report once published.

1.2 Introduction:

Coal dust is associated with a number of occupational diseases in the coal mining industry, but there is little published information on exposure to coal dust in South African coal mines and on the burden of coal dust associated diseases in SA coal mines. This research report presents data on dust levels in Mpumalanga coal mines and disease data bases to explore the reported burden of disease in SA coal mines.

1.2.1 Underground mixed coal dust – liberation

Coal mine workers during a normal working career are regularly exposed to mixed coal dust. Mixed coal dust is not merely coal dust, but the mixture of substances including coal dust and silica (as alpha quartz). The coal miner during normal mining activities is exposed to silica particulates, which sometimes exceed the occupational exposure limits as set out by the Department of Mineral

Resources. The probable origin of the silica is when the coal miner intersects silica rich country rock.

Mixed coal dust is created underground during many mining activities. These range from: 1) the physical breaking of the coal in the workface; 2) the transfer of the coal from the continuous miner or the mining tool used to break the coal from the strata, to the shuttle car that transfers the coal from the face to the feeder breaker; 3) the feeder breaker where the coal is reduced in size to facilitate conveyance; 4) transfer points over many metres and sometimes kilometres of conveyance materials, to bring the coal to surface; 5) coal is dumped on a stockpile; and 6) transferred to a coal beneficiation plant, to where the coal is either crushed or managed before it is transferred to where the inherent energy that has sustained many an economy is utilised. Other activities also create dust that is not directly related to the mining in the coal face, like the blasting operations of rock or overhanging strata by means of explosives.

The mixed coal dust in the underground areas of the mine if not stopped from being liberated during the mining activities or transfers, is conveyed into the air stream of the underground passageways where employees are exposed to the airborne dust.

Many initiatives have been implemented to assist with the reduction of the dust at source where dust is liberated. [Du Plessis, 1999]

1.2.2 Dust measuring methodologies:

There are two basic methods of sampling airborne dust; filtration sampling and direct reading instruments. The first type, which is the most common type of sampling in use, make use of drawing a known volume of air through a pre-weighed filtering device by means of an air pump, weighing the filter before and after will determine the mass of dust that was collected. The concentration of the average dust collected is obtained by dividing the mass by the volume of air drawn through the filter for the sampling period. Filtration units have been reduced in size over the past decade to ensure that an employee could carry it during his normal working routine to ensure that real exposure information is obtained. The shortfall of these instruments is that the instrument only monitors the average dust and not the "spikes" of high exposures that an employee might encounter during a working day.

To ensure accuracy, the sampling filters are weighed up to 1 µg. The flow rates of the pumps are checked by using either calibrated rotameters or a soap bubbler.

Respirable dust is captured by making use of a cyclone cassette. The dust laden air is drawn through a slot on the side of the cassette and with the cyclonic action of the cassette the larger particles are "spun" out and proceed to the bottom portion of the cassette where a grit pot is attached. The larger dust then settles in the grit pot. See Figure 1.1 for a schematic drawing of the cassette.

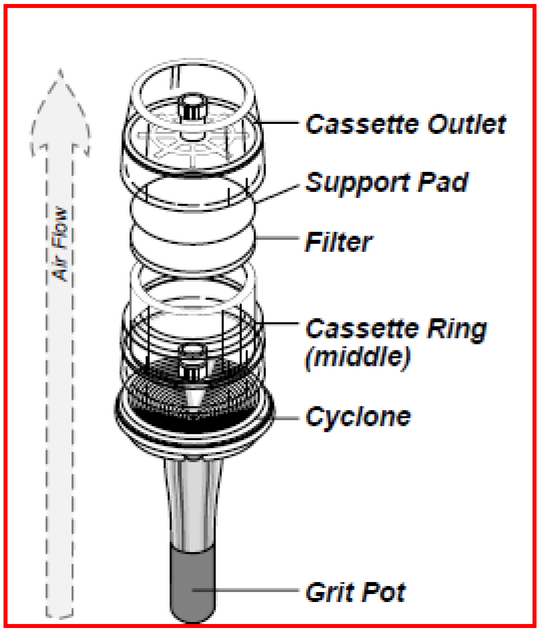


Figure 1.1 a schematic representation of a respirable dust sampling cassette holder, used to sample respirable dust according to the ISO/CEN/ACGIH curve, please note the ISO, CEN and ACGIH are defined separately in the abbreviations table.

The second method involves using an instrument that gives a direct reading of the dust concentrations; some of the instruments have the capability for data recording and therefore can provide the average over time, a maximum reading encountered during the survey as well as the time when the incident was encountered.

A typical personal dust monitor (PDM) was developed by Rupprecht & Patashnick Co., Inc (now Thermo Fisher Scientific) under contract with NIOSH for personal exposure measurements of respirable coal dust. The instrument has a mass sensor, tapered element oscillating microbalance (TEOM), which continuously measures the mass of particulates from the mine atmosphere collected on the sample filter. The main components of the device includes a cap lamp with a sample inlet on the end of an umbilical cable, a belt mounted enclosure containing the respirable dust cyclone, sampling and mass determination system as well as a charging and communication module used to transmit data between the monitor and personal computer (pc) while charging the batteries. Figure 1.2 illustrates the unit. The PDM calculates the shift exposure and allows exposure data to be continually displayed during the shift, to enable a proactive approach to high dust exposures [Stanton et al., 2007].

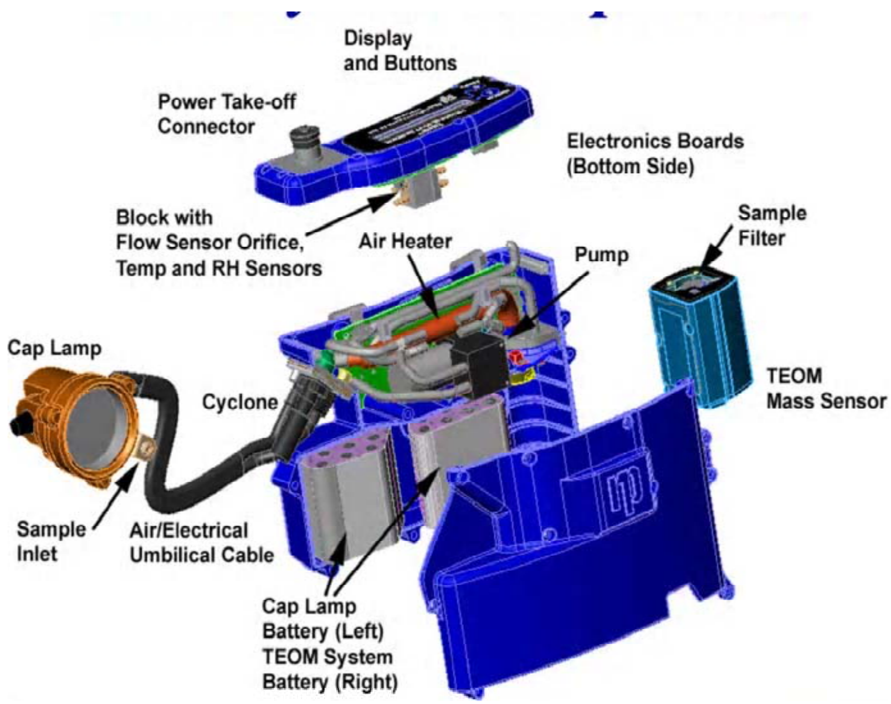


Figure 1.2 Thermo Fisher Scientific PDM with integrated cap lamp and battery charger

Both the filtration and direct reading instruments can be used when taking static or point measurements at specific areas.

1.2.3 Occupational Exposure Limits

The South African Department of Mineral Resources (DMR) has 2.0 mg/m^3 as an occupational exposure limit, time weighted average (8hours) (OEL-TWA 8hrs) for personal exposure to respirable mixed coal dust; 5.0 mg/m^3 (respirable) OEL-TWA 8hrs for control at the continuous miners and 0.1 mg/m^3 OEL-TWA 8h for personal exposures to respirable silica.

1.2.4 Sampling Strategies

In order to ensure that sampling strategies for the mining industry in South Africa are constantly applied, the Directorate Occupational Hygiene of the DMR published a codebook which is called the "South African Mines Occupational Hygiene Programme" (SAMOHP) in January 2002**.** Further to the code and the regulations, a guideline was distributed on the establishment of an occupational hygiene system for airborne pollutants that had to be complied with by the mines in which specific requirements were given on sampling and sampling frequencies.

The sampling schedules are risk based and the frequency as per risk category has been prescribed by the DMR, the frequencies of sampling are contained in Table 1.1 below. The SAMOHP clearly defines how the Occupational Hygiene data should be interpreted, the risk categories determined and what sampling frequencies should be for specific risk categories, these requirements are stipulated in Table 1.2.

Table 1.1: Summary of the sampling frequency as indicated in the DMR guidelines for the compilation of a mandatory code of practice – no. 1 personal exposure to airborne pollutants

Category	**Minimum Sampling Frequency**
A	Sample 5% of employees within a HEG* on a 3 monthly basis with a minimum of 5 samples per HEG, whichever is the greater.
B	Sample 5% of employees within a HEG on a 6 monthly basis with a minimum of 5 samples per HEG, whichever is the greater.
C	Sample 5% of employees within a HEG on a annual basis with a minimum of 5 samples per HEG, whichever is the greater.

* HEG - Homogenous Exposure Group - *means a group of employees who experience pollutant exposures similar enough that monitoring exposures of any representative sub group of employees in the group provides data useful for predicting exposures of the remaining employees.*

Table 1.2: Summary of the classification bands as indicated in the DMR guidelines for the compilation of a mandatory code of practice – no. 1 personal exposure to airborne pollutants

Category	**Classification Bands**
	Personal Exposure Level
A	Exposures ≥ the OEL or mixtures of exposures ≥1
B	Exposures > 50% of OEL and < OEL or mixtures of exposures > 0.5 and < 1
C	Exposures > 10% of OEL and < 50% of the OEL or mixtures of exposures > 0.1 and < 0.5

Agreed milestones for Silica was presented to the mining industry in South Africa by the DMR in which it was agreed that;

1. By December 2008, 95% of all exposure measurement results will be below the occupational exposure limit for respirable crystalline silica of 0.1mg/m3 (these results are individual readings and not average results).

2. After December 2013, using present diagnostic techniques, no new cases of silicosis will occur among previously unexposed individuals. Previously unexposed individuals are individuals unexposed prior to 2008, that is, equivalent to a new person entering the industry in 2008.

1.2.5 <u>Illness caused by coal mine dust</u>

1.2.5.1 Coal workers' pneumoconiosis

There is a clear similarity between the pathological appearances and behaviour of pneumoconiosis whether it is because of coal or other carbonaceous material. The terms coal workers' pneumoconiosis and progressive massive fibrosis have been used to describe the lesions. Coal workers' pneumoconiosis refers to small, discrete macules (macula means a stain or spot) or nodules not larger than approximately 10mm in diameter. Progressive massive fibrosis (PMF) on the other hand describes confluent masses of dust and collagen fibrosis more than 1 cm in diameter. [Parkes, 1994a]

1.2.5.2 Silicosis

Silicosis is a fibrotic disease of the lungs produced by the inhalation and deposition of dust containing damaging amounts of respirable free crystalline silica or silicon dioxide. Although silicosis can take an acute form under conditions of intense exposure, the most usual form encountered is the chronic form, requiring several to many years to develop. It has frequently been associated with tuberculosis and other mycobacteria as silica increases the risk of tuberculosis. [Merchant, 1986]

1.2.5.3 Chronic obstructive pulmonary Disease

"Chronic obstructive pulmonary disease (COPD) is a disease state characterized by airflow limitation that is not fully reversible. The airflow limitation is usually both progressive and associated with an abnormal inflammatory response of the lungs to noxious particles and gases" [Boschetto and Quintavalle, 2006]

Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality in both industrialized and developing countries. A great risk factor for COPD is cigarette smoking. Literature published within the last years indicate that about 15% of COPD cases are work-related. [Boschetto and Quintavalle, 2006]

Coal mining according to Sundeep and Barnes [2009], is associated with COPD.

1.2.5.4 Chronic bronchitis

Chronic bronchitis is defined for epidemiological purposes by the presence of chronic or recurrent cough which occurs without localised bronchopulmonary disease, is productive of phlegm or sputum, and is present for at least three months of two sequential years. The pathologic definition of bronchitis is descriptive and includes two elements: hypertrophy and hyperplasia of bronchial mucous glands, together with goblet cell hyperplasia and squamous metaplasia of the surfaces of large and medium sized airways, and goblet cell metaplasia of the small airways; i.e airways without cartilaginous support. [Merchant, 1986]

1.2.5.5 Emphysema

Emphysema is a condition of the lung characterised by increase beyond the normal in the size of airspaces distal to the terminal bronchiole either from dilation or from destruction of their walls. [Parkes, 1994c]

A series of papers from South Wales, (quoted in Parkes, 1994c) have proposed that coal miners have a higher prevalence of emphysema than non-miners. According to the studies, coal miners with pneumoconiosis often can be shown to have an increased prevalence of emphysema. [Parkes, 1994c]

1.2.5.6 Tuberculosis

In early years, the theory that tuberculosis modified by mixed coal-mine dust played an important role in the development of illness was highly regarded for some years. This hypothesis was mainly based on the post mortem evidence in miners in south Wales, where endemic tuberculosis had been prevalent.

This hypothesis is less well accepted today, [Parkes, 1994a] but due to this early belief, tuberculosis is still reported in various countries for coal mine workers and for this reason the TB cases are included in this report.

1.2.6 Incidence or Prevalence rates

The incidence rate of coal workers' pneumoconiosis; i.e the number of new cases of CWP per 1000 employees per year or over another specified period in coal mining is mainly related to the intensity of respirable mixed coal dust to which coal mining employees have been exposed. [Walton et al., 1977] Smoking habits do not affect this outcome. A clear association between dust retained in the lungs and profusion of small opacities was demonstrated by some researchers who showed that the higher the proportion of coal in the dust, the more dust is needed to produce a given radiological category [Parkes, 1994a].

1.2.7 Affect of HIV on the incidence of Silicosis and Tuberculosis

According to a study done by Park et al. [2009], serious health consequences could be caused by exposure to silica dust and Mycobacterium tuberculosis in the context of the high HIV/AIDS prevalence in miners. This study also highlights the fact that miners with HIV, exposed to airborne silica dust are at an increased risk to contract pulmonary tuberculosis. The miners with silicosis are also at increased risk of developing active pulmonary tuberculosis.

HIV-infected miners that have previously contracted TB and have been treated are at a two to five times higher risk of re-infection. Miners who are infected with both Silicosis and HIV are at an even higher risk to contract tuberculosis, due to a multiplicative interaction.

1.2.8 South African data bases

The DMR and NIOH monitor the following illnesses for all coal mine workers: (1) coal workers' pneumoconiosis, (2) silicosis, (3) chronic obstructive pulmonary disease, and (4) tuberculosis / pulmonary tuberculosis. The statistics used for the purpose of this report notes the rate for these recorded cases.

1.3 Literature review

Respirable coal and silica dust are well recognised health hazards in the coal mining industry and much information has been collected by the DMR and the chamber of mines w.r.t this topic. Meaningful published data on respirable dust levels in underground coal mines in Africa are however scarce. [Naidoo et al., 2006]

1.3.1 Coal dust levels

Although significant gains in longwall dust control have been made, they have been challenged by substantial increases in coal extraction rates, which result in the potential to generate more dust. Average production during compliance sampling by USA mine operators has increased from an average of 2 800 tons per shift in 1990 to an average 5 600 tons per shift in 2004. [Rider and Colinet, 2007]

Consequently, longwall operations continue to have difficulty in maintaining consistent compliance with the federal dust standard of 2.0 mg/m^3. During a five-year span from 2000 through 2004, mine operators and mine safety and health administration (MSHA) inspectors collected 7 421, and 1 587 compliance dust samples, respectively. Analysis of these samples showed that 14% of the mine operator samples and 15% of the MSHA samples were equal to or exceeded 2.1 mg/m^3, the level at which a citation is issued. [Rider and Colinet, 2007]

According to a report by Colinet et al., [2007], called "Controlling respirable dust in underground coal mines in the United States", of the dust samples submitted in the United States of America in 2005, 11% of continuous miner operator and 12% of roof bolter operator samples exceeded their applicable dust standard. After the initiation of the x-ray surveillance programme in the US coal mining industry in 1970, "*the prevalence of Coal Workers' Pneumoconiosis (CWP) in the workforce has been declining. For mine workers with 25 or more years of experience, the prevalence of CWP has dropped from 28.2 % in 1973 to 3.3 % in 1999. However, recent x-ray surveillance data have uncovered cases of rapidly progressing CWP and also revealed an upturn in the prevalence rate*". [Colinet et al, 2005]

1.3.2 <u>Disease burden</u>

Among workers with similar cumulative exposures to coal mine dust, those with a longer exposure had a higher prevalence of coal workers' pneumoconiosis [Parkes, 1994a]. The prevalence of profusion category 0/1 or more coal workers' pneumoconiosis (CWP) increase progressively in the range of low- to high-rank coals; from approximately 4 to 21 percent respectively. There are other factors that influence the development of CWP as there is a three- to fivefold difference in prevalence in workers from collieries of equal rank. [Parkes, 1994a]

A study conducted in 1961 of 20 collieries in Britain concluded that the average period of work at the coalface required to produce a 20% prevalence of CWP in high, medium and low rank coals were 8 years, 16 years and 36 years respectively. [Phillips and Belle, 2003]

There has been a decline in prevalence of PMF in British coal miners between 1960 and 1991, due to progressive improvements in dust control as can be seen in Figure 1.3 and Figure 1.4. Similar trends over the same period appear to have occurred in the USA, Australia, Germany, France and Belgium. It is difficult to make a valid comparison of prevalence between different countries because of the difference in composition of coal mine dust, working conditions and the technique and standards of radiological surveys as well as other criteria [Walton et al., 1977].

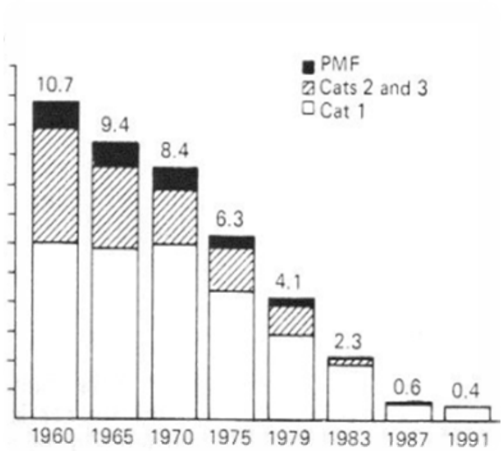


Figure 1.3 Prevalence of pneumoconiosis in British coal miners 1960 – 1991

It should be noted that these figures from all coal fields do not relate to an identified and exclusive cohort of miners followed over time. The data nevertheless give a valuable indication on the trend of pneumoconiosis over these years.

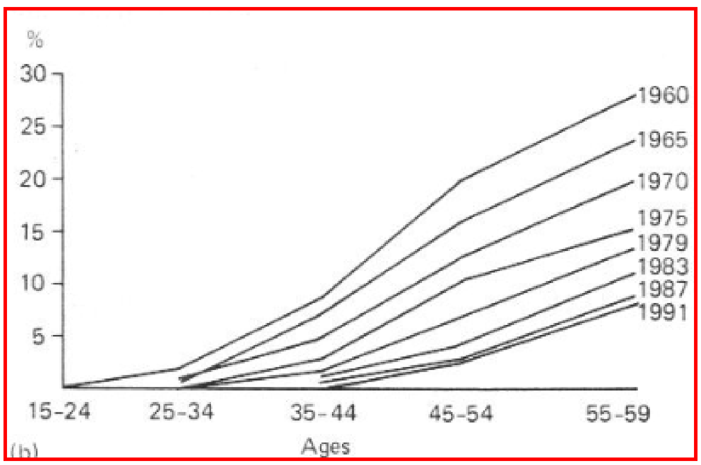


Figure 1.4 Prevalence of pneumoconiosis according to age at collieries surveyed in the years 1960 to 1991. This shows that the onset of radiographic changes has been progressively delayed over the years. [Parkes, 1994a)

1.3.3 Mortality

According to the US Census Bureau and their monitoring of deaths related to coal workers' pneumoconiosis, the number of deaths has decreased at a steady rate since the 1980's. Below is a graph depicting the number of deaths for U.S residents of age 15 and over for the period of 1968 to 2005.

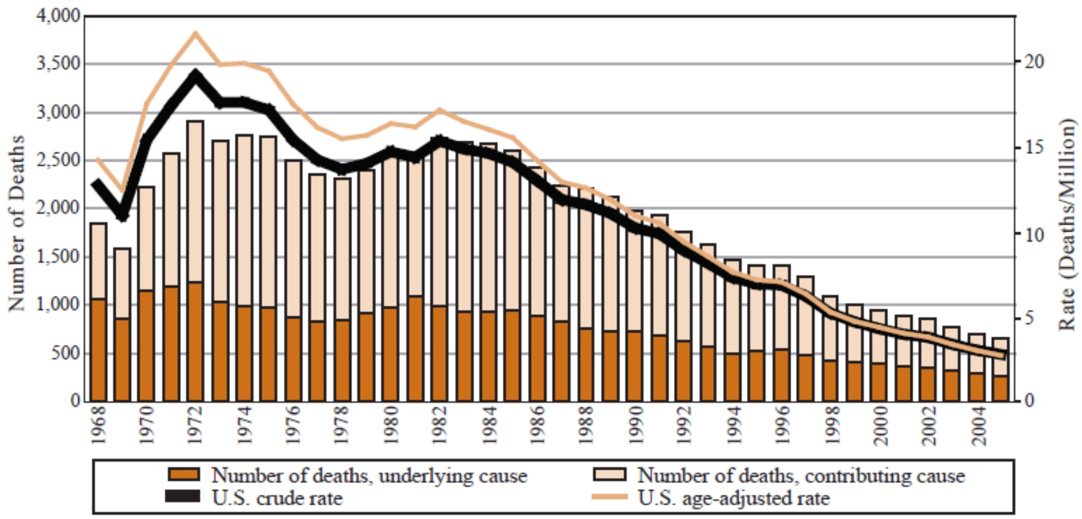


Figure 1.5 Coal workers' pneumoconiosis: number of deaths, crude and age adjusted death rates, U.S. residents age 15 and over; 1968-2005 [NIOSH, 2008]

1.4 South Africa

1.4.1 Coal mine dust

The Department of Mineral Resources (DMR) publishes annual reports on Health and Safety in Mines. These reports include dust levels in the coal mines of Mpumalanga. According to the report published by this organization for 2005 the "Statutory returns received from the mines indicate no significant improvement as far as personal dust exposure is concerned. Meetings are held with the different mines' management to discuss areas of system failure and the way forward in addressing high exposures" [Republic of South Africa, 2004/5]

A study was conducted by Naidoo et al. [2005] on differential respirable dust related lung function effects between current and former South African coal miners. According to this study, a statistically significant decline in forced expiratory volume (FEV (1)) of 1.1 and 2.2 ml/mg-year/m was found in representative 40-year-old, 1.7-m tall current and former miners, respectively. There was however significant differences found between the highest and medium exposure categories. Ex-miners had a lower mean per cent predicted lung function than current miners for each cumulative exposure category, suggesting a "healthy worker" effect. Past history of TB contributed to 21 and 14% declines in per cent predicted FEV (1) and forced vital capacity (FVC), respectively. The study further suggested a dose-related decline in lung function associated with respirable dust exposure, with a magnitude of effect similar to that seen in other studies and important differences between current and former employees.

1.4.2 Disease burden in South Africa

There are several studies of dose-response relationships between respiratory outcomes and radiology, but only a few studies on the outcomes of autopsy. A study was conducted by Naidoo et al. [2004] that described the prevalence of respiratory outcomes among South African coal miners at autopsy, and the study was developed to determine whether dose response relationships existed between emphysema and exposure. [Naidoo et al., 2004]

The study reported the prevalence of silicosis, tuberculosis (TB), coal workers' pneumoconiosis (CWP), and moderate and marked emphysema as 10.7%, 5.2%, 7.3%, and 6.4%, respectively. All diseases, except TB, were associated with exposure duration. In models unadjusted for age, and including smoking, moderate to marked emphysema was strongly associated with exposure duration. Exposure-related risk estimates were reduced when age was introduced into the model. Age and duration of exposure were highly correlated, ($r = 0.68$) suggesting a dilution of the exposure effect by age.

Naidoo et al. [2004], in an article “Radiographic outcomes among South African coal miners” documented the prevalence of pneumoconiosis among a living South African coal mining cohort. They describe dose-response relationships between coal workers' pneumoconiosis and respirable dust exposure, and relationships between pneumoconiosis and both lung function deterioration and respiratory symptoms. [Naidoo et al., 2004]

The overall prevalence of pneumoconiosis according to the study was low (2%-4%). An association and trend for pneumoconiosis with increasing categories of cumulative respirable dust exposure (CDE) among current miners was seen in their study. [Naidoo et al., 2004] According to this study those with pneumoconiosis had an additional 58 mg-years/m^3 compared to those without.

According to the team, a decline in the lung capacities was observed in current miners with pneumoconiosis which is attributable to CDE. [Naidoo et al., 2004]

1.4.3 Research Objectives

The main aim of this research report is to determine whether current dust levels in Mpumalanga mines are above generally recommended standards and to review information on the burden of coal associated diseases in the coal mines of Mpumalanga.

The objectives of this research project are (1) to describe the coal mine dust and silica concentrations as measured by personal breathing zone sampling in Mpumalanga coal mines over the period 2003 to 2006 and (2) to describe the prevalence of coal-associated diseases reported on the autopsy reports received from NIOH Pathology Department and in the SAMODD data base in Mpumalanga coal mines over the period 2002 to 2006.

2 CHAPTER TWO: METHODOLOGY

This chapter describes the reason for the selection of the fifty three underground coal mines' personal breathing zone (PBZ) samples in Mpumalanga; it also describes the study design used to review the SAMODD, PATHAUT and DMR data bases. The ethical considerations are covered in the closing of this chapter.

2.1 <u>Study design</u>

The study is a retrospective descriptive study in which already existing historical data on dust concentrations and disease burden are reviewed.

2.2 <u>Data sources</u>

2.2.1 <u>Dust measurements</u>

Personal breathing zone dust measurement data; i.e dust measurement samples collected within 300 mm from the mouth and nose of a person were obtained from sampling programmes established according to the DMR – SAMOHP from fifty three coal mines in the Mpumalanga region. At the time of the study, the sampling programme strategies were co-ordinated by a central laboratory services: Colliery Environmental Control Services. The raw data were obtained from this laboratory for the periods 2003 to 2006 in Microsoft Excel spread sheet format.

2.2.2 Burden of disease

The annual reports of NIOH on the autopsy data for the coal mining sector in Mpumalanga province were obtained from the web site of NIOH. Data sheets were drawn up to extract the information contained in the graphs of this report.

The DMR collects medical information from coal mines across South Africa, the information was obtained from the local inspectorate who exported the data base information into Microsoft Excel format. The data contained in the report were of all mines in South Africa, consequently a filter was applied in the Microsoft Excel spread sheet, to extract the information for Mpumalanga mines and shown in the graphs of this report. The data were collected per commodity, per province and per mine; the filter was applied to obtain information for coal mining commodity and Mpumalanga province.

The information contained in the DMR data base is collected from the yearly reports of the mines' occupational medical practitioners, recorded during the yearly medical surveillance of the mining industry for the Mpumalanga province.

2.3 Study population

2.3.1 Mine selection criteria personal breathing zone samples and sample size

At the time of the project, most of the mines in the Mpumalanga province made use of a central laboratory (Collieries Environmental Control Services – (CECS)) which was established by the Chamber of Mines in South Africa. This laboratory has ISO/IEC 17025:2005 accreditation and is SANAS accredited for respirable coal dust and silica (Appendix B). A total of fifty three (53) Mpumalanga coal mines out of the total 65 made use of this laboratory at the time of this study.

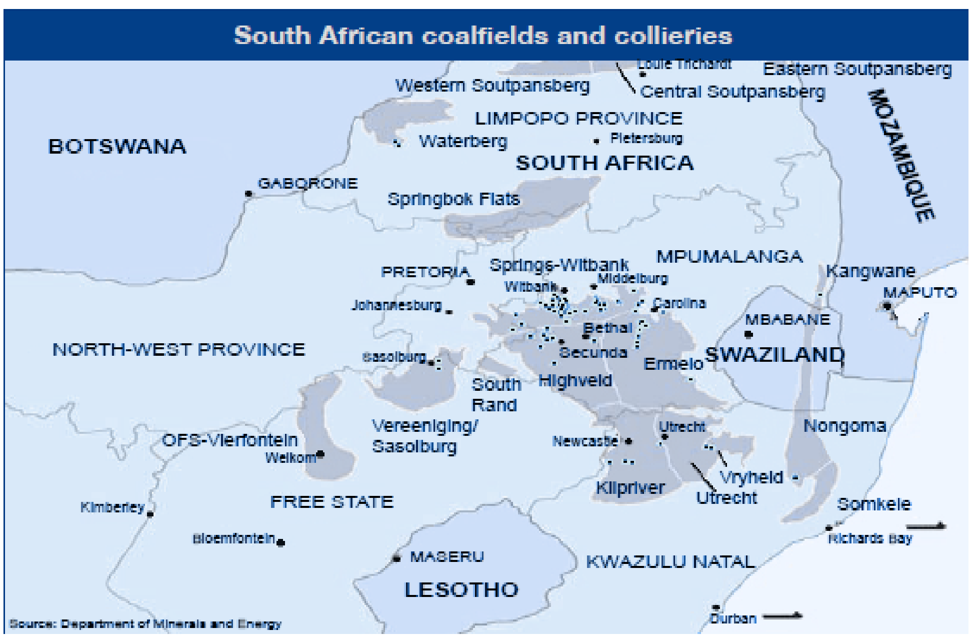


Figure 2.1 Overview of the location of the coal fields in South Africa, which indicates that the majority of coal fields are situated in the Mpumalanga province [Serebro, 2008]

The central laboratory at the time of the study assisted the 53 mines centrally with the following services: 1) establishing sampling strategies; 2) preparation of the sample cartridges; 3) over-inspection of sampling processes at the mines; 4) record keeping as well as data analysis of sampling information; and 5) compilation of DMR reports for submission to the DMR local Inspectorate.

All of the above promotes the consistency of data and therefore it was decided to utilise all of the measurement data available at the Laboratory for the years 2003 - 2006.

The data received from the laboratory did not identify mines, i.e. the information is grouped per number, the investigator was not informed which number referred to which mine; hence the investigator or any other person cannot make a connection of which mines' data were released.

2.4 Medical and Autopsy data

The medical and autopsy data could not be separated to include only the information for the mines for which the dust results was obtained, as, firstly, the mines were not disclosed by the laboratory; and secondly, the autopsy data are only broken down to the region and mining commodities. The information therefore is for all the mines in the Mpumalanga region.

2.5 Data Collection Techniques

Tables were developed to record the extracted information from the SAMODD data base as well as the PATHAUT data base. The rates were calculated by using the number of workers reported by the medical practitioners (included in the spread sheet) and mathematically calculating it to the rates per 1000 employees.

2.6 Ethics

Prior to proceeding with the study, permission was formally sought from the following authorities:

- Ethics committee for research on human subjects (medical), University of the Witwatersrand. (Copy of the permission letter is attached as Annexure A.)
- Manager of Collieries Environmental Control Services. (The letter is attached as Annexure B.)

All information collected is retrospective information, hence the information has already been published in the public domain, and the information from CECS has also been released under a letter (Annexure B) in which the conditions of the use of information has been described.

3 CHAPTER THREE: RESULTS

This chapter presents firstly, the results obtained from the occupational hygiene sampling data collected for the years 2003 to 2006 on coal mine dust and silica dust in the coal mines in Mpumalanga and; secondly, the burden of disease by using the autopsy data and medical data collected from the NIOH and DMR respectively.

3.1 Dust measurement data from CECS 2003 – 2006

The summary of dust measurement data below is grouped into two different portions, the first portion are the data that had been collected for coal mine dust for the period 2003 to 2006 and the second portion is dedicated to the summary of respirable silica dust concentrations.

3.1.1 Summary of total number of samples collected for coal mine dust for the period 2003 to 2006.

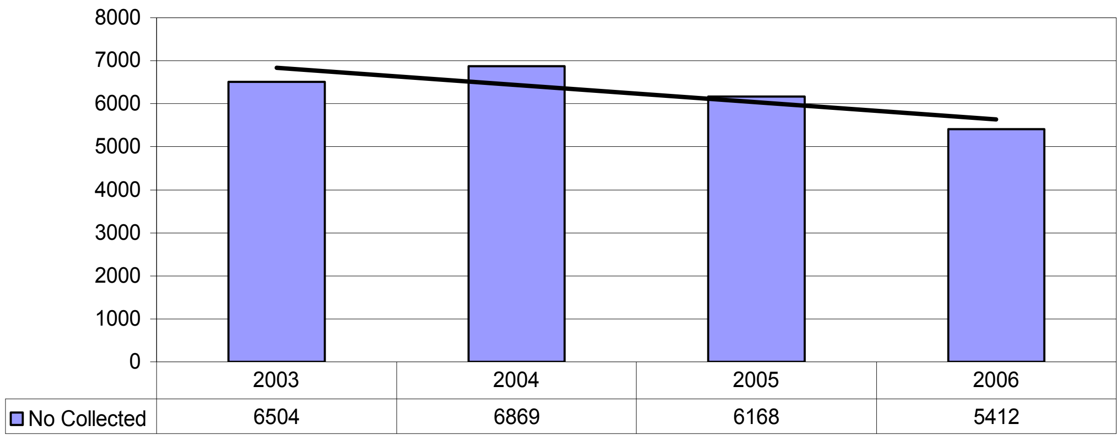
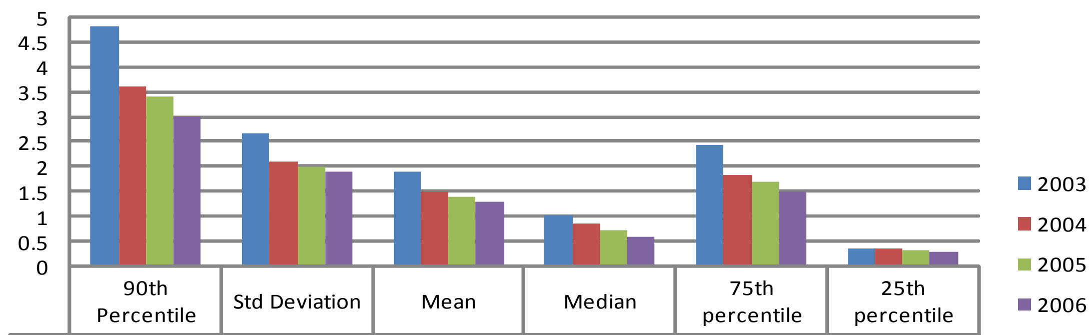


Figure 3.1 The total number of respirable dust samples collected in fifty three Mpumalanga coal mines for the period 2003 to 2006

There was a reduction of more than one thousand samples collected in the Mpumalanga collieries over the four years. The sampling strategy determined by the DMR – SAMOHP is risk based and if correctly applied, would reduce the number of samples collected when the risk reduces; i.e. the amount of dust to which the employees were exposed reduced.

3.1.2 <u>Coal mine dust measurements per year for 2003 to 2006</u>



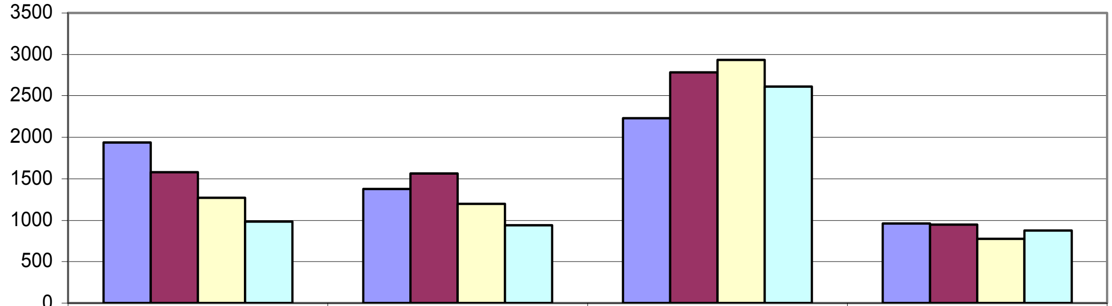
	90th Percentile	Std Deviation	Mean	Median	75th percentile	25th percentile
2003	4.82	2.69	1.9	1.03	2.44	0.36
2004	3.63	2.11	1.5	0.86	1.86	0.37
2005	3.43	2.02	1.4	0.75	1.71	0.34
2006	3.02	1.9	1.3	0.62	1.5	0.29

Figure 3.2 Respirable coal dust concentration in mg/m³ for the fifty three Mpumalanga coal mines during 2003 to 2006

There was a reduction in the recorded concentration of respirable dust levels of the coal dust in the collieries. The average coal dust exposures reduced from 1.9 mg/m³ in 2003 to 1.3 mg/m³ in 2006, a reduction of 0.6 mg/m³ in the average exposures over the four year period.

The Department of Mineral Resources placed emphasis on the 90th percentile and most of the sampling strategies are centred on this figure. Figure 3.2 depicts a steady decline in the 90th percentile. Although the 90th percentile decreased from 4.82 mg/m³ to 3.02 mg/m³ (i.e. 1.8 mg/m³) over the four year period, this level is still unacceptable as it is above the required statutory limit of 2.0 mg/m³.

3.1.3 <u>2003 – 2006 Risk band based on percentage of OEL-TWA</u>



	A Risk (Total no. of samples > OEL-TWA)	B Risk (Total No. of samples > 50 % to OEL-TWA)	C Risk (Total No. of samples > 10 % < 50% OEL-TWA)	D Risk (Total No. of samples < 10 % OEL-TWA)
2003	1938	1378	2228	960
2004	1579	1560	2781	949
2005	1270	1195	2931	772
2006	983	943	2608	878

Figure 3.3 Risk band categories' values for respirable coal dust for fifty three Mpumalanga coal mines during 2003 to 2006

Figure 3.3 indicates a decline in the A and B risk categories. There is an increase in the "C" category, hence there is a movement from the "A" and B Risks to the "C" risks category. There is however no increase in the "D" category for the four years.

3.2 Silica dust measurements

3.2.1 Summary of total number of samples collected for silica dust for the period 2003 to 2006.

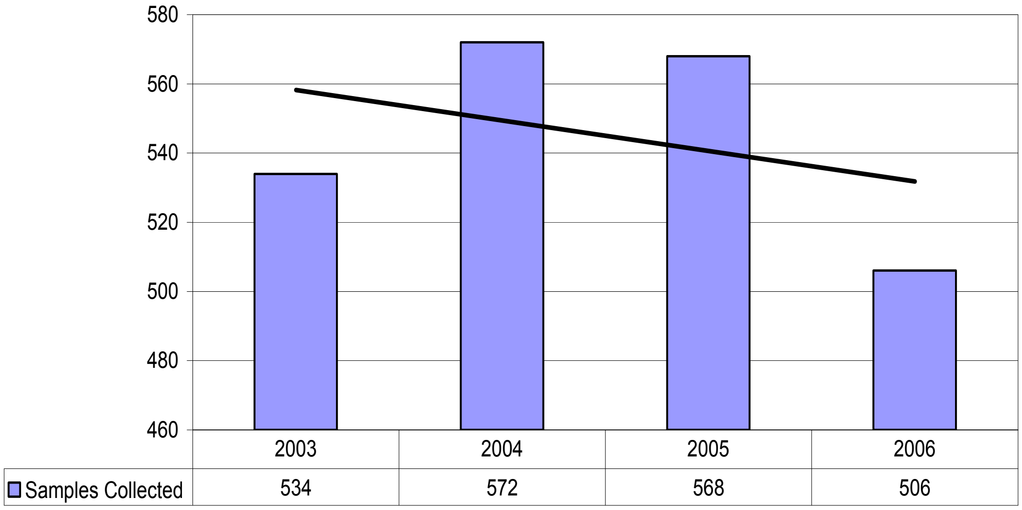


Figure 3.4 Respirable silica measurements in fifty three Mpumalanga coal mines during 2003 to 2006

3.2.2 Silica measurements for the years 2003 – 2006

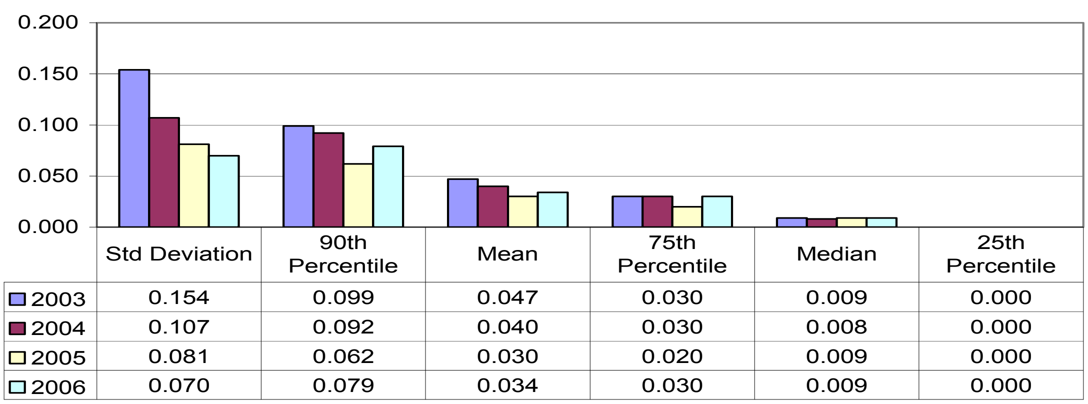
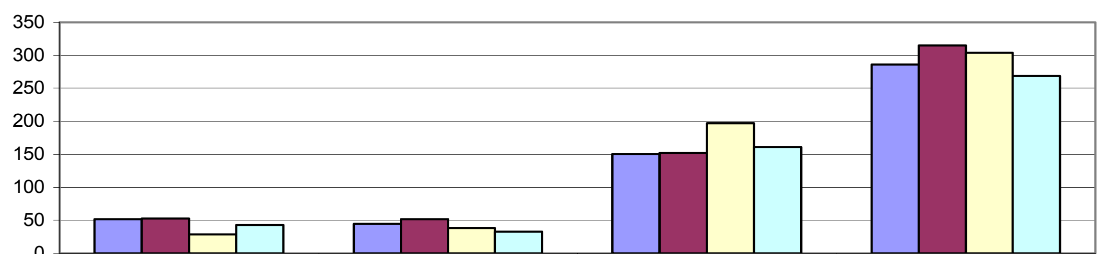


Figure 3.5 Respirable silica dust measurements collected in fifty three Mpumalanga coal mines during 2003 to 2006

There is a reduction in the concentrations of silica dust in the collieries. The average silica dust exposures reduced from 0.047 mg/m³ in 2003 to 0.034 mg/m³ in 2006. During the interrogation of the sampling data, 19 mines on average per year had at least one measurement greater than 0.1 mg/m³.

The Department of Mineral Resources place emphasis on the 90th percentile and most of the sampling strategies are centred on this figure, hence the values are shown in Figure 3.5 A decline in the 90th percentile is observed as the concentrations decreased from 0.099 mg/m³ to 0.079 mg/m³, a reduction of 0.02 mg/m³ in the 90th percentile over the four year period.

3.2.3 <u>2003 – 2006 Risk Band based on Percentage of OEL-TWA analysis data</u>



	A Risk (Total no. of samples > OEL-TWA)	B Risk (Total No. of samples > 50 % < OEL-TWA)	C Risk (Total No. of samples > 10 % < 50% OEL-TWA)	D Risk (Total No. of samples < 10 % OEL-TWA)
2003	52	45	151	286
2004	53	52	152	315
2005	29	38	197	304
2006	43	33	161	269

Figure 3.6 the risk band categories' values for respirable silica dust for the total number of samples collected in fifty three Mpumalanga coal mines during 2003 to 2006

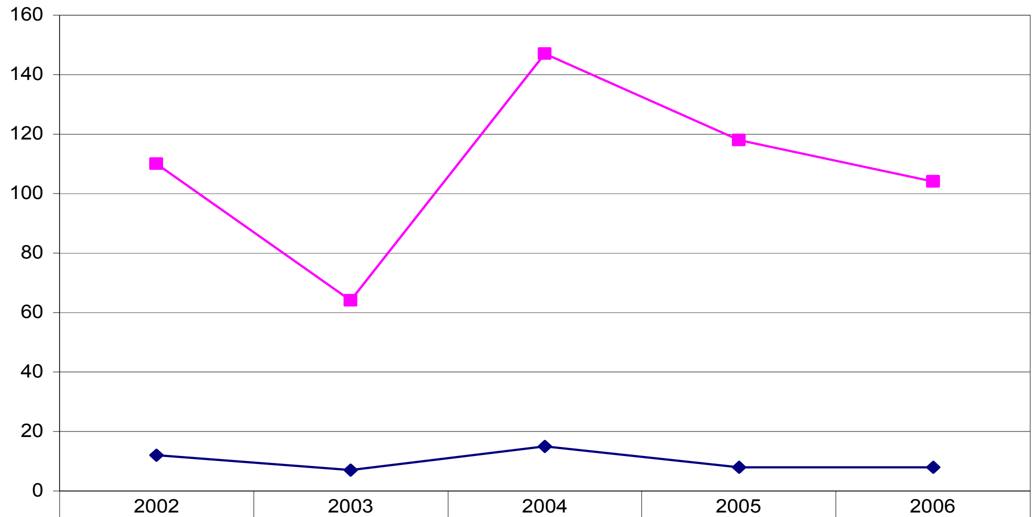
Although there was a reduction in the A and B risk profiles of the collieries in the Mpumalanga province, i.e. a reduction from 52 to 43 in the “A” category and a 45 to 33 reduction in the “B” category, there is not a consistent decline year on year, hence more years of measurements are required to infer a reduction.

Table 3.1 Number of mines per year with A and B risk categories for respirable silica measurements and percentage of the 53 mines:

Year	A	% of mines A	B	% of mines B
2003	21	39.6 %	27	50.9 %
2004	19	35.8 %	27	50.9 %
2005	15	28.3 %	21	39.6 %
2006	20	37.7 %	15	28.3 %

3.3 Autopsy data from NIOH reports 2002 – 2006

3.3.1 Pulmonary tuberculosis

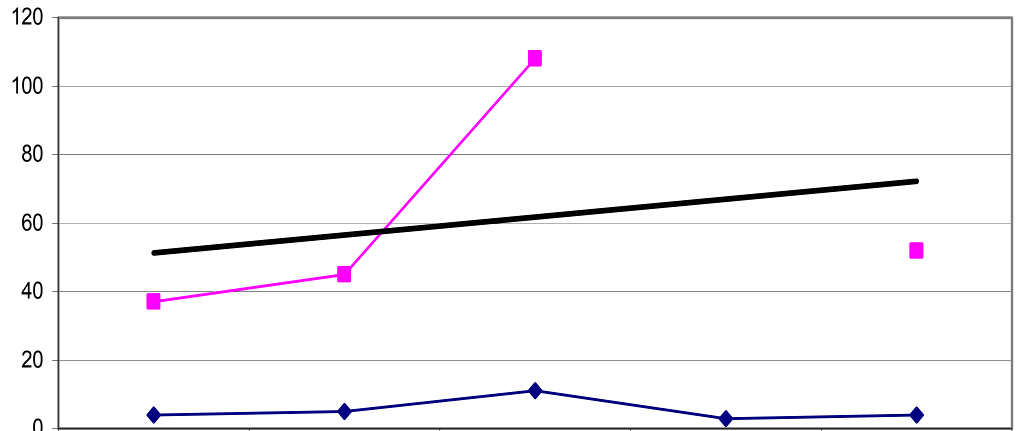


	2002	2003	2004	2005	2006
N	12	7	15	8	8
Rate	110	64	147	118	104

Figure 3.7 Number of cases and rate of active pulmonary tuberculosis in coal mining commodity (rate = /1000 autopsies performed) for the years 2002 to 2006 according to NIOH Pathology Division yearly reports

The number of employees in the coal mining industry with pulmonary tuberculosis (PTB) at autopsy decreased from 12 in 2002 to eight in 2006, but there is not enough information to draw conclusions. The rate fluctuated within a narrow band during the five year period, and no obvious increase or decrease in the rate is evident.

3.3.2 Number of cases and rate of silicosis in coal mining commodity (rate = /1000 autopsies performed)

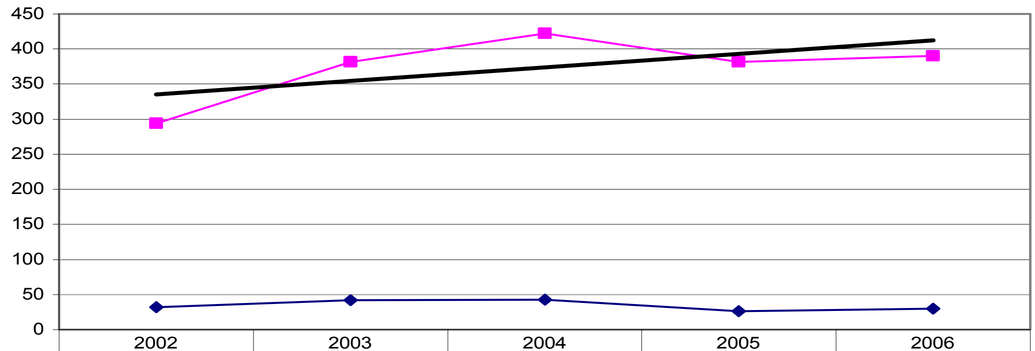


	2002	2003	2004	2005	2006
N	4	5	11	3	4
Rate	37	45	108		52

Figure 3.8 Silicosis autopsy data for the period of 2002 to 2006 from NIOH pathology reports

The number of employees in the coal mining industry with silicosis at autopsy was between 3 to 4 cases per year except in 2004 where there were 11, but in general the cases stayed constant over the five year period. The rate of silicosis per 1000 autopsies performed however showed an increase over the five year period as the rate increased from 37 to 52. This could be investigated further in a few years time, to establish whether a trend develops.

3.3.3 <u>Number of cases and rate of emphysema in coal mining commodity (Rate = /1000 Autopsies performed)</u>



	2002	2003	2004	2005	2006
N	32	42	43	26	30
Rate	294	382	422	382	390

Figure 3.9 Number of deceased workers with emphysema at autopsy, from the NIOH pathology reports for the years 2002 to 2006

The number of identified emphysema cases at autopsy stayed fairly constant with 32 cases in 2002 to 30 cases in 2006 with an increase in 2003 and 2004 to 42 and 43 respectively. Although the number of cases does not indicate an increase, the rate per 1000 autopsies increased from 294 in 2002 to 390 in 2006.

3.3.4 Number of cases and rate of coal workers' pneumoconiosis in coal mining commodity

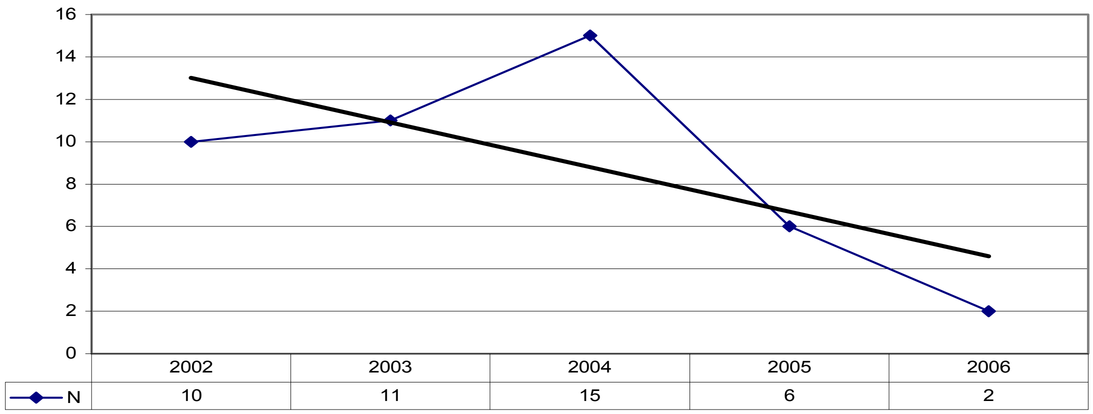
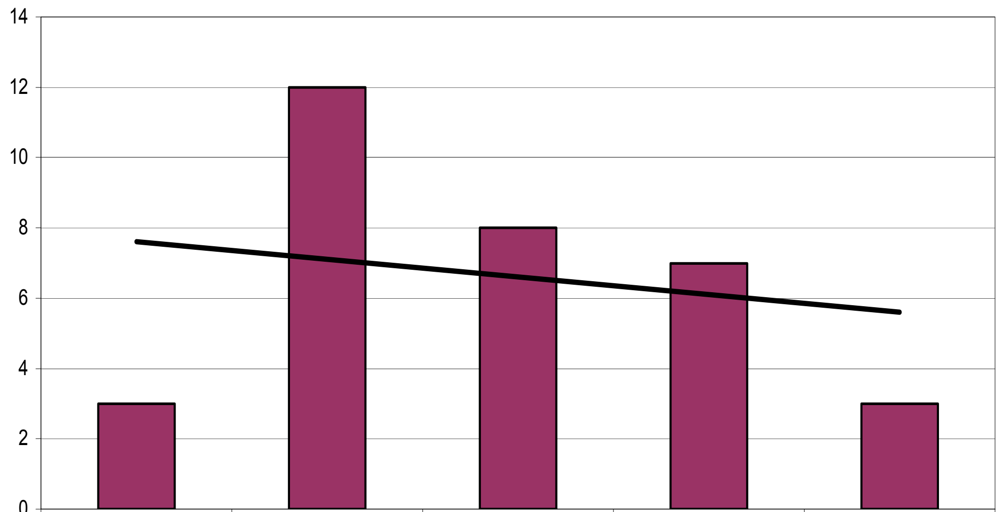


Figure 3.10 Coal workers' pneumoconiosis autopsy data for the years 2002 to 2006, from the NIOH pathology reports

There was a decrease in the number of employees in the coal mining industry with coal workers' pneumoconiosis at autopsy from 2002 to 2004 from 10 to 2 cases, but there was an increase during the years 2003 and 2004 to 11 and 15 respectively. Unfortunately rates could not be calculated from NIOH reports.

3.4 Data from DMR SAMODD data base 2002 - 2006

3.4.1 Number of cases of coal workers' pneumoconiosis in coal mining commodity in Mpumalanga



	2002	2003	2004	2005	2006
No. Cases	3	12	8	7	3

Figure 3.11 Number of cases of coal workers pneumoconiosis for Mpumalanga coal mines for the period 2002 to 2006

The total number of employees with coal workers pneumoconiosis (CWP) decreased from 2003 to 2006, with a reduction from 12 cases in 2003 to three in 2006.

3.4.2 Number of cases of chronic obstructive pulmonary disease in the coal mining commodity in Mpumalanga

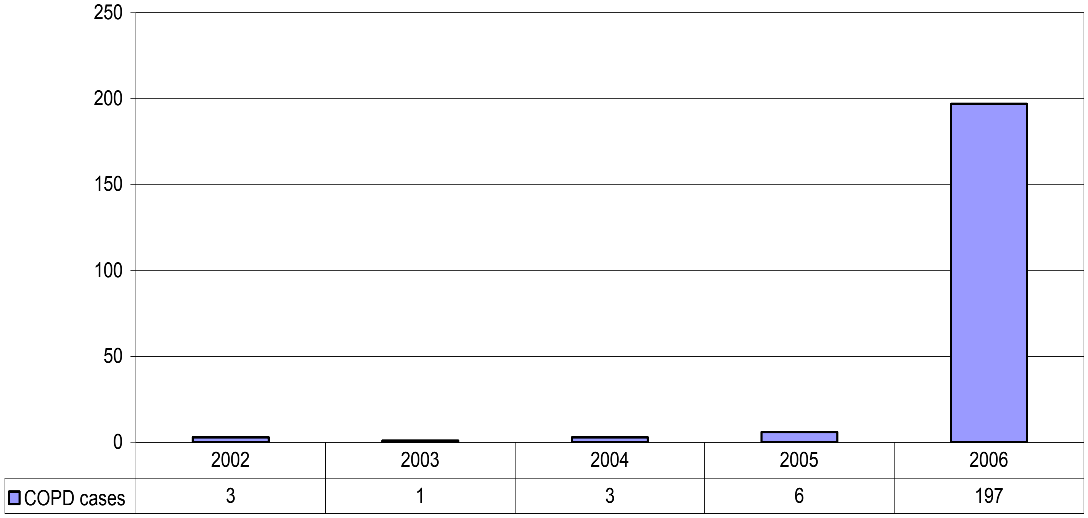


Figure 3.12 the number of chronic obstructive pulmonary disease cases in Mpumalanga Coal mines for the period 2002 to 2006

There was an increase in the number of cases of chronic obstructive pulmonary disease (COPD) from six cases in 2005 to 197 cases in 2006.

3.4.3 Number of cases of silicosis in the coal mining commodity in Mpumalanga

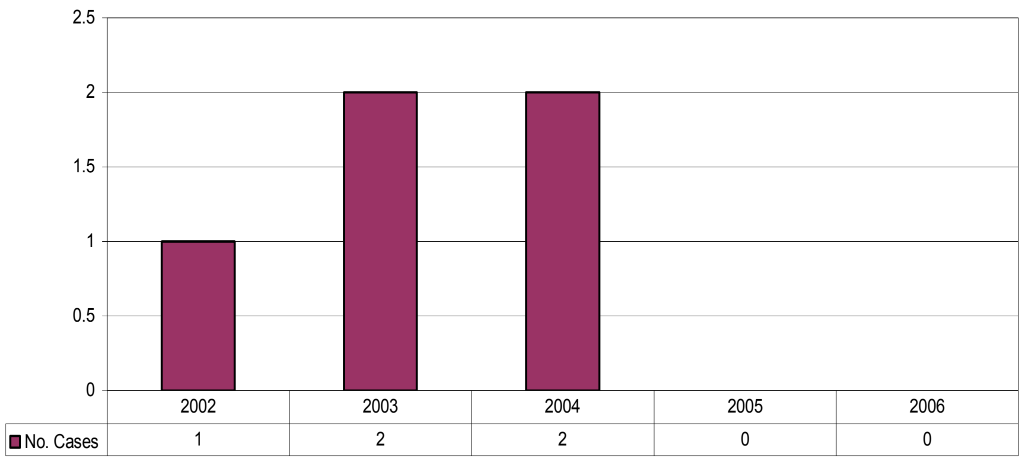


Figure 3.13 the number of silicosis cases reported from Mpumalanga coal mines for the period 2002 to 2006

Few cases were reported and it is notable that none was reported for 2005 and 2006.

3.4.4 <u>Number of cases of pulmonary tuberculosis in the coal mining commodity in Mpumalanga</u>

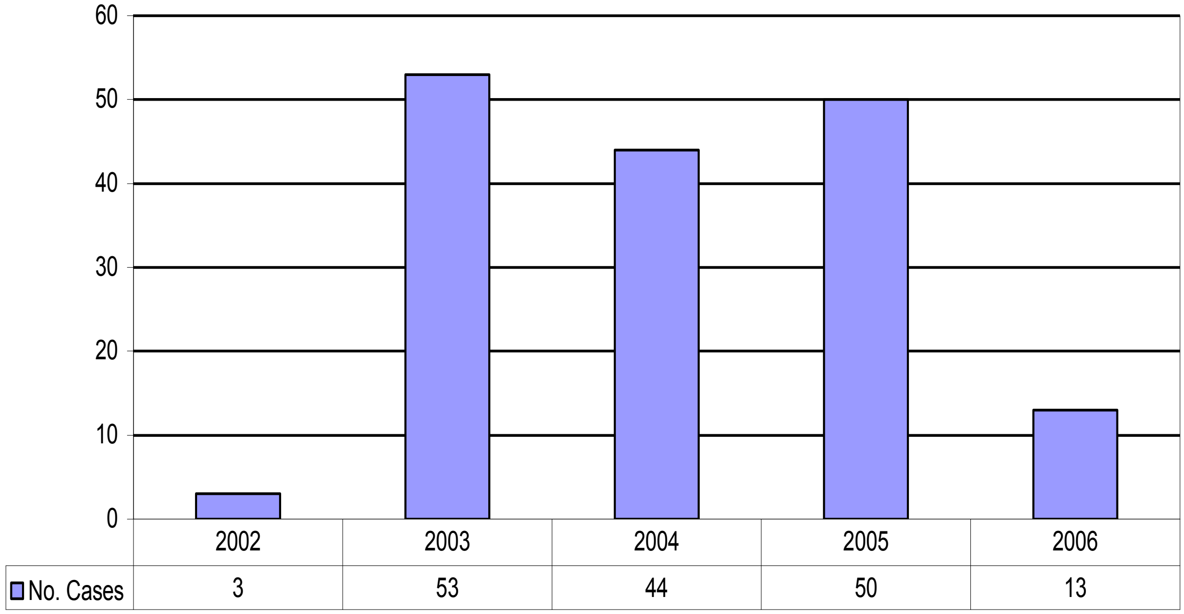


Figure 3.14 The number of tuberculosis cases reported from Mpumalanga coal mines for the period 2002 to 2006

Tuberculosis; with initially only three cases in 2002, an increase in cases was experienced in 2003 to 2005 to 53, 44, 50 respectively. A reduction was observed in 2006 with 13 cases.

4 CHAPTER FOUR: DISCUSSION

In the discussion section, the major findings are summarised and possible limitations discussed.

The main aim of this report was to describe respirable mixed coal mine dust concentrations, i.e for coal dust and silica, for the four year period 2003 to 2006. Additionally to describe the coal-associated diseases reported on the autopsy and medical reports received from NIOH and the DMR for the five years period from 2002 to 2006.

4.1 Dust Sampling Information

4.2 Limitations:

4.2.1 Validity of dust measurements

- Non-compliance with the prescribed sampling procedure. It might be uncomfortable to work underground with extreme environmental conditions and still wear a gravimetric sampling pump. The temptation does exist to leave the pump at a waiting place in clean air before entering the working face and fitting the instrument again once leaving the workplace. This unfortunately is difficult to quantify due to the lack of resources for continual supervision. Please note that although CECS does regular inspections on the collection stations at the mines, the physical workplaces where the sampling is carried out by the employees are monitored by the employees' supervisor, this is where the most crucial supervision is supposed to be done. Partial supervision forms are normally submitted by these supervisors, but the knowledge of the supervisors might not be adequate to ensure that the sampling is done correctly and that the validity of the information is completely trustworthy.

- The people working in different occupations underground are exposed to different conditions e.g. a continuous miner operator would spent 100% of his shift at the working face but an assistant would only spend 60% of his shift at the same location. The results obtained from the sampling might be wrongly allocated to the wrong Homogeneous exposure groups (HEG's) and if the employees are sampled incorrectly, the information might be incorrect. All occupations in a specific HEG must be sampled to get a true representation of the exposures of the different occupations.
- Gravimetric sampling pumps are sometimes abused by placing the pumps on the ground where dust is pulled onto the filter; and sometimes water enters the cyclones damaging the filters. The laboratory analyst readily identifies these samples and a resample together with an investigation is requested.

- A large number of filters were weighed in the gravimetric sampling central laboratory. All the results are entered into a computer data base and some data entry errors may occur.

A management system is in place to prevent such errors; this includes internal audits, external audits, investigations, inspections on the wearer and management of the output data as well as partial supervisor appointments of the line manager of employee being sampled. Consequently, although dust measurement data may not all be valid, sufficient confidence in the system exists to accept the findings in general.

4.2.2 Representative sampling data

There are 65 coal mines in Mpumalanga province of which 53 made use of the CECS laboratory service during the time of the study. Nearly 82 percent of the mines' data were therefore collected from the central data source. These mines are scattered over the Mpumalanga province and mines do not mine the same rank of coal, some mine coal have an ash content as high as 50%. The mines also do not intersect the country rock at the same times or same concentrations. Consequently, the data presented, although probably representative of Mpumalanga coal mines is a summary and dust problems in particular mines or ranks of coal have not been identified.

4.2.3 Discussions of findings:

Twenty four thousand nine hundred and fifty three respirable gravimetric samples were collected for respirable coal mine dust for the four-year period. Samples were collected per risk category: when the risk is higher; more samples are taken than when the risk is low. During the periods in question, the “A” and “B” risks decreased, hence there may have been an improvement in the dust management of the collieries.

There were however still nine hundred and eighty three (983) samples taken for the “A” risk in 2006. The interpretation of this is that there are still approximately two hundred and twenty five (225) samples collected every quarter for people exposed to coal dust in the “A” risk category. The DMR SAMOHP requires that 5% of the employees be sampled per quarter, hence if extrapolated, it means that there were still some 4,900 employees in the coal industry exposed to coal dust above the statutory limit of 2.0 mg/m^3.

The arithmetic mean respirable dust concentration for the fifty three mines in the report reduced from 1.9 mg/m^3 in 2003 to 1.3mg/m^3 in 2006. The 90^{th} percentile for the fifty-three mines was reduced from 4.82 mg/m^3 to 3.02 mg/m^3.

4.3 Autopsy information:

4.3.1 Limitations:

4.3.1.1 Incomplete information:

Statistics: 1) Autopsies on migrant workers who have returned to labour-sending areas are known to be incomplete. Consequently under reporting is likely. 2) Migration of workers from one mining commodity to another is not always accounted for in the reports, hence service history is not always complete. Some misclassification of commodity is thus likely, but the bias this might introduce is unclear.

4.3.2 Discussions of findings:

4.3.2.1 Pulmonary tuberculosis:

Although overall the PTB incidence cases reduced from 12 in 2002 to eight in 2006, the conclusion can be made that there was a reduction in the number of cases over the five year period, the rate per 1000 employees does not support this; the rate fluctuated too much to make a reasonable deduction. [Refer to Figure 3.7]

4.3.2.2 Silicosis:

There seems to be a slight increase in the rate of employees in the coal mining industry with silicosis from 37 to 52, the rate is not supported by the number of cases. The reason for this increase could also be explained by the HIV the same as for the PTB. [Refer to Figure 3.8]

4.3.2.3 Emphysema:

There seems to be a general increase in the rate of autopsies from 294 to 390 in 2002 to 2006 respectively. [Refer to Figure 3.9]

4.3.2.4 Coal workers' pneumoconiosis:

Coal workers' pneumoconiosis was not common at autopsy during the time period of the study, therefore no rates per 1000 is cited in the NIOH reports. A general decrease from 2002 to 2006 from 10 to 2 respectively overall is reported. These figures can not be substantiated though over the full period of the study as an increase form 11 and 15 in 2003 and 2004 respectively was recorded. [Figure 3.10]

4.4   SAMODD (DMR) Data

4.4.1   Limitations:

Under-reporting of disease to surveillance programmes is common and the extent of under-reporting to SAMODD is unknown, but may be substantial, as it has been documented that not all mines report to the DMR. [Republic of South Africa, 2004/5] Also the changes in disease burden by year may simply be variations in reporting compliance, hence this SAMODD data need to be read with these limitations in mind. [Figure 3.11]

4.4.2 <u>Discussions of findings:</u>

- There is an initial number of 3 CWP cases reported in 2002 and an immediate increase in 2003 to 12, but from 2003 to 2006 a decline from 12 to 3 has been recorded. [Figure 3.11]
- There was an increase in the number of COPD cases from 3, 1, 3, 6 and 197 in 2002, 2003, 2004, 2005 and 2006 respectively. The data do not seem to be correct even if COPD is common; the reason for this statement is that only 7 cases were sent to the compensation commissioner for evaluation during 2006 and 197 cases are recorded in the same year by the DMR. [Figure 3.12]
- Very few cases of silicosis were reported to SAMODD. This is surprising given the findings of Naidoo et al. [2004] and the respirable silica levels shown in the report. Further research is needed to explore this issue. [Figure 3.13]
- There was an overall increase of PTB from 2002 to 2006 in Mpumalanga coal mines. This increase over the five year period might also be attributable to the HIV rates as previously discussed in the introduction section of this report. [Figure 3.14]

5 CONCLUSIONS AND RECOMMENDATIONS

A reminder of the objectives of the report are (1) to describe the coal dust and silica concentrations as measured by personal breathing zone sampling in Mpumalanga coal mines over the period 2003 to 2006 and (2) to describe the burden of coal-associated diseases reported by autopsy examinations received from NIOH Pathology Department and in the SAMODD data base in Mpumalanga coal mines over the period 2002 to 2006.

5.1 Conclusions

- There may have been an overall reduction in the dustiness of the coal mining industry in the Mpumalanga province as the arithmetic mean of the samples collected decreased from 1.9 to 1.3, which shows an improvement overall on the dustiness of the samples collected. International research does not consistently show adequate dust control in coal mining; for example, Colinet et al., [2007] reported 11% and 12% of samples collected in the United States for continuous miner and roof bolter exceed the applicable standards.

  Although the dust reduction is noteworthy, the 90th percentile level of dust is still above the occupational exposure limit prescribed by the DMR.

- The mean concentrations of silica in the Mpumalanga coal mines decreased from 0.047 mg/m³ in 2003 to 0.034 mg/m³ in 2006, but on average per year, 19 mines had at least one measurement > 0.1 mg/m³. The requirement of the milestones for silica agreed upon by industry is the compliance of 95% for individual samples. The total number of samples complying per year is: 2002 = 97.7%, 2003= 97.4%, 2004 = 97.81, 2005 = 98.83%, 2006 = 97.93%, therefore according to the milestones set by the DMR, the information indicates that the industry does comply with the requirements.

- The data show a decline in CWP; this is in line with the international research from the United Kingdom, USA, Australia, Germany, France and Belgium. [Walton et al., 1977]
- In line with the conclusions of the autopsy data, there was a decline in the number of cases of CWP.
- The information on the silicosis cases are limited and too little information is available on silicosis to make useful deductions; the information contained in this report does however suggest that the milestones are obtainable. [Figure 3.13]
- There was an increase in the number of tuberculosis cases for the five year period. This is also supported by the report by Harriet H. Park, et al., [2009].

5.2 Recommendations

- Respirable coal dust levels above 2 mg/m³ and respirable silica levels above 0.1 mg/m³ were common. Consequently, efforts to reduce dust are required.

- Silica results for some of the mines are done per batch and averaged for wafers, silica results should be done per sample as per normal Occupational Hygiene principles.
- Many items from the NIOH autopsy data contained “unknown” information and although the occurrences of these are in the decrease, the replacing of the “unknowns” with the correct information will ensure the collection; collation and interpretation of data could be done more accurately.
- Regular audits should be conducted by industry on the data base and collection and recording system of the Department of Mineral Resources.
- Under reporting of illnesses to the SAMODD is disturbing (only 343 mines or 54.61% reported illnesses to SAMODD) [Republic of South Africa 2004/5] and greater effort should be put in to reduce under-reporting; legislation should be instituted and better control measures should be taken by the DMR to ensure inspections are done on smaller mine groups to ensure the data reported are representative of this cohort.
- Occupational illnesses should be reported under a central data base nationally, to ensure the correct estimation of mortality and morbidity

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UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 du Toit

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M080531**
PROJECT	Description of coal associated diseases and coal dust concentrations in Mpumalanga coal mines
INVESTIGATORS	Mr A du Toit
DEPARTMENT	Faculty of Health Sciences
DATE CONSIDERED	08.05.30
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 08.06.11 **CHAIRPERSON** ....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Mr A Swanepoel

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

A Division of Colliery Training College (Pty) Ltd.
Incorporated in the Republic of South Africa
Reg. No. 1965/007106/07

Collieries Environmental Control Service

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Ref.: 08/02/07

19 July 2007

TO WHOM IT MAY CONCERN

Sir/Madam

CONSENT FOR USE OF DATA

It is hereby certified that permission has been granted to Mr. A.Z. du Toit to use the data supplied by us for analysis purposes.

The data supplied does not contain any names of collieries under investigation, nor does it contain any personal information that could lead to the identification of any company or individual.

A copy of the final report is required for verification and informatory purposes.

Yours sincerely.

D.J. DE VILLIERS
MANAGER : CECS

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Your Reference: **T0257**

11th March 2008

Mr D J de Villiers
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2280

AC NOTIFICATION

Dear Mr D J de Villiers,

This letter serves to confirm that following the SANAS Approval Committee meeting held on 23rd February 2008, continued accreditation has been granted in accordance with **ISO/IEC 17025:2005** to **Collieries Environmental Control Service (T0257)**.

Regards,

SANAS, Administration.