TIMS
TB IN THE MINING SECTOR IN SOUTHERN AFRICA

Resource for **Inspectorates**

HEALTH FOCUS

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INTRODUCTION TO THE MODULE

Mining plays a significant role in the development process of the Southern African Development Community (SADC) by creating wealth and employment and a market for other industries such as manufacturing and services.

Assuring the safety and protecting the health of the large workforce employed by the mining sectors is a concern of policy makers and regulators across the Southern African sub-region. A review of existing legislation in 10 countries of the region, namely in Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe, shows that countries have set up complex legislative and regulatory frameworks for Occupational Safety and Health in mining, often rooted in the colonial past of the countries and failing to address the challenges that come with the expansion and privatization of the mining industry.

Acknowledging that a thriving mining sector can contribute to economic development, alleviation of poverty and an improved standard and quality of life throughout the region, member states of the SADC have signed a Protocol on Mining agreeing to adopt internationally accepted regional standards within the mining sector (Enforced 10/02/2000)[15].

There is a large workforce in the mining sector, which by nature of the job is exposed to different harmful elements, which may be in the form of airborne pollutants such as dusts (e.g. silica / quartz, coal dust etc.), fibres and other harmful substances. Employees exposed to these environmental conditions may develop occupational illnesses, which lead to either long or short term suffering or death. This module will only deal with dust exposure, specifically silica dust associated with mining operations.

The role of the inspectorate is to ensure that the country's safety and health standards established to manage dust exposure and protect the mineworkers are effectively applied within the mining sector. The inspectorate will ensure compliance by conducting workplace audits and inspections, and promoting safety and health education programs. However, in some countries inspectors find themselves working in challenging conditions with limited human resources and budgets for equipment, transport and a lack of practical tools that enable them to do their job. As a result, the inspectors may not be able to adequately inspect and support all mining operations in the country with particular challenges around inspections of artisanal small-scale mines (holding valid mining licences), who often do not adhere to the regulations.

This module provides occupational safety and health inspectorates who are responsible for the mining sector with knowledge about dust hazards in mine work and its effects on mineworkers' health as well as with state of the art dust control frameworks, measures and tools for inspecting mining operations for compliance.

Tools are included such as the mine inspection checklist, toolbox talks for health and safety training and dust sampling procedures.

[15] SADC (1997): Protocol on Mining in the SADC. Online http://www.sadc.int/documents-publications/show/808

BACKGROUND READING

Occupational lung diseases in mining

Since the early days of mining the relationship between dust exposure and lung diseases has been described and investigated. The inhalation of respirable dust over prolonged periods of time causes mineworker pneumoconiosis, which is one of the most important occupational diseases worldwide. The World Health Organisation (WHO) states that "the respirable particulate fraction (of dust) is that fraction of inhaled airborne particles that can penetrate beyond the terminal bronchioles into the gas-exchange region of the lungs[16,17]". South Africa considers 200 eight-hour shifts exposure to elevated levels of respirable dust as a risk for developing pneumoconiosis.

Dusts for which the respirable fraction offers the greatest hazard include quartz and other dusts containing free crystalline silica as well as cobalt-containing and other hard metal dust. Silica is the common name for silicon dioxide, a white or colourless compound found naturally in sand, granite and many other types of rock. Quartz is the most common form of silica and is the second most common mineral in the earth's surface. Since it is so abundant, quartz is present in nearly all mining operations. People who work in mining may breathe in tiny bits of silica, and eventually, develop a serious lung disease called silicosis. There is no cure for silicosis. Lung damage from silicosis is permanent, but with proper precautions it is preventable. Silicosis usually develops after years of exposure to low levels of silica dust. However, it can develop much sooner (even within a few weeks) if you breathe in high levels of silica dust. Mineworkers working at both surface and underground mines are at risk of being exposed to silica-containing dust. The most common mine activities where exposure may be elevated include the drilling of rock, breaking or crushing, and loading of mine material.

Specific names have been given to illnesses caused by various dusts:

Coal workers' pneumoconiosis (black lung)	Coal workers' pneumoconiosis is caused by breathing in respirable coal dust.
Silicosis	Silicosis is caused by particles of free crystalline silica (quartz, sandstones, flint).
Asbestosis	Asbestosis is caused by excessive mineral fibre exposure. These mineral fibres are comprised mainly of silicate chains. They may also cause cancers of the bronchial system, lung tissue and abdominal organs.
Siderosis	Siderosis is caused by mineral dusts emanating from iron ore.
Stannosis	Stannosis is caused by mineral dusts emanating from tin ore.
Aluminosis	Aluminosus is caused by mineral dusts emanating from bauxite ore.

As stated earlier, pneumoconiosis is incurable and therefore prevention of the condition is the best strategy a country can employ. If a mineworker contracts pneumoconiosis, this makes him or her more prone to contracting tuberculosis. Tuberculosis (TB) is a disease caused by bacteria (mycobacterium tuberculosis), which are prevalent in working and living environments. Most tuberculosis infections manifest in the lungs (also called pulmonary TB), but there are also other forms of tuberculosis. A healthy body (intact immune system) getting in contact with TB bacteria would not automatically manifest the disease.

[16] WHO (1999): Hazard Prevention and Control in the Work Environment: Airborne Dust WHO/SDE/OEH/99.14. Chapter 1
[17] Note: Dust particles smaller than 10 microns are labelled as respirable dust

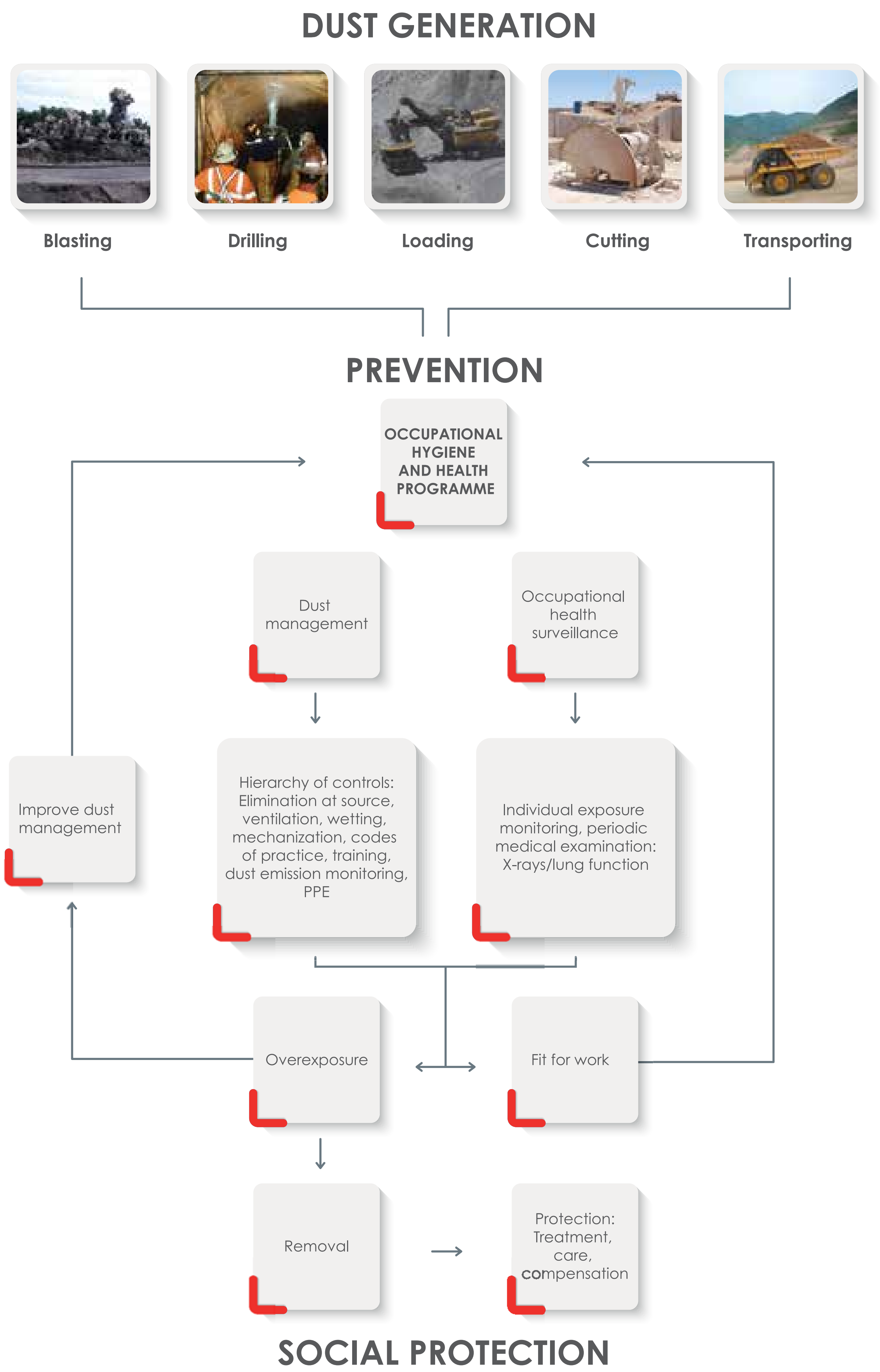
A person suffering from any kind of disease compromising the body immune and defence system, such as HIV or pneumoconiosis, has an increased risk or susceptibility to contracting tuberculosis and developing the illness. TB transmission is more likely to happen in confined spaces and in dusty, hot and humid working environments, as is distinctively prevalent in underground mining operations. However, certain open cast mining operations produce considerable amounts of dust as well, namely in cutting, transport and loading areas.

Mineworker's pneumoconiosis is considered a preventable disease today, when appropriate control measures are applied in the workplaces. WHO, in its Global Programme on the Elimination of Silicosis, points out: "Today, society possesses all the necessary means to combat this preventable disease and there is no excuse for silicosis persistence throughout the world. In the absence of effective specific treatment of silicosis, the only approach towards the protection of workers' health is the control of exposure to silica-containing dusts".[18]

Standards and controls for good management of dust exposure

Inspectors need to be aware of the specific controls to manage dust exposure that have been prioritized and will be covered under the following framework:

[18] Fedotov, I (2003): The ILO/WHO Global Programme on Elimination of Silicosis. GOHNET Issue No. 5.


DUST GENERATION
Blasting
Drilling
Loading
Cutting
Transporting
PREVENTION
OCCUPATIONAL HYGIENE AND HEALTH PROGRAMME
Dust management
Occupational health surveillance
Improve dust management
Hierarchy of controls: Elimination at source, ventilation, wetting, mechanization, codes of practice, training, dust emission monitoring, PPE
Individual exposure monitoring, periodic medical examination: X-rays/lung function
Overexposure
Fit for work
Removal
Protection: Treatment, care, compensation
SOCIAL PROTECTION

Harmful dust exposures

The first step for inspectorates is to have a baseline of hazardous dust exposure levels in the areas for which they are responsible. The Chief Inspector of Mines (or other such required Governmental Authority) can institute a mandatory Code of Practice (CoP) for the assessment and management of personal exposure to hazardous airborne pollutants, including particulate matter, such as respirable dust. An example of such a code is included as part of the tools section of this module.

Inspectors must be knowledgeable about the management of hazardous airborne particulate matter in mines, and must be capacitated to inspect, or to where necessary, have exposure samples taken of persons who may be exposed to dust in the workings of any mine, more especially in the informal and artisanal small scale mining sector.

Inspectors will ensure that all mines undertake a base-line evaluation of airborne particulate matter.

Should employers not conform to the mandatory CoP or have personal dust exposure values exceeding the limits as legislated for that specific country, inspectors must have powers to suspend operations at any mine and the order of suspension may only be lifted once such an Inspector is satisfied that the employer has demonstrated sufficient measures to comply forthwith.

How to measure occupational exposure limits (OELs)

Employers, where dust hazards have been identified through a risk assessment, must as far as is reasonably practicable, monitor workplace conditions if exposure to a health risk warrants it. Exposure monitoring will confirm whether workers are exposed to dust (respirable crystalline silica) at potentially harmful levels, and if existing control measures are working effectively.

It is equally important to note, however, that exposure monitoring does not replace the need for control measures to reduce exposure. An Industrial/Occupational Hygienist will be able to provide guidance on when dust sampling measurements are required, including the appropriate sampling techniques to be utilized.

How much crystalline silica is hazardous depends on how long and how often a worker is exposed as well as the level of exposure. Because respirable silica dust particles which are the cause of silicosis cannot be seen with the naked eye and because the dust which can be seen is coarse and comparatively harmless, the human eye is not a reliable guide to any dangerous dust in the air. It is therefore necessary to make use of dust sampling instruments which can provide indications of the concentrations of respirable dust in air. Any respirable dust sampling instrument should be designed to capture only dust particles of a size considered to be dangerous to health – usually smaller than about 10 microns.

A specialist or trained, competent person in airborne dust measurements can determine whether a worker is overexposed by sampling the air a worker breathes and comparing the exposure measured with the relevant Occupational Exposure Limit (OEL). The OEL is a limit value set for an occupational exposure in the workplace and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day for a working life without adverse health effects. In the case of crystalline silica, the OEL is the maximum amount of airborne respirable crystalline silica dust that one can be exposed to during a full work shift and is expressed in milligrams per cubic meter (abbreviated to mg/m3).

Various international and regulatory bodies that provide guidance on exposure to crystalline silica have recommended exposure to respirable quartz be kept as low as reasonably practicable below the legislated OEL.

Inspectors should be responsible for keeping records from the mines on occupational exposures and conducting random testing to validate information that is supplied. An example of a portable dust monitor is shown below.

What should a dust sampling strategy contain?

In any work environment, there are spatial and temporal variations in the concentration of airborne contaminants, so that exposure may differ with workers' movement as well as with time of the day, week, or even month. There are also sampling and analytical errors: some can be avoided by careful procedures, while others are inherent to a certain methodology and must be accounted for when deciding on the degree of reliability required for the estimation of the true value of the exposure parameter. Therefore, a sampling strategy, accounting for all factors that may lead to any variation in the results, must be designed and followed, so that the data obtained is representative of the workers' exposure, thus ensuring a reliable exposure assessment.

Important factors include:

- the day, week, or month sampling is performed,
- production rate,
- raw materials,
- work shift,
- task performed,
- individual performing task,
- dust control measures,
- technology used,
- number of workers,
- climate,
- other nearby processes,
- distance of worker from source, and
- errors in sampling and analytical procedures.

If the national authority responsible for the adopted OELs has laid down an accompanying assessment strategy, this should be followed. If not, the responsible professional should design and follow a suitable strategy. In any case, professional judgement during an assessment is indispensable.

The classic questions when designing a sampling strategy are:

- Where to sample?
- For how long to sample?
- When to sample?
- How many samples to collect?

This subject has been widely discussed in the specialized literature (e.g. BOHS, 1993). However, although specific methodological principles have been well established, there are nuances in their application. Obviously, any sample must be representative of the worker's exposure, which usually determines where and when to sample. Also, for the same type of agent and the same type of collecting medium, the recommended duration of sampling will be of the same order. However, specific situations may dictate differences in the number of samples required for an evaluation, because this, together with the quality of the measuring system, will determine the accuracy and precision of the obtained results, and the degree of reliability required will depend on the objective of the hazard evaluation.

For the assessment of inhalation exposure, it is necessary to characterize the air that workers are inhaling; therefore, the samples should be collected in the "breathing zone," which is usually defined as a hemispherical zone with a radius of approximately 30cm in front of the head. Some design considerations should include "worst case" exposure sampling or sampling a representative number of worker's indicative of all job categories. Sampling should be of fullshift duration or for the complete length of a process cycle, if the objective is to determine a time-weighted average concentration. Due to the variability in results and the probable lognormal distribution of dust exposures, sampling needs to be conducted over several shifts and over several days to best characterize the workplace exposures.

When assessing exposure to fast-acting substances (seldom the case with dusts) that can cause irreversible damage even on brief high exposures, sampling of very short duration (at the right time) is required, to detect concentration peaks, particularly if there are appreciable concentration fluctuations. High concentrations occurring for short periods can remain hidden, and undetected, if a sample is collected over a longer period during which very low concentrations also occur. Infrequently performed tasks also need to be characterized so that potential short duration but high concentration or peak exposures can be documented.

For the same exposure situation (including the expected environmental fluctuations), if the coefficient of variation of the measuring procedure is known and constant, it is possible, through the application of inductive statistical methods, to determine how reliable an estimate is, or what degree of uncertainty can be expected from a certain number of samples or measurements. This will guide the decision on how many samples to collect or how many measurements to make. The better the sensitivity, accuracy and precision of the measuring system and the greater the number of samples, the closer the estimate will be of the true concentration.

It is usually accepted that, if measurements are needed, they should be as accurate and precise, that is, as "reliable" as possible. However, there is the issue of the associated cost and, in practice, an acceptable and feasible degree of reliability must be established, per the purpose of the investigation and in view of the available resources. One approach is to look at the purpose of the results. For example, in determining control measures the results should be reliable enough to decide what control action is necessary. A different accuracy may be required if the measurements are part of an epidemiological investigation.

If it seems too costly and difficult to establish compliance (or non-compliance) with a standard, it may be better just to reduce the exposure. Considering that new knowledge on risk assessment often leads to a decrease in acceptable exposure limits, good practice should aim at controlling exposures to the lowest possible level. The required reliability depends largely on the consequences of making a wrong decision based on the collected data.

How to conduct size-selective sampling

Dust exposures can span a wide range of particle sizes with health effects dependent upon the region of deposition in the lung. For this reason, size-selective dust sampling is performed. The American Conference of Governmental Industrial Hygienists (ACGIH), the International Organisation for Standardisation (ISO) and the European Standardisation Committee (CEN) have reached agreement as to particle size-selective sampling criteria and defined three fractions for health-related measurement, namely inhalable, thoracic and respirable, as follows:

- Inhalable Fraction for those materials that are hazardous when deposited anywhere in the respiratory tract (50% cut off at 100µm);
- Thoracic Fraction for those materials that are hazardous when deposited anywhere within the lung airways including the gas exchange region (50% cut off at 10µm); and,
- Respirable Fraction for those materials that are hazardous when deposited anywhere in the gas exchange region (50% cut off at 4µm).

There has been international agreement that OELs for particles should normally be specified as one of the above fractions. Modern exposure limits for dusts are usually expressed in terms of the inhalable or respirable fractions.

What type of measuring equipment is required?

Measurements can be made by:

- the use of direct-reading instrumentation, to obtain results in (near) real time
- collection of samples, for weighing or subsequent laboratory analysis.

Each has its advantages and disadvantages and has its recommended application, as will be described. Sampling for airborne particles requires instruments that extract them from a measured volume of air and collect them in a manner that permits subsequent weighing and/or chemical analysis, or particle counting under a microscope. These instruments comprise a sampling head, an air mover (with a power source) and a flowmeter.

The sampling head must be designed to collect the fraction of airborne particles to which the OEL applies. The head will therefore consist of a collecting device (e.g. a filter in a filter holder), and a pre-collector such as a cyclone for the respirable dust fraction or a specially designed entry if the inhalable dust fraction applies.

It is essential that the air mover (sampling pump) functions at a measurable and practically constant flow rate and that the flow is always checked before and after sampling with a properly calibrated flowmeter. Analysis of air samples should be performed by a qualified laboratory which has an established quality assurance/quality control programme.

For exposure assessment, the best practice is to utilize personal samplers, which are portable sampling units carried by the workers as they move around. A common procedure is to attach the air mover to the belt, and the sampling head (which should be in the breathing zone) to the lapel of the worker's clothing. Care must be taken, however, when evaluating exposures to airborne particles, because it may happen that particles collected in the clothing (especially specialized PPE like disposable coveralls) are re-entrained into the sampling unit when being removed, thus introducing a bias in the sampling (Cohen et al. (1984).

The different type of size-selective samplers

An OEL which is expressed in terms of the inhalable or respirable fraction requires a sampling method which can collect particles of the desired size distribution. The objective of inhalable or respirable dust sampling is thus to separate out the larger particles from the dust stream, and to collect the remaining dust fraction on a filter or other media. The removal of the non-inhalable or non-respirable fraction by size-selective samplers such as elutriators, cyclones, and impactors is usually dependent on the greater mass and inertia of these larger particles (see ACGIH, 1995; Vincent, 1995; Kenny et al., 1997). Because of their size and operating requirements, elutriators are used for area sampling. Cyclones and impactors are available for personal and for area sampling.

Brief details follow:

Elutriators

The dusty air is sucked along a vertical or horizontal channel, and the particles separated per their settling velocities. Elutriators must be used in their design orientation, so they cannot be used for personal sampling.

Cyclones

Cyclones use centrifugal force to remove dust. A particle in a rotating air stream is subjected to a centrifugal force that accelerates it towards a surface where it will impact and lose momentum, thus being removed from the air stream. These cyclones are usually of small sizes, from 10 mm to no more than 50 mm in diameter. They have been widely used since the 1960s to collect the respirable fraction. In a typical cyclone pre-collector, the air enters tangentially at its side and swirls around inside. Particles above a certain size are thrown to the cyclone walls and collected at its base ("grit pot"). The air containing the respirable dust leaves through the central exit in the top of the cyclone, and the air is filtered to collect the dust. Because of the complexity of fluid behaviour in cyclones, it is difficult to predict mathematically their collection characteristics and they are based on empirical design. To achieve the proper size selection, however, the air sampling pump must be calibrated to provide the appropriate flow throughout the cyclone opening, within a specified variability, and the flow must be smooth. If the pump is not calibrated correctly, the selection will be shifted, either to larger (for low flow) or smaller (for high flow) aerodynamic diameters.
Once calibrated, cyclones can be used for all particles, but are not generally used for fibres. The cyclones available on the market to be used as pre-collectors in two-stage samplers are usually made of nylon or aluminium. Different cyclone designs and manufacturers each have their own specific operational flow rates and filter cassette configuration (2-piece or 3-piece).

Impactors

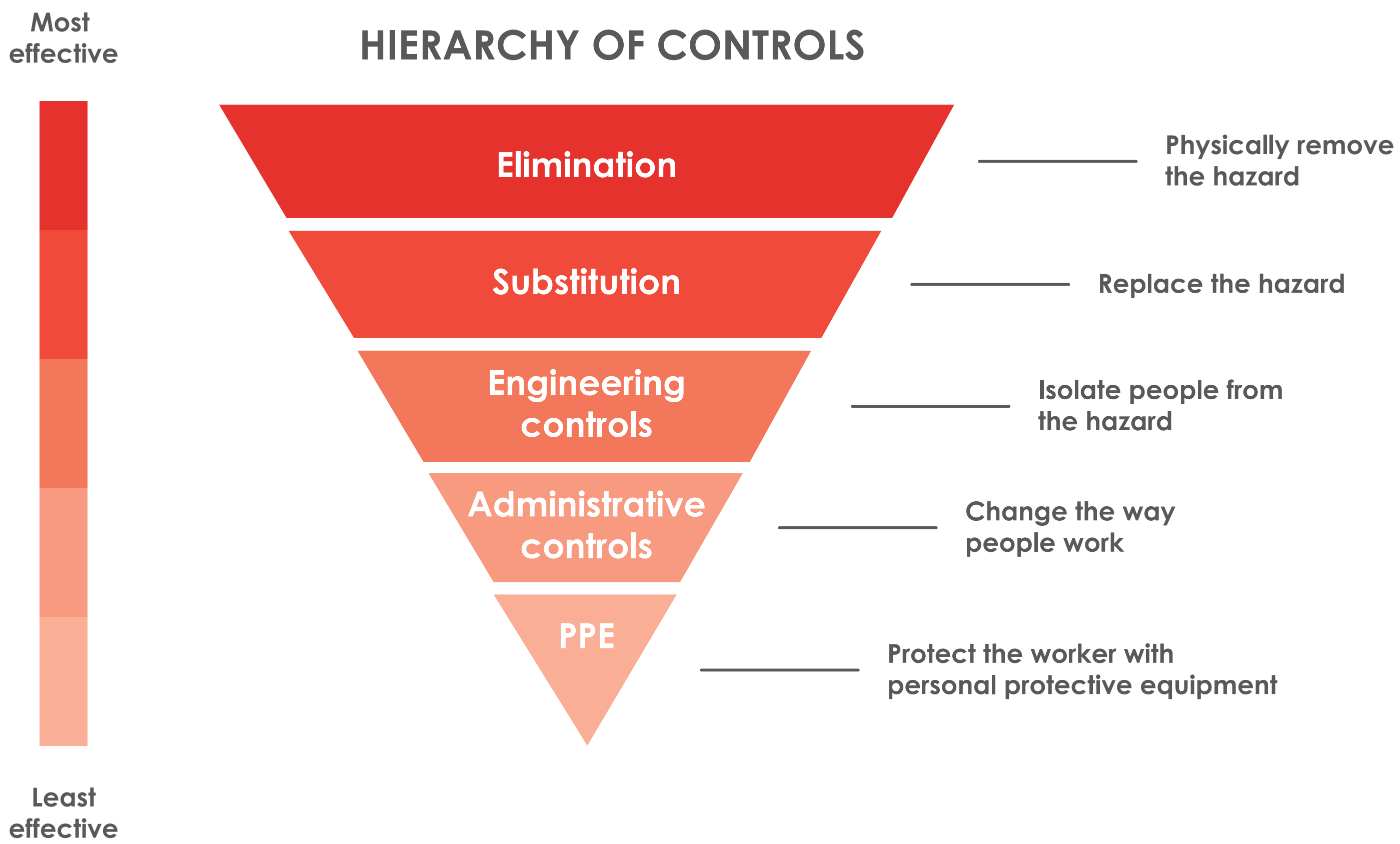
When a dust-laden airstream is forced to make a sudden change in direction, as when it flows directly and at high velocity against a flat surface, the momentum of the larger dust particles causes them to hit the surface. The particles may be collected on a liquid or gel surface for further analysis. The collection efficiency of an impactor, which relies on this principle, depends on the aerodynamic diameter of the particles and the velocity of the air stream. The multistage jet impactor, e.g., the Andersen sampler for viable particles, is used to separate fractions of different particle sizes.

Filters

Filtration is in fact a combination of principles as it involves direct interception, inertial collection, diffusion, electrical forces, adhesion and re-entrainment. Filtration efficiencies vary depending on parameters which include particle shape, density, surface characteristics, amount, humidity and collection velocity, but the filters used with dust samplers are close to 100% efficient. A great variety of filters are commercially available, for example: silver membrane, nucleopore, cellulose ester membrane, glass fibre, plastic fibre, etc., and the choice is usually determined by the analytical method to be used. If the filter is to be weighed, it is necessary to ensure that it is not significantly affected by changes in relative humidity. Polyvinyl chloride (PVC) or Teflon (PTFE) filters are most commonly used to reduce mass gain or loss from humidity. Information provided by filter and sampling equipment manufacturers will usually aid filter selection.

Prevention and risk mitigation

Inspectors are responsible for ensuring that mine managers apply the following hierarchy of controls to eliminate dust hazard exposures in the mining work place. There are brief descriptions for each of the controls below for inspectors to familiarize themselves with.



Elimination

The mine management should have records of their dust exposure levels and have systems in places to reduce the levels if above the national OEL.

Substitution

The mine management is responsible for replacing a dust generating process with a process generating less dust (e.g. use of wet process instead of dry process, or an automated process instead of manual process).

Engineering controls

Use of engineering controls are very effective towards reducing employee exposures, examples of such controls include:

Good ventilation

Good ventilation systems are used to dilute dust from the working environment and when combined with good filtration systems, dust can be effectively removed from the atmosphere and exposure to humans. Generally, a sound exhaust system is used whereby dust is removed and disposed of remotely from the working face but instances of a force exhaust overlap system may also be required.

Wet drilling and water sprays are most effective at allaying dust at its source, thus preventing it from being released into the general air. Drilling is one of the primary sources of dust creation in any mine.

Mechanization

The use of machinery is advantageous as it aids productivity. It does however create large volumes of dust because of the energy levels being applied. Operators are offered protection by way of being housed in closed cabins in order not to be exposed to the dust created by those machines. Employers will be well advised to fit such cabins with air conditioning units to prevent persons from opening doors and windows because of a hot environment and to supply filters to the intake ventilation systems of these units.

Where possible machines should be able to be operated from stations remote from the source of dust being created by these machines.s).

Machinery operated from a closed cabin

Drill stations

Drill stations should be provided with skirts to prevent the ejection of air into the atmosphere, in addition to suction tubes to collect the dust and to deposit it at another place remote from the operator by way of a cyclone and skirt. Hand held drills must be supplied with clean water which is disposed of through the axial holes of the drill stems and the front head release ports of the machines.

Where dry drilling needs to take place good ventilations systems need to be used, the presence of persons in the vicinity of that activity must be limited and good PPE used (respiratory protective dust masks of a make and specification commensurate with the type of dust being created and the risk attached thereto).

Wet and damp surfaces

All surfaces in the vicinity and intake airways to workings of a mine should be kept wet and damp. This will assist in allaying dust particles and the disturbance of residual dust on foot walls and other surfaces.

Dust suppression with water

Administrative controls

Training and education

Training and education of workers and supervisors alike is an important step towards the limitation of exposure to dust by persons working in the mine. This training should also include the identification and rectification of hazardous conditions; especially as far as hazardous airborne particulate matter is concerned.

Workplace sampling

Work places need to be sampled regularly to not only determine the dust loads to which persons may be exposed but also to determine the efficiency of the engineering controls that have been introduced. Here one would be able to pick up issues such as poor ventilation, recirculating air currents, break down in ventilation arrangements, insufficient water usage, clogged filtration units, etc.

Personal dust sampling equipment including calibrator

Correct use of personal dust sampler

Well documented practice

A good documented practice for the prevention of and protection from pneumoconiosis is essential in that it lays down the rules and activities required for maintaining a healthy and safe working environment. It should also contain the maximum allowable exposure limit of dust that people may be exposed to during their working shift and should be common knowledge among employees and supervisors alike.

Programmes aimed at the prevention of occupational lung diseases need to be audited regularly to ensure they function optimally and that certain areas are not neglected. This will ensure also that a role player ensures their part is taken care of and that the system is maintained in a healthy functioning state.

Surveillance

A good medical surveillance programme will assist in the early detection of possible lung diseases and assist to evaluate the efficiency of the dust control management system. Persons should be screened regularly and be counselled regarding the state of their occupational health and the necessity of conforming to health measures instituted at their mine.

Employees need to be consulted and incorporated during the development phase of the dust management programme and related standards. This will ensure that they have insight in the working of the programme and as such will be more inclined to comply with its requirements.

Personal protective equipment

The provision of Respiratory Personal Protective Equipment (PPE) is an absolute last resort, but may be used in conjunction with the other measures, such as above. Dust masks issued to employees must be of a type commensurate with the type of risk being faced, must be comfortable to wear and must be accompanied by training in the use and proper care of such units. Employees must be free to have access to such PPE Units on a regular basis (preferably daily) and should be permitted to exchange such units without prejudice from their employer or supervisor. Disposable N95 or FFP3 filtering face pieces and reusable half face respirators can be used only if silica dust levels are less than 10 times the dust limit. More information about PPE fit testing can be found using this link: *https://www.cdc.gov/niosh/npptl/stps/respirator_testing.html*

Provision of hygiene facilities, such as change-house and ablution (washing) facilities must be provided on site to ensure that contaminated clothing and equipment is not taken off-site where it may endanger the lives of other persons.

The N95 dust mask

Social protection

Inspectors should check that mineworkers know their rights about compensation. The mine safety and health legislature should clearly specify which occupational lung diseases are compensable. TB should be recognised as a compensable disease where there has been significant exposure to silica dust at work such that this exposure would be sufficient to cause silicosis, as evidenced by radiography or histology. This dose (a function of time and exposure level) needs to be defined properly – it cannot be just one work shift where exposure is below 10% of the Occupational Exposure Limit (OEL) and it cannot be 20 years where exposure is clearly above the OEL.

Benefit medical examinations (BME) for ex-mineworkers should be offered after an employee has left the mine, in correspondence with the type and duration of work. In South Africa all ex-mineworkers are entitled to a 2 yearly BME according to the Occupational Diseases in Mine Works Act (ODMWA), however other countries may determine the frequency of BMEs by how long the ex-miner worked on the mine and the level of exposure. The legislature should make provision for an ex-mineworker to have easy access to an accredited occupational health facility or public health facility (if appropriate) where x-rays and lung function tests may be taken and suitably qualified staff are able to diagnose pneumoconiosis and make submissions to the social security/ worker compensation systems in that country.

Penalties should be introduced through levies if a mine is found to have a higher OEL than the agreed national limit. Inspectorates should work with the industry to develop a shared narrative around the harmfulness of dust and should commit to work together to reduce the levels of dust in the work environment.

TOOLS FOR INSPECTORATES

Good practice: Checklist for mine inspections

Good practice: Dust Sampling procedure

Good practice: Sampling and analytical method for respirable crystalline silica dust

(Available on the CD)

Good practice: Checklist for mine inspections

INSPECTION OF MINES/WORKS/QUARRY	
Name of Inspector	

INSERT LOGO HERE

Date of Inspection	Y	Y	M	M	D	D	Financial Year			Mine Code											

A. Company / Site Information

Company Name[1]:	

			YY	MM
Name of shaft(s)/site(s):		Date of commencement:		

Primary Commodity:	

B. Employment Information[2]

Employer's Register[3] is up to date?	Yes	No	Total Number of Employees				
Number of Permanent Employees					Number of Contract Employees				

	South Africans	Zimbabwe	Lesotho	Swaziland	Mozambique	Botswana	Other (Specify)
Permanent							
Contract							

	Permanent	Contract	Total
Number of new employees since the previous calendar year			

	Permanent	Contract	Total
Number of Employees exiting			

	Permanent Employees	Contract Employees	Total
Number of employees performing risk work			

c. Risk Determination

Information for Section C should be obtained from the site-appointed Health and Safety/SHEQ Manager

Are dust measurements being conducted?	Yes		No	
Occupational Hygiene services rendered by whom?	In-House Staff		Private Company	

Comment: (If private company check accreditation and/or registration status)					

What are the type of dust measurements collected?	Personal	Area / Static

What Sampling / Analytical Method is used for sampling?	NIOSH 7500	OSHA ID-142	OTHER:

Are air sampling pumps fitted with cyclones when collecting dust?	Yes	No

If Yes above, what equipment and flow rates were used?	Nylon Cyclone: Flow Rate: 1.7L/min	HD Cyclone: Flow Rate: 2.2L/min	Aluminium Cyclone: Flow Rate: 2.5L/min	Other:

What is the level of dust measured?	Low: < 10% of OEL	Medium: ≥ 10% OEL < 50% OEL	High: ≥ 50% OEL ≤ OEL	Very High: > 100% OEL

Are dusts analysed for Silica/Quartz or any other hazardous components?	Yes	No
Comment: (If Yes above, give details on the type of hazardous components)		

Are Approved / Reputable Laboratories used for Silica/Quartz analysis?	Yes	No
Comments: (If Yes, provide applicable accreditation details of Laboratory)		

What type of controls does the mine / works / quarry use to control dust levels?	Engineering	Work Practices	Administrative	PPE
Comment: (Provide details on the methods of control used (and maintenance where applicable) and their effectiveness) Examples include: Ventilation and dust collection systems, water sprays, wet drilling, enclosed cabs and drill platform skirts.				

Action plan available to reduce risk	Yes		No	
Comment: (Provide details on the action plan(s) utilized)				

D. MEDICAL SURVEILLANCE

Unless otherwise stated, indicate the number performed/compensated/treated during the last calendar year.

Pre-placement Examinations	
Permanent	
Contractors	
Total	

Certificate of fitness issued	With restrictions (Respiratory)
Permanent	
Contractors	
Total	

Periodic Examinations	
Permanent	
Contractors	
Total	

Certificate of fitness issued	With restrictions (Respiratory)
Permanent	
Contractors	
Total	

Exit Medical Examinations				

Sufficient evidence that all risk workers have a fitness certificate conducted by*/with#: (Tick as applicable)	Yes	No

Fitness examinations as pertaining to cardio-respiratory fitness conducted by*/with#: (Tick as applicable)	Occupational. Health Nurse*	Yes	No
	Occu. Medical Doctor*	Yes	No
	Chest X-ray#	Yes	No
	Spirometry#	Yes	No

Quality Assessment (tick appropriate)	Service/Calibration Records		Date
Chest X-ray	Yes	No	
Spirometry	Yes	No	

E. TUBERCULOSIS SURVEILLANCE

Do you conduct TB screening for all workers in your mine/works/quarry?	Yes	No
Comment:		

If Yes, what is the frequency of the screening?	

Date of screening	Number of workers screened	Permanent	Contractors	Total
	High Risk			
	Low Risk			
	High Risk			
	Low Risk			

	TB		MDR		XDR		Total
	Permanent	Contract	Permanent	Contract	Permanent	Contract	
Of those workers screened, number found symptomatic							
Of those workers symptomatic for TB; number tested for TB?							

Number of new cases[5] confirmed							
Of those workers tested positive for TB, number started on TB treatment[6]							
Of those workers tested for TB, number found to be drug resistant							
Number of patients who completed treatment[7] (mention cohort date, note that it would be a year prior to your inspection for susceptible TB)							
Number of patients cured[8]							
Number of defaulters[9]							
Number of patients lost to follow up10							
Number of patients that have died[11]							
Number of patients for whom treatment failed[12]							
Number of patients not evaluated[13]							

TB Patient Identifier	Risk Category	Occupational Group	Homogenous Exposure Group (HEG)	Concentration per Occupation (mg/m3)	Average of HEG (mg/m3)

Type of Facility(s) rendering services to the workers	Onsite clinic	Private Clinic (Specify)	Public Facility (Specify)
Access to TB Drugs			

Laboratory Support	Government	Private (Specify)

Referral of MDR/XDR	Public Facility (Specify)

TB Policy	Yes	No	Comments
Is a copy of the TB Policy available?			
Does the TB policy follow the NTBCP Guidelines?			
Does the TB policy stipulate responsibility for the TB control programme?			
Does the TB policy cover contract workers?			
Is there a Referral System policy and or SOP for TB patients?			
Is there an infection control policy and/or SOP?			
Is there a Contact Tracing policy/system and/or SOP?			

	Yes		No
Does the mine / works offer Housing Facilities for the permanent and contract miners?	Comment:		
If yes, type of facilities offered	Hostels	Houses	Other:
	Comment:		

F. COMPENSATION OF OCCUPATIONAL DISEASE

Number of deaths					Number of autopsies performed?			

Occupational Disease	Total number diagnosed during the reporting year			Number Submitted to MBOD			Number Certified		
	Permanent	Contract	Total	Permanent	Contract	Total	Permanent	Contract	Total
Tuberculosis (any)									
Silicosis									
Pneumoconiosis									
COPD									
Systemic sclerosis									
Other									
Other									

Patient treatment paid by (tick appropriate)	Medical Aid	Company Directly	Patient

G. POLICY AND GOVERNANCE

Indicate if the following is conducted / available	Tick appropriate		Comments
HIV & AIDS Management Policy	Yes	No	
Training & Promotional Material on • TB • HIV/AIDS	Yes	No	

H. ADDITIONAL COMMENTS

FOR OFFICE USE ONLY:	
Name of Official	
Designation	
Signature	
Date	

Quality Check	**Yes**	**No**	**Comment**
All fields entered			
All accompanying documents submitted			

Explanations and definitions

This form is used to record information collected while performing mines and works inspections, as provided for under the [INSERT DETAILS OF THE APPLICABLE LEGISLATION HERE]. All the form fields in this "Explanation and Definitions" are required.

FIELD NAME	DEFINITION
1. Company name	As per the 'Companies Act' of the country.
2. Employment information	To be completed upon inspection of the register of persons performing risk work.
3. Register	A log of this patients on treatment
4. Personal dust exposure monitoring	Please request personal exposure monitoring data from the mine/work/quarry; including the annual report submitted to the Legislated Ministerial Department.
5. New cases	A patient that has never been treated for TB
6. Patients on treatment	Patients on active treatment
7. Treatment completed	A TB patient who completed treatment without evidence of failure BUT with no record to show that sputum smear or culture results in the last month of treatment and on at least one previous occasion were negative, either because tests were not done or because results are unavailable.
8. Cured	A pulmonary TB patient with bacteriologically confirmed TB at the beginning of treatment who was smear- or culture-negative in the last month of treatment and on at least one previous occasion.
9. Defaulters	Patients who do not take their medication
10. Lost to follow-up	A TB patient who did not start treatment or whose treatment was interrupted for 2 consecutive months or more.
11. Died	A TB patient who dies for any reason before starting or during treatment.
12. Treatment failed	A TB patient whose sputum smear or culture is positive at month 5 or later during treatment.
13. Not evaluated	A TB patient for whom no treatment outcome is assigned. This includes cases "transferred out" to another treatment unit as well as cases for whom the treatment outcome is unknown to the reporting unit.
14. COPD	Chronic Obstructive Pulmonary Disease.
15. CPD	Continuing Professional Development.

Good practice: Dust sampling procedure

1. Introduction

Sampling is conducted to quantify occupational exposures to workplace stressors. In most cases, when a qualitative positive determination is made, sampling is necessary to determine the extent of the exposure, adequacy of control methods in use, or additional controls required to eliminate or minimize the hazard.

2. Scope & purpose

This procedure covers the sampling methodologies to be utilized by personnel conducting dust exposure sampling. The procedure is applicable to all personnel employed at [INSERT COMPANY NAME HERE]

3. Definitions

- Air monitoring means monitoring of concentrations of airborne hazardous chemical substances.
- Air Filter means a mechanical device that collects contaminants from an air stream.
- Compliance means to comply with health and safety legislation and / or recommended guidelines.
- Engineering Control Measures means control measures that remove or reduce the exposure of persons at the workplace by means of engineering methods.
- Hazardous Chemical Substance means any toxic, harmful, corrosive, irritant or asphyxiant substance or mixture of such substances for which an occupational exposure limit is prescribed, or for which an occupational exposure limit is not prescribed, but which creates a hazard to health.
- Monitoring means the planning and carrying out of a measurement programme and the recording of the results thereof.
- Occupational Hygiene means the anticipation, recognition, evaluation and control of conditions arising in or from the workplace, which may cause illness or adverse health effects to persons.
- Risk means the probability that injury or damage will occur.

4. Sampling procedure

The sections that follow describe the methods and work processes to be followed when conducting dust exposure sampling.

4.1. Equipment and consumables

i. The following equipment and consumables are required for dust/respirable dust sampling:

a) Primary flow calibrator
b) Air sampling pumps. Ensure pumps are clean and fully charged before use.
c) Sample holder / collection device
- 2 or 3-tier cassettes for regular particulate dust sampling.
- Dust cyclone meeting ISO Standard 7708 for respirable dust sampling.
  - ISO 7708 specifies a 50% (median) cut-point of 4µm for respirable dust

d) Dust collection filters as the applicable approved sampling methods (e.g. NIOSH or OSHA etc.).
- Mixed Cellulose Ester (MCE)
- Polyvinyl Chloride (PVC)

e) Tygon tubing

4.2. Calibration considerations / precautions

i. The purpose of calibration is to determine the volumetric flow rate that will pass through the sampling media during the time the sample is taken.

a) The flowrate is used to calculate total air volume.

ii. For general dust sampling, it is not necessary for the flowrate to be the exact flow specified in the method. Just be sure you know exactly what it is.

a) Take at least 3 flow measurements that agree within 5% and use the average of the readings as your flow rate measurement.

b) If pre-and post-averages differ by more than 5%, your sample is called into question.

iii. Do not handle sampling equipment and consumable materials with your bare hands as this may cause contamination *(both personally and to the sampling media)*

a) Wear disposable nitrile gloves when preparing sampling equipment / consumables.

4.3. Pump flow calibration

i. Let your pumps run 5 minutes before calibration after removing them from the battery charger to let the flow stabilize.

ii. The pump must be calibrated with representative sample media in line.

a) Use a clean set of media to collect the sample in the field after calibration.

iii. When necessary (for respirable dust cyclones), use a calibration adapter to attach the sampler to the calibrator.

a) Alternatively, use a calibration jar of a size to fit the sampler.

b) Do not use an extremely large jar with the piston style calibrators.

c) Consider the "jar less" calibration method when using piston-style primary calibrators.

iv. Ensure the primary flow meter (Calibrator) has been externally calibrated and within its calibration cycle prior to use.

a) Do not use equipment that is out of calibration.

v. Attach the cyclone to the calibrator pressure port and pump to the suction port.

vi. After sampling, clean all parts of the cyclone, by utilizing an ultrasonic bath

a) Don't forget to clean the grit pot.

b) Dry the cyclone (Air-dry or blow-dry).

vii. Record all pre-and post-calibration (after sampling) flow rates on the appropriate field sampling form or sampling register/log book.

4.4. Sample collection using sampling pumps (active sampling)

i. Discuss the purpose of the sampling strategy and select the employee to be sampled.

a) Advise the employee not to remove or tamper with the sampling equipment.

b) Inform the employee where and when the equipment will be removed.

ii. Instruct the employee to notify the occupational hygiene inspector or supervisor should there be a need to temporarily remove the sampling equipment.

iii. Place the sampling equipment on the employee so that it does not interfere with work performance.

iv. Attach the collection device (e.g., filter cassette) to the shirt collar (i.e., within the employee's breathing zone).

a) The inlet orifice should generally be in a downward vertical position to avoid contamination.

b) Ensure the collection device inlet will not be covered by loose items of clothing.

c) Position and secure any excess tubing (if available) so as not to interfere with the work of the employee.

v. Turn on the pump and record the sample start time.

vi. Do not leave sampling equipment unattended for extended periods.

a) Monitor the operation and employees throughout the work shift to ensure that sample integrity is maintained, and cyclical activities and work practices are identified.

b) Record the time course of events, taking detailed notes concerning airborne contaminants and other conditions to assist in determining appropriate engineering controls.

vii. Prepare field blank(s) during the sampling period.

a) Blanks are prepared in the same manner as the actual sampling devices, except air is not drawn through them.

b) Blanks should also be from the same lot number as the samples collected.

c) For NIOSH sampling methods, a minimum of 2 field blanks are required for each set of samples of a specific type.

d) If a set contains more than 20 samples, the number of field blanks required by NIOSH is 10% of the total number of samples with all fractions rounded up.

e) NIOSH states that in no case are more than 10 field blanks required regardless of the number of samples in the set.

viii. At the end of the sampling period turn off the pump and record the sampling end time.

ix. Determine the sampling pump post-flow rate, before charging. Take at least 3 flow measurements that agree within 5% and use the average of the readings as your post-sampling flow rate measurement

x. Carefully remove the collection device from the pump and cap open ends (e.g., for cassettes, insert cassette plugs).

xi. Prepare the samples for submission to an accredited analytical laboratory following an appropriate chain of custody process.

a) Sampling media should be properly sealed to prevent tampering.

4.5. Reporting of damaged / deteriorated inspection media or equipment

i. Occupational hygiene staff / inspectors must report any damaged or deteriorated inspection media or equipment to the responsible person immediately after returning from sampling activities.

5. Responsibilities

5.1. Industrial/occupational hygienist

i. Shall be accountable and have oversight over the implementation of this procedure, and ensure that the requirements of this procedure are followed by all personnel.

ii. Shall facilitate the periodic review of this procedure.

iii. Maintain all records arising from the execution of this procedure.

5.2. Occupational hygiene practitioners / inspectors

i. Shall perform hazardous chemical substance (dust) sampling when requested and promote compliance with the requirements of this procedure.

6. References

- Occupational Health and Safety Act, Act No 85 of 1993, South Africa.
- Regulations for Hazardous Chemical Substances, 1995 as promulgated under the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) South Africa.

INSERT COMPANY LOGO HERE	[INSERT COMPANY NAME HERE] FIELD SAMPLING RECORD	Sample Number:

Filter Medium/Type:	MCE		GF		PVC		OVM-1		Other		

Dust Fraction Type:	Personal		Strategic		Date:
Business Unit / Section:	Sampling Location:				

Person Exposed:		Start Time:
Staff No.	HEG No:	Stop Time:
Job Category:		Total Minutes:
Pump/Dosimeter type:	IH Equipment No:	Pre-sampling flow rate:
Ventilation Used:		Post- sampling flow rate:
Respiratory Protection Type:		Ave Flow rate:
Sampling / Analytical Method No:		Volume:

Gravimetric Analysis?	Yes	No	Substance/Agent:
Lab Analyses Required ?	Yes	No	Lab Name:

Occupational Exposure Details		OEL:		IDLH:
		STEL:		Action Level:
Shift	From:	To:		Work Team:

Deviations from Method (If any):

Environmental Parameters:	Temp (°C or K):	Relative Humidity (%):	Other:

Wind Speed (m/s or Km/hr):	Barometric Pressure (mm Hg or Pa):

Remarks / Comments / Observations:

Sampled by:	Signature:
Checked & Approved by:	Signature:

Good practice: Sampling and analytical methods for respirable crystalline silica dust (CD)

Sampling is conducted to quantify occupational exposures to workplace stressors. In most cases, when a qualitative positive determination is made, sampling is necessary to determine the extent of the exposure, adequacy of control methods in use, or additional controls required to eliminate or minimize the hazard.

Two robust sampling/analytical methods that inspectorates can use for measuring silica are contained in the CD under module two:

NIOSH Method 7500
OSHA Method ID-142

TB in the Mining Sector Southern African Programme (TIMS)

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