

Mine Health and Safety Council



MHSC

Develop an operations manual for the implementation of the revised code of practice for the assessment of personal exposure to airborne pollutants

Final Report

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Abbreviations and Nomenclature

ASPASA	Aggregate and Sand Producers of Southern Africa
COP	Code of Practice
DMR	Department of Mineral Resources
GEE	Group Environmental Engineers
HEG	Homogeneous Exposure Group
MHSC	Mine Health and Safety Council
MHSI	Mine Health and Safety Inspectorate
MOHAC	Mining Occupational Health Advisory Committee
OEL	Occupational Exposure Limit
OHTTT	Occupational Health Technical Task Team
SAMRASS	South African Mines Reportable Accidents Statistical System
SANAS	South African National Accreditation System
SANS	South African National Standards
SAMOHP	South African Mines Occupational Hygiene Programme
TWA	Time weighted average

Executive Summary

The MHSC requested the development of an operations manual for the revised guideline.

The revised guideline was compared with the current guideline. Besides the editorial changes, there were a few aspects that will have a significant impact on the mines, e.g. Homogeneous Exposure Group (HEG) classification based on statistical analysis as this may result in a significant increase in sample volumes. The revised guideline compares well with International Best Practice; however, there are areas for improvement that will aid standardisation across the industry.

Feedback was obtained from all stakeholders to determine where the problem areas were with the current guideline. Specific areas were highlighted, such as the classification of HEGs, statistical analysis, reporting, etc. This information was used to develop the operations manual with practical examples and to provide guidance on how to address certain aspects of the guideline. The operations manual was not aimed at being prescriptive, or to provide training on the relevant disciplines (i.e. occupational hygiene), revise the guideline or to contradict current mandatory requirements.

Feedback was also received on matters of principle that are not addressed by the guideline, SAMOHP or the associated regulations (e.g. no category for exposures below 10% of the Occupational Exposure Limit (OEL)).

The outcome of the project was an electronic (i.e. eBook) operations manual with two examples of printable versions. The manual contains practical examples and video tutorials to assist the end-user of the revised guideline. The electronic manual may be accessed at <https://www.dropbox.com/sh/ntvslljf3f699pr/AACrBdZVoehrSOI24A45CeyOa?dl=0>

Please note that this link expires 31 March 2016 after which the operations manual will only be available from the MHSC.

1. Introduction

The Mining Occupational Health Advisory Committee (MOHAC) of the Mine Health and Safety Council (MHSC) requested that an operations manual be developed for the revised “Guideline for the compilation of a mandatory code of practice for the assessment of personal exposure to airborne pollutants”. The need for such a manual arose because there are different ways in which the current guideline is being interpreted by end-users. The result is that codes of practices for personal exposure to airborne pollutants are not standardised across the South African mining industry.

2. Objective

The objective of this project was to develop an operations manual that will be issued with the revised “Guideline for the compilation of a mandatory code of practice for the assessment of personal exposure to airborne pollutants” (herein referred to as “revised guideline”). The aim of the manual was to assist the end-user of the revised guideline to develop a code of practice for the assessment of personal exposure to airborne pollutants (herein referred to as “Code of Practice (COP)”).

It was intended that the end-result would be a standardised implementation of the Code of Practice.

3. Methodology and Outcomes

In order to achieve the objective of the project, the following methodology was followed:

a. Obtain feedback on current challenges

In order to develop an operations manual it was necessary to determine where the challenges were with the current “Guideline for the compilation of a mandatory Code of Practice for an occupational health programme on personal exposure to airborne pollutants” (herein referred to as “*current* guideline”). A letter was sent through the MHSC requesting information from all stakeholders (Annexure A).

The research team arranged meetings with the Department of Mineral Resources (DMR), the Group Environmental Engineers (GEE) and the Aggregate and Sand Producers of Southern Africa (ASPASA). At the meetings the scope and nature of the project were discussed and the following information was requested:

- Participants were requested to be specific about the challenges that they faced when using the current guideline for the development of a code of practice for airborne pollutants.
- Mines were requested to provide copies of their current codes of practice for review by the research team.
- Where audits were conducted on the current code of practice by an external party, copies of these audits were requested.
- The Mine Health and Safety Inspectorate (MHSI) was requested to specify what problems they encountered during audits.
- The MHSI was requested to provide copies of their code of practice audit reports for review by the research team.

In addition to the above, it was requested that a small task team from each party was made available to the research team. The purpose of the small task teams was to assist with the piloting of the manual.

The team received feedback from the DMR on seven large-scale mining operations, four from ASPASA and none from Labour. The request was re-submitted and the deadline for a response was extended to the end of June 2015 as it was important that the feedback we received was representative of the industry.

In general, the following challenges regarding the current guideline were highlighted:

- The current guideline was open to interpretation;
- Classification of HEGs and assessing their validity;
- Statistical analysis of data and the subsequent interpretation;
- Dose allocation;
- Linkage of occupational hygiene data with medical records; and
- Reporting of personal exposure measurements.

The research team also received some comments that were not related to the implementation of the guideline, but to principles that were not addressed in the guideline or the associated regulations. For example:

- The HEG re-classification is done annually and does not accommodate any changes in personal exposure throughout the year. For example, when the statistical analysis reveals that there are two categories in one HEG, the HEG cannot be re-classified in the middle of the year. This has an impact on the sampling strategy and reporting of exposure.
- The lack of time (i.e. one month) between the annual assessment of the HEGs and the re-classification of HEGs and the review of the sampling schedule of the next year. This can be quite a complex task when the workforce population is large (e.g. 30 000 employees).
- Dose allocation done during quarterly reporting compared to when it is done during progressive reporting.
- How to treat exposure measurements that are below 10% of the OEL since there is not a category for this classification band.
- How to accommodate short-term contractors, i.e. temporary employees who are employed for only two weeks or three months, for example. Again, the sampling schedule cannot be changed frequently, and for consistency of the system, these employees are probably not included.
- Linking of medical surveillance when not all employees are linked to a HEG, especially when exposure is below 10% of the OEL.

During the next revision of the guideline, these points may have to be considered for inclusion.

b. Highlight amendments in revised guideline

The revised guideline was compared with the current guideline to show the end-user where changes were made. Please refer to Annexure B for detailed records on the sections that

were reworded, removed or newly included in the revised guideline. A summary of the changes made in the revised guideline is given below:

- Minor editorial changes throughout the document;
- Changes to some of the definitions;
- A section included under the Occupational Hygiene Programme (control, linking to medical surveillance and training);
- Section 8.2 on Occupational Medical Surveillance was removed;
- Annexures A – C were included from the SAMOHP Codebook; and
- Annexure D was updated with new references.

Some of the changes to the revised guideline that will have a significant impact on the end-user are:

- The legal implications now that the implementation of the Code of Practice (COP) as developed by the mine is mandatory.
- The revised definition of the HEGs now states that it should be based on statistical evaluation.
- Risk assessment and control: taking the new definition of HEGs into account and the stipulated conditions for the review of risk assessment.
- Determination of HEGs: SAMOHP Codebook information is included in this section (step-by-step). Baseline risk assessment is to be used to identify HEGs and the rewording of the criteria for the revision of the HEG classification.
- Personal exposure monitoring: representative employee exposures within a shift and between shifts should not be combined. There will be a cost implication for the volume of individual personal samples as per the new milestones.
- Sampling, analysis, methodology and quality control: the sampling strategy from the SAMOHP Codebook is included in this section. Chemical analysis of individual samples done by a SANAS-accredited laboratory (South African National Accreditation System). Weighing laboratories do not have to be accredited.
- Reporting and recording are mandatory according to the requirements of the guideline.
- Personal exposure measurements will be linked to medical records.
- Employees to be trained on specific issues identified.
- Some of the documents that were listed in Annexure D of the guideline could not be found via a search on the Internet.

The research team wanted to understand why some of the changes had been made and requested the minutes of the Occupational Health Technical Task Team's (OHTTT) meetings. However, the minutes did not contain justifications for the changes. The stakeholders were consulted but no substantiating information could be provided to the team. As a result, no explanations were given in the manual for the reasons of the changes.

One of the aspects that required confirmation was the continuation of the SAMOHP Codebook. During the revision of the current guideline, the intention was to discontinue the SAMOHP Codebook and adopt relevant information in an operations manual for the revised guideline. However, since the completion of the revision there have been some concerns about the discontinuation of the SAMOHP Codebook. The Codebook contains information

that is not captured in the guideline or the associated regulations, e.g. commodity and pollutant codes. The SAMOHP also contains information that is relevant to Noise and Thermal Stress.

The research team requested confirmation from the Mining Occupational Health Advisory Committee (MOHAC) on the status of the SAMOHP Codebook. At a meeting held on 30 September 2015, the MOHAC made a decision that the SAMOHP Codebook would be continued. However, it was decided that the SAMOHP should be reviewed as soon as possible to update the reporting periods and the reporting forms to align the occupation codes with SAMRASS (South African Mines Reportable Accidents Statistical System) codes and to revise the document in general.

When the revised guideline was compared to the current guideline, some minor editorial errors were found. It would be advisable to correct these minor editorial errors in the revised guideline prior to its release. Recommendations on these corrections can be found in Annexure E.

c. Compare revised guideline with International Best Practice

The revised guideline was compared with International Best Practice. Similar guidelines and international standards were sourced for the comparison. The following international documents were used:

- The Occupational Exposure Sampling Strategy Manual (OESSM) from the National Institute of Occupational Safety and Health (NIOSH) of the USA.
- The Sampling Guide for Air Contaminants in the Workplace of the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST) in Canada.
- The European standard EN 689 “Workplace atmospheres — Guidance for the assessment of exposure by inhalation of chemical agents for comparison with limit values and measurement strategy”.
- Guidance on the interpretation of workplace exposure standards for airborne contaminants from SafeWork Australia.
- ISO 18158 “Workplace air — Terminology”.
- BOHS/NVVA Sampling Strategy Guidance – Testing Compliance with Occupational Exposure Limits for Airborne Substances (UK and the Netherlands).
- Good Practice Guidance on Occupational Health Risk Assessment from the International Council on Mining and Metals (ICMM).

Please refer to Annexure C for a detailed comparison. For the purposes of this report, a few matters are highlighted:

- Some guideline definitions are either lacking or the definitions are not in ISO/DIS 18158. There is scope to include more detailed definitions in the revised guideline.
- The DMR revised guideline does not provide enough statistical data to enforce decisions on the accuracy and variability of the measured exposures and there is a lack of guidance on the interpretation of the data.
- Although the risk assessment steps are specified in the revised guideline, the sample size is not specified when compared to international best practice. However, the revised guideline does specify the sample size for continuous monitoring.
- Some international documents contain specific information on airborne pollutants such as their OELs, how to sample, which analysis methods to use and any additional information that is relevant to the user. This leads to standardised implementation in the countries that make use of this guideline.

- One of the international documents provided very good statistical explanations and examples. The document provides information on how to statistically evaluate the validity of the HEGs and also when to repeat the baseline risk assessment. This document also guides the user on how to deal with analysis values below the limit of detection.

During the next revision of the guideline, these documents may provide information for consideration.

d. Develop Operations Manual

The intention was to develop an operations manual for the revised guideline that would give end-users sufficient supporting information to allow them to develop a COP for their respective mining operations. The revised guideline was included in the operations manual so that the end-user would have all the information at hand when using the manual.

The approach was to develop an electronic, web-based manual that can be operated off-line (i.e. without Internet access) and stored on a CD or other portable device. Where possible, several examples were given, video tutorials were included to explain complex matters and, where relevant, references to reputable standards were provided.

Three examples of the operations manual were completed:

- The following link contains the completed operations manual in electronic (i.e. eBook) format:
<https://www.dropbox.com/sh/ntvslljf3f699pr/AACrBdZVoehrSOI24A45CeyOa?dl=0>
- A printable version was created and is available in Annexure D.

The scope to develop the operations manual did not include:

- The training of occupational hygienists, ventilation officers or engineers on the principles of their respective disciplines;
- The revision of the revised guideline;
- Being prescriptive of every aspect of the guideline for every type of mining operation;
- Information that may contradict what was contained in the guideline, associated regulations or the SAMOHP Codebook.

e. Informal piloting and testing of the manual

At the start-up presentation of this project, MOHAC requested that the research team should conduct an informal piloting of the operations manual to obtain inputs from all stakeholders. Throughout the project there were interactions with the different stakeholders and inputs were requested from various parties. The draft manual was presented to the DMR and the GEEs in separate sessions. ASPASA received the draft manual via e-mail as a meeting could not be arranged in time.

The DMR had six representatives at the session and each of them received a copy of the operations manual on CD. The comments received from the DMR and the research team's responses are as follows:

- The tutorials should be separate from the guideline
Response: the guideline content was included for ease of use by the end user.
- More explanation on how the guideline should be implemented e.g. how files should be "readily available"

Response: It was requested that the MHSI specify their requirements. But Section 6 discusses Quality Control Systems that may be implemented to ensure that documents are 'readily available' during audits.

- Uniform methodologies should be specified especially how to do biological monitoring

Response: Section 8.1.2 Step 3 guides the user to standard methodologies that may be used for different airborne pollutants. Biological monitoring is not within the scope of the revised guideline but in the Guideline for Medical Surveillance.

At the GEEs session there were 16 representatives from various South African mining operations. All of them were given CDs of the draft operations manual. The following comments were received from one mine and the research team responded as follows:

- HEG determination is still open for interpretation

Response: Examples of HEGs for different commodities were included in the HEG tutorial to assist users. In addition, the statistical analysis method is described in detail and should be done at the end of the sampling cycle to refine the HEG classification.

- Not sufficient guidance on the number of samples that should be sent for quartz analysis

Response: In Reporting Tutorial 9 it is explained that all the samples that are included in the sampling schedule for quartz, should be analysed for quartz.

- Which percentage of quartz to use for the dose allocation; the current year or the previous year's percentage?

Response: The percentage quartz of an individual sample should be calculated and allocated to the individual sample only. This is explained in Reporting Tutorial 9.

- Quality of the tutorial videos

Response: The Reporting videos were professionally recorded after the piloting stage.

- The headings of the Reporting Forms are not clearly explained and are interpreted differently by the users.

Response: Reporting Tutorial 8 discusses each heading and guides the end user through the completion of the form.

- Milestone reporting and how it should be done

Response: The Milestones are not covered by the guideline and should be addressed through the Mine Health and Safety Summit structures.

The draft manual was sent to ASPASA after the DMR and GEE sessions and an extended deadline was granted. Unfortunately, no comments were received from them either.

4. Conclusion

The MHSC requested the development of an operations manual for the revised guideline.

The revised guideline was compared to the current guideline. Besides the editorial changes, there were a few aspects that will have a significant impact on the mines, e.g. HEG

classification based on statistical analysis as this may result in a significant increase in sample volumes. The revised guideline compares well with International Best Practice; however, there are areas for improvement that will aid standardisation across the industry.

Feedback was obtained from all the stakeholders to determine where the problem areas lay with the current guideline. Specific areas were highlighted, such as the classification of HEGs, statistical analysis, reporting, etc. This information was used to develop the operations manual with practical examples and to provide guidance on how to address certain aspects of the guideline. The operations manual was not aimed at being prescriptive, or to provide training on the relevant disciplines (i.e. occupational hygiene), revise the guideline or to contradict current mandatory requirements.

Feedback was also received on matters of principle that are not addressed by the guideline, the SAMOHP or the associated regulations (e.g. no category for exposures below 10% of the OEL).

The outcome of the project was an electronic (eBook) operations manual with two examples of printable versions. The manual contains practical examples and video tutorials to assist the end-user of the revised guideline.

5. Recommendations

Based on the outcomes of this project, a number of recommendations are made:

- Correct editorial errors: on review of the revised guideline a number of editorial errors and typos were found. It is recommended that these errors be corrected before the guideline is released for use. Recommendations on these corrections are given in Annexure E of this report.
- Annexure D of the revised guideline: It is recommended that the useful references in Annexure D of the guideline be made available on the MHSC or DMR website so that users can have direct access to them when conducting a search of the Internet.
- Revise the SAMOHP Codebook: Considering that a decision was made to keep the SAMOHP Codebook, it is recommended that it should be revised as soon as possible. It is recommended that the revision include (but is not limited to) the updating of the reporting forms, updating of the reporting periods and alignment with the SAMRASS occupation codes.
- Revise the guideline: throughout this project many areas were identified that require revision so that it may be aligned with the SAMOHP Codebook and/or the associated regulations. There is also a need to clarify certain requirements so that standardisation across the industry can be achieved. Some aspects in the guideline that require revision (but are not limited to) are:
 - Clarification of some definitions and expanding the list;
 - Inclusion of a qualitative risk assessment;
 - Acceptance criteria for the quality of HEG classification within the South African context;
 - Development of a chain of custody for sampling as part of the quality control; and
 - Inclusion of a category for exposures below 10% of the OEL.

- Revise the associated regulations: It is recommended that the occupational exposure limit regulations be revised to include the Pollutant codes. It is recommended that the reporting forms and associated regulations be reviewed and adjusted to ensure standardised completion by the industry.
- When the SAMOHP Codebook, the guideline and the associated regulations, have been revised and aligned with one another, it is recommended that the operations manual be updated to reflect the alignment.

6. Acknowledgments

The research team would like to thank the MHSI, the GEEs and ASPASA for participating in this project and providing valuable inputs to the development of the operations manual.

Annexure A: Request for information letter



Council for Scientific and Industrial Research

PO Box 395

Pretoria

0001

Email: cpretorius@csir.co.za

Reference: MHSC/031/14-15

16 March 2015

Makhosazana Kunene
Programme Manager: MOHAC Committee
Mine Health and Safety Council (MHSC)
Woodmead Business Park
145 Western Service Road
Woodmead

Dear Ms Kunene

REQUEST FOR INFORMATION FOR THE MHSC/031/14-15 PROJECT: DEVELOPMENT OF AN OPERATIONS MANUAL FOR THE IMPLEMENTATION OF THE REVISED CODE OF PRACTICE FOR AIRBORNE POLLUTANTS

During the start-up presentation of the abovementioned project, the CSIR requested MOHAC and its members to provide the research team with information relevant to this project. We ask that this request is passed on to the members of the Chamber of Mines and that we are provided with representative feedback from the large- and small-scale mines. We also ask that this request is passed on to the Department of Minerals and Resources' (DMR) and its national and regional Mine Health and Safety Inspectorates (MHSI).

The information required by the research team is as follows:

- Challenges that the mines face when using the current guideline for the development of a code of practice for airborne pollutants. We request that members be specific about the challenges that they face.

- We request the mines to provide us with copies of their current code of practice for review by the research team.
- Where audits were conducted on the current code of practice by an external party, we request copies of these audits.
- We request that the MHSI specify what problems they encounter during audits.
- We request that the MHSI provide us with copies of their code of practice audit reports for review by the research team.

Members are requested to forward the information directly to cpretorius@csir.co.za and a summary report will be sent to MOHAC for their records. The deadline for receiving the information is 10 April 2015. The information obtained will be treated as confidential and will be used for the purpose of developing an operations manual. Feedback will be given to the MOHAC members throughout the project for them to assess that the research team has an accurate understanding of the information that was provided to them.

If you need any further information, please contact Cecilia Pretorius at cpretorius@csir.co.za or 083 276 4460.

Yours sincerely

Cecilia Pretorius

Administrative Project Leader

Annexure B: Highlighted changes

Highlighted changes: Legend for colours and font types:

green = **Wording Changed**; blue = **New/Added**; red= **Excluded/Removed**

REFERENCE NUMBER: DMR 16/3/2/4-A1

LAST REVISION DATE 11TH OF AUGUST 2010

DEPARTMENT OF MINERAL RESOURCES

Minerals and Energy for Development and Prosperity

MINE HEALTH AND SAFETY INSPECTORATE



GUIDELINE

FOR THE COMPILATION OF A MANDATORY

CODE OF PRACTICE

FOR THE ASSESSMENT OF

PERSONAL EXPOSURE TO AIRBORNE POLLUTANTS

Chief Inspector of Mines

Date:

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PART A: THE GUIDELINE

1. FOREWORD

- 1.1. The Commission of Inquiry into Safety and Health in the Mining Industry chaired by the Honourable Mr. Justice R N Leon identified occupational health as one of the four major issues affecting occupational health and safety in the mining industry.
- 1.2. In an attempt to address this issue a tripartite sub-committee was established under the auspices of the **Mining Occupational Health Advisory Committee (MOHAC)**. MOHAC found it necessary that in order to address this issue a guideline for a mandatory **Code of Practice (COP)** for Airborne Pollutants be drafted.
- 1.3. The Mine Health and Safety Council (MHSC), in order to address occupational health, instructed the **Department of Mineral Resources (DMR)** to establish an Occupational Hygiene Database. Information submitted to the **DMR** in terms of this guideline will be incorporated into this database.
- 1.4. Significant risks to health exist in mining. In order to protect, monitor and promote employees' health status, an occupational health programme is **required** where exposure to such significant risks occur. MOHAC considered it appropriate to prepare **a guidelines** covering both occupational hygiene and medical surveillance to ensure compliance and uniform standards.
- 1.5. Where the employer's risk assessment indicates a need to establish and maintain either a system of occupational hygiene measurements **or a system of medical surveillance**, or where **either** such system is required by regulation, the employer must prepare and implement a COP based on this guideline.

- 1.6. When determining the HEGs as required in paragraph 8.1.2 of the guideline, regard must be had to the SAMOHP issued by the DME.
- 1.6. This DMR guideline will assist employers with the assessment of personal exposures to airborne pollutants, but does not stipulate specific requirements for specific circumstances. It sets out a basic system for managing risk to health. The first component of any management system is finding out **what the situation is**, the second is deciding **what to do about it**.
- 1.7. This guideline replaces the earlier “*Guideline for the compilation of a mandatory COP for an occupational health programme on personal exposure to airborne pollutants*” published by the DMR in 2002.
- 1.8. The occupational hygiene programme section in this guideline replaces the existing “GUIDELINES FOR THE GRAVIMETRIC SAMPLING OF AIRBORNE PARTICULATES FOR RISK ASSESSMENT IN TERMS OF THE OCCUPATIONAL DISEASES IN MINES AND WORKS ACT NO 78 OF 1973”.

2. LEGAL STATUS OF GUIDELINES and COPs

In accordance with section 9(2) of the **Mine Health and Safety Act (MHSA)** an employer must prepare and implement a COP on any matter affecting the health and safety of employees and other persons who may be directly affected by activities at the mine if the Chief Inspector of Mines requires it. These COPs must comply with any relevant guidelines issued by the Chief Inspector of Mines [section 9(3) **MHSA**]. Failure by the employer to prepare or implement a COP in compliance with this guideline is a breach of the MHSA. **Any contravention of, or failure to comply with, a COP is not, in itself, a breach of the MHSA, except a contravention or failure by an employer that also constitutes a failure to implement the COP. Since the DME does not approve COPs, its focus is not to enforce them either. The focus of the DME is to ensure that employers provide healthy and safe working environments at mines, i.e. focusing on system failures and compliance with the MHSA, rather than enforcing compliance with COPs.**

2.3, 2.4, 2.5

3. OBJECTIVE OF THE GUIDELINE

- 3.1 The objective of this guideline is to enable the employer at every mine to compile a COP, which, if properly implemented and complied with, would protect and improve the health of employees at the mine by monitoring and reducing their exposure to airborne pollutants.

It provides guidance of a general nature on the required format and content for the COP and details sufficient technical background to enable the drafting committee at the mine to prepare a comprehensive and practical COP for their mine.

It sets out the two components of an Occupational Health programme namely:

- **Occupational Hygiene**
- **Medical Surveillance**

3.2 Where an employer is required, in terms of regulation 9.2(2) or in terms of risk assessment, to establish and maintain a system of occupational hygiene measurements in respect of airborne pollutants, this guideline should assist the employer in doing so.

4. DEFINITIONS and acronyms

“**airborne pollutant**” means any substance in the air that is harmful to health, including dust, fumes, aerosols, gases, fibres, vapours or mists;

“**analysis methodology**” means analysis techniques used to quantify a pollutant collected on or in sampling media (e.g. gas chromatography/mass spectrometry);

“**biological exposure indices (BEI)**” are guidance values for assessing biological monitoring results. BEIs represent the levels of determinants that are most likely to be observed in specimens collected from healthy workers who have been exposed to a specific substance;

“**biological monitoring**” means a planned programme of periodic collection and analysis of body fluid, tissues, excreta or exhaled air in order to detect and quantify the exposure to or absorption of any substance or organism;

“**COP**” means Code of Practice;

“**DMR**” means the Department of Mineral Resources;

“**dose**” means the concentration of an airborne pollutant(s) to which a person is exposed;

“**exposure**” means the subjection of a person to an airborne pollutant in the course of employment through any route of entry (e.g. inhalation, ingestion, skin contact or absorption);

“**HEG**” means a homogeneous exposure group;

“**homogeneous exposure group (HEG)**” means a group of employees whose exposures to a hazardous agent have been determined to be statistically similar enough that, by monitoring a small number of individuals in the group, the exposures of the remaining workers can be defined. ;

“**MOHAC**” means Mining Occupational Health Advisory Committee;

“**monitoring**” means the repetitive and continued observation, measurement, and evaluation of health and/or environmental or technical data, according to prearranged schedules, using nationally or internationally acceptable methodologies;

“**MHSA**” means Mine Health and Safety Act, 1996 (Act No.29 of 1996) as amended;

“**MHSC**” means Mine Health and Safety Council;

“**NIOSH**” means the United States National Institute for Occupational Safety and Health;

“SAMOHP” means the South African Mines Occupational Hygiene Programme

Codebook;

“occupational exposure limit (OEL)” means the time weighted average concentration for a 8 hour work day and a 40 hour work week to which nearly all workers may be repeatedly exposed without adverse health effects ;

“sampling cycle” means the end of the planned sampling programme for the year, which must terminate at the end of each calendar year;

“significant airborne pollutant” means any airborne pollutant to which any employee is exposed in concentrations equal to or exceeding the **OEL** contemplated in regulation 9.2.1.;

“90th percentile” means the **statistical value of exposure data** which must be used to determine when HEG's need to be re-classified. This value can be calculated by:

- 1) using Microsoft Excel programme (percentile function); or
- 2) first placing all sample results in order from the lowest concentration to the highest concentration (i.e., concentration of specific contaminants). Next, assign each sample result a number, starting with the number 1 for the lowest concentration result up to the highest concentration being given the number equal to the total number of samples collected in that HEG. Multiply the total number of samples collected by 0.9. The sample result with the number corresponding to this calculated value is the 90th percentile.

5. Scope

5.1 A COP for the **assessment of** personal exposure to airborne pollutants must be prepared, in compliance with this guideline, and implemented in terms of Regulation 9.2(2). **This** requires that a system of occupational hygiene measurements on personal exposure to airborne pollutants must be prepared and implemented when the results of the risk assessment conducted has identified that the following **OEL** prevail:

- Particulates \geq **10%** of the occupational exposure limit
- Gases \geq **50%** of the occupational exposure limit

5.2 In terms of Section 9.3 **of the MHSA** a COP must comply with the guideline issued by the Chief Inspector of Mines, therefore the COP prepared by the employer must comply with this guideline.

5.3 This guideline covers a basic Occupational Health Programme for the purpose of measuring occupational exposures to airborne pollutants **to ensure compliance with OELs to protect worker health** and **to link** these exposures to employee medical records.

5.4 The Occupational Health Programme should through monitoring identify employees with significant exposures and, where necessary, provide for the implementation of

control measures. This guideline does not stipulate the control measures but only the hierarchy to be followed to control exposures.

- 5.5 Formal **submission of occupational hygiene data by the mining industry to the DMR** will be used to establish and maintain an industry occupational hygiene database for airborne pollutants.

6. **MEMBERS OF THE ORIGINAL REVISION TASK GROUP.**

B A Doyle – Chairperson	State
R H McIntyre	State
T B Letanta	State
K Beukes	State
M Motlhamme	State
J Olivier	Employer
C Badenhorst	Employer
J D R Beukes	Employer
B Brits	Employer
K Dekker	Employer
D J De Villiers	Employer
I Labuschagne	Employer
J Lynch	Employer
D W Stanton	Employer
J van Rensburg	Employer
P Mboniswa	Labour
D Labuschagne	Employer
B Belle	Employer

MEMBERS OF THE REVISION TASK GROUP – 2009/10.

<i>N mOKHONOANA</i>	<i>STATE</i>
T Motitimi	State
P Huma	State
D Labuschagne	Employer
K Dekker	Employer
I Labuschagne	Employer
M de Koker	Employer
D J de Villiers	Employer
M B Motlhamme	Employer

J Beukes	Employer
C J Badenhorst	Employer
D Mellet	Employer
V de Take	Employer
B Doyle	Employer
J E van Niekerk	Employer
G C van der Westhuizen	Employer

PART B: AUTHOR'S GUIDE

1. The COP must, where possible, follow the sequence laid out in Part C "Format and Content of the COP". The pages as well as the chapters and sections must be numbered, [where possible](#), to facilitate cross-referencing. Wording must be unambiguous and concise.
2. It should be indicated in the COP and on each annex to the COP whether-
 - (a) the annex forms part of the COP and must be complied with or incorporated in the COP or whether aspects thereof must be complied with or incorporated in the COP; or
 - (b) the annex is merely attached as information for consideration in the preparation of the COP (i.e. compliance is discretionary).
3. When annexes are used the numbering should be preceded by the letter allocated to that particular annex and the numbering should start at one (1) again. (e.g. 1, 2, 3, A1, A2, A3,...).
4. Whenever possible illustrations, tables, graphs and the like, should be used to avoid long descriptions and/or explanations.
5. When reference has been made in the text to publications or reports, references to these sources must be included in the text as footnotes or side notes as well as in a separate bibliography.

PART C: FORMAT AND CONTENT OF THE MANDATORY COP

1. Title Page

The COP should have a title page reflecting at least the following –

 - 1.1 name of mine;
 - 1.2 the heading: "Mandatory Code of Practice for the Assessment of Personal Exposure to Airborne Pollutants";
 - 1.3 a statement to the effect that the COP was drawn up in accordance with the [Department of Minerals Resources Guideline Reference Number DMR 16/3/2/4-A11](#) issued by the Chief Inspector of Mines;
 - 1.4 the mine reference number for the COP;

- 1.5 the effective date; and
- 1.6 revision dates (if applicable).
- 1.7 [DMR mine code number](#)

2. Table of Contents

The COP must have a comprehensive table of contents.

3. Status Of [MANDATORY](#) COP

This section must contain statements to the effect that-

- 3.1 the COP was drawn up in accordance with [Guideline DMR Reference Number Department of Mineral Resources 16/3/2/4-A1](#) issued by the Chief Inspector of Mines;
- 3.2 this is a mandatory COP in terms of section 9(2) and (3) of the MHSa;
- 3.3 the COP may be used in an accident investigation/inquiry to ascertain compliance and also to establish whether the COP is effective and fit for purpose;
- 3.4 the COP supersedes all previous relevant COPs; and
- 3.5 all managerial instructions, recommended procedures (voluntary COPs) and standards on the relevant topics must comply with the COP and must be reviewed [on regular intervals](#) to ensure compliance.

4. Members of THE Drafting Committee

- 4.1 In terms of section 9(4) of the MHSa the employer must consult with the health and safety committee on the preparation, implementation or revision of any COP;
- 4.2 It is recommended that the employer should, after consultation with the employees in terms of the MHSa, appoint a committee responsible for the drafting of the COP;
- 4.3 The members of the drafting committee assisting the employer in drafting the COP should be listed giving their full names, designations, affiliations and experience. This committee must include competent persons sufficient in number to effectively draft the COP.

5. General Information

General relevant information relating to the mine must be stated in this section of the COP, [which must include at least the following](#):

- 5.1 a brief description of the mine and its location;
- 5.2 the commodities produced;
- 5.3 the mining method or combination of methods used at the mine must be listed. This section must discuss the degree of mechanisation, taking care to identify the potential sources of pollutants, and possible pathways of exposure and also possible exposure scenarios;
- 5.4 [the general controls in place to prevent exposure to airborne pollutants including ventilation arrangements](#);
- 5.5 other related COPs and management standards must be reviewed concurrently in order to avoid conflict of requirements as laid down by the [employer](#). The objective would be to have an integrated system; and
- 5.6 the unique features of the mine that have a bearing on this COP and cross-reference them to the risk assessment conducted.

6. Terms and Definitions

Any word, phrase or term of which the meaning is not absolutely clear or which will have a specific meaning assigned to it in the COP, must be clearly defined. Existing and/or known definitions should be used as far as possible. The drafting committee should avoid jargon and abbreviations that are not in common use or that have not

been defined. The definitions section should also include acronyms and technical terms used.

7. Risk Management

7.1 Section 11 of the MHSA requires the employer to identify hazards, assess the health and safety risks to which employees may be exposed while they are at work, record the significant hazards identified and risks assessed. The employer must determine how the significant risks identified in the risk assessment process must be dealt with, having regard to the requirement of section 11(2) and (3) that, as far as reasonably practicable, attempts should first be made to eliminate the risk, thereafter to control the risk at source, thereafter to minimise the risk and thereafter, insofar as the risk remains, to provide personal protective equipment and to institute a programme to monitor the risk.

7.2 To assist the employer with the risk assessment all possible relevant information such as accident statistics, ergonomic studies, research reports, manufacturers specifications, approvals, design and performance criteria for all relevant equipment should be obtained and considered.

7.3 In addition to the periodic review required by section 11(4) of the MHSA, the COP should be reviewed and updated after every serious incident relating to the topic covered in the COP, or if significant changes are introduced to procedures, mining and ventilation layouts, mining methods, plant or equipment and material.

8. Aspects to be addressed in the cop

Where the employer's risk assessment indicates a need to establish and maintain **either** a system of occupational hygiene measurements, or where **either** such system is required by regulation, the following key elements must be addressed in the COP:

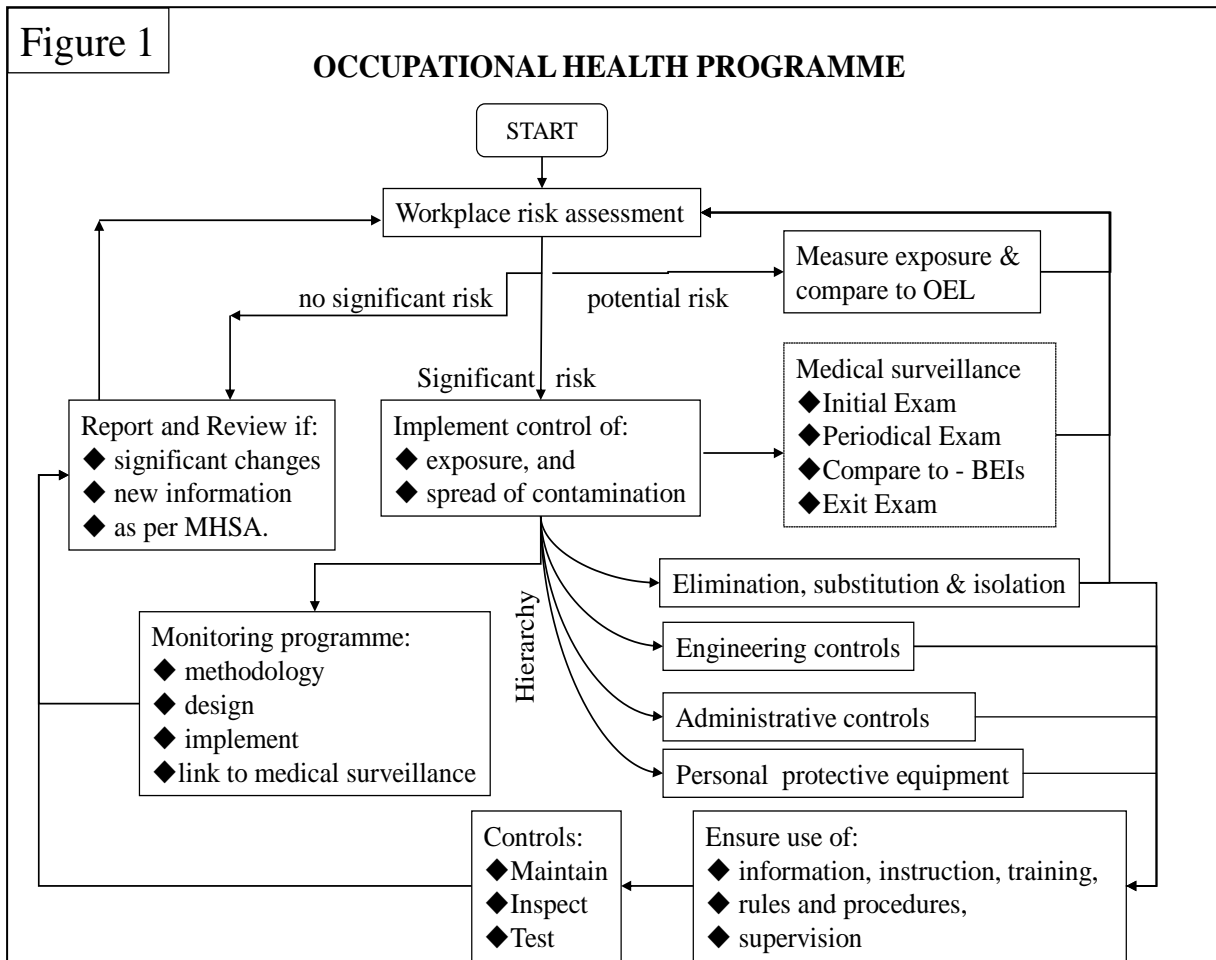
Risk assessment and control

- Personal exposure monitoring
- Hierarchy of controls
- Reporting and reviewing

These key elements are shown in Figure 1 below.

The Occupational Health Programme to be implemented on the mine must be summarised in the COP in a flow chart similar to Figure 1.

Figure 1



The Occupational Health Programme has two components namely:

- Occupational Hygiene; and
- Medical Surveillance (which is not dealt with in this Guideline)

8.1 Occupational Hygiene Programme

The employer must ensure that when undertaking an Occupational Hygiene Programme the following steps are included:

Step 1 - Risk Assessment and Control

Step 2 - Determination of **Sampling Population**

Step 3 - Sampling and Analysis Methodology and Quality Control

Step 4 - Personal Exposure Monitoring

Step 5 - Reporting

8.1.1 Risk Assessment and Control

The COP must address the following points:

8.1.1.1 Baseline Risk Assessment

At the initial commencement of a system of occupational hygiene measurements, as contemplated in Section 12.2 of the MHSA, a baseline risk assessment is to be conducted to assess exposure to airborne pollutants.

8.1.1.2 The baseline risk assessment must be described with reference to:

- (a) any significant airborne pollutant/s to which employees are being exposed to;
- (b) the route of entry (where applicable i.e. inhalation, absorption, ingestion etc.) and health effects that these significant individual airborne pollutants can have on employees;
- (c) where such pollutants may be present, e.g. welding bay, spray painting booth, battery charging stations, stope face, development end etc.;
- (d) the airborne nature of those pollutants identified, e.g. gases, fumes, vapour mists, fibres, dusts etc.;
- (e) the nature of the key workplace operations and activities that pose the greatest potential for exposure to the significant airborne pollutants;
- (f) the occupations and number of employees who are being exposed to significant airborne pollutants;
- (g) the pattern, i.e. intermittent, continuous etc., duration and frequency of employee exposure to the significant airborne pollutants identified;
- (h) the actual exposure levels measured compared to occupational exposure limits per working shift i.e. day shift, night shift and the sampling size is to comply with internationally acceptable statistical methodologies.
- (i) the control measures in place, i.e. substitution, engineering, administration, personal protective equipment etc., the additional control measures required to be instituted in order to reduce or maintain exposures to below the occupational exposure limits, and if applicable the planned programme of implementation;
- (j) the frequency of any ongoing monitoring to assess the effectiveness of the controls mentioned above; and
- (k) the relevant material safety data sheets as contemplated in section 21(4) (a), (b) and (c) of the MHSA.

8.1.1.3 Review of Baseline Risk Assessment

The baseline is to be reviewed whenever circumstances arise or change at the mine that could have an impact on the original assessment, and at least in the following instances:

- (a) When outcomes of medical surveillance programmes indicate the need for it;

- (b) When a section 11.5 investigation indicates the need for it
- (c) When new or revised legislation is introduced;
- (d) When new mining methods are introduced;
- (e) When process changes are introduced (e.g., in process plants);
- (f) When new types of machinery are introduced; and
- (g) at intervals not exceeding 5 years.

8.1.1.4 Post Baseline

Historical data is to be maintained as provided for in section 15(2) (a).

8.1.2 Determination of HOMOGENEOUS EXPOSURE GROUPS (HEG)

THE COP MUST ADDRESS THE FOLLOWING POINTS:

8.1.2.1 HEGs must be identified for purposes of personal exposure monitoring. The baseline risk assessment will enable the identification of HEGs, which are to be established as follows:

Step 1

Sub-divide the mine into Sampling Areas (i.e. Surface = Sampling Area 1, Underground Section A = Sampling Area 2, Underground Section B = Sampling Area 3, Underground Section C = Sampling Area 4, etc).

Step 2

Sub-divide the Sampling Areas into Activity Areas as per the Activity Area Code List found in ANNEX A. ANNEX A forms part of this guideline and must be complied with.

Step 3

Ensure that adequate measurements of personal exposures to identified *significant airborne pollutants* for each Activity Area are available. (Refer also to paragraph 8.1.4 below). If professional judgment concluded that insufficient historical personal exposure data is available regarding the extent of the risk, a personal monitoring survey must be undertaken for each *significant airborne pollutant*. Acceptable methodologies such as stipulated by NIOSH should be used for this assessment. Once the concentration and composition of the airborne pollutants identified in the Activity Area are determined then proceed to step 4.

Step 4

Compare the results of the significant pollutants present, either from historical data or from measured data during the personal sampling strategy, in that particular Activity

Area to their respective OEL values. These OEL values and Pollutant codes are contained as Schedule 22.9(2)(a) in Chapter 22 of the regulations.

If samples have been taken in previous years, the results may provide valuable information, especially if the process has not changed significantly. If changes have occurred, the monitoring data will provide some basis for estimating potential exposures of employees in HEG's based on professional judgments. Plotting past data over time to determine whether the exposure trends are higher or lower may be helpful. If the exposure trends exist, the occupational hygienist may use only the most recent exposure data in the initial assessment. If substantial data is available, some statistical analysis may be appropriate.

In order to ensure that HEG's are correctly allocated a statistical analysis of the results is to be done, an **example** of such an approach is shown in ANNEX B. ANNEX B is attached for information purposes only.

Once the personal exposures within each Activity Area have been compared to their respective OEL values, each Activity Area can now be categorised into classification bands to determine the various HEG(s) within that Activity Area. The classification bands for airborne pollutants are tabled in ANNEX C. ANNEX C forms part of this guideline and must be complied with.

Please note that an Activity Area e.g. stoping is not a HEG, this Activity Area i.e. stoping, must be subdivided into the classification bands as shown above. These classification bands are the HEGs within that particular Activity Area.

Repeat step 4 for every significant pollutant identified in the risk assessment process.

Step 5, Step 6

8.1.2.2 HEGs identified in terms of paragraph 8.1.2.1 must be clearly demarcated on a plan/sketch/ description.

Note: Where chemical processes are involved a flow chart of the process must be included.

8.1.2.2 At the end of the sampling cycle (annually - end of calendar year) sampling results for each HEG must be statistically analysed and re-classified when required. Re-classification of HEGs should be done by means of statistically recognised principles. 90% Confidence limits are to be used to test the homogeneity of HEGs. Refer to Annex B for an example.

8.1.2.3 HEGs must be re-assessed whenever circumstances arise or change at the mine and at least when the following occur:

- (a) exposure levels change due to controls being initiated and likewise when controls deteriorate;
- (b) employee complaints are received;
- (c) processes are changed (e.g. change in procedures, mining and ventilation layouts, mining methods, plant, equipment or material);
- (d) occupational illness occurs;
- (e) a change in exposure category occurs; and
- (f) other events warranting re-evaluation occurs;

- (i) new technological data; and
- (ii) new regulatory initiatives.
- (g) Should the review of the baseline assessment warrants it

This re-classification must only be done if results are proven and consistent. The monitoring strategy within a HEG must be adapted when either of the above (i.e. 8.1.2.3 and/or 8.1.2.4) occurs.

8.1.3 Personal Exposure Monitoring

Personal exposure monitoring is to be conducted to obtain reliable estimates of employee shift exposures in a workplace.

8.1.3.1 Samples taken must be:

- (a) accurate;
- (b) meaningful;
- (c) representative of all full working shifts;
- (d) randomly spread over the full sampling cycle period for each HEG; and
- (e) randomly spread across all occupations within the HEG.

8.1.4 Sampling, Analysis Methodology and quality Control

The COP must address the following points:

8.1.4.1 CONTINUING SAMPLING STRATEGY (CHECK SUB HEADINGS BOLD/NOT BOLD)

CONTINUING SAMPLING MUST BE CONDUCTED IN ORDER TO ASSESS WHETHER SIGNIFICANT CHANGES IN TRENDS HAVE OCCURRED AND SHOULD BE ADDED TO ACCUMULATED DATA DURING STATISTICAL ANALYSIS [RE-CLASSIFICATION OF HEGs].

A minimum of 5% or 5 samples (whichever is the greater) per HEG should be taken as per classification bands in Annex C as per the following:

Category A – 5% or 5 samples per quarter

Category B – 5% or 5 samples six-monthly

Category C – 5% or 5 samples per annum

The mandatory sampling frequency of this sampling is stipulated on the statutory report forms 21.9(2) (a) and (b) in Chapter 21 of the regulations and in terms of regulation 9.2(7).

The occupational hygienist must use his/her professional judgment to decide whether additional samples need to be taken in order to increase the confidence that HEGs are appropriately categorised.

8.1.4.2 SAMPLING STRATEGY AND SCHEDULES

A sampling strategy including a monitoring schedule for each HEG **must be** compiled for the **sampling cycle period**, and records thereof are kept for a period of **three** years.

8.1.4.3 SAMPLING METHODOLOGY

For each significant pollutant identified, an appropriate sampling methodology, **which complies with internationally compatible best practice** must be selected and implemented.

Note: The relevant methodology chosen for each significant pollutant identified must be stated in the COP, **see example below**

Methodology: for Ammonia, use could be made of the US National Institute for Occupational Safety and Health (NIOSH) Analytical Method 6015.

A quality control programme for the sampling methodology, compatible with internationally acceptable methodology must be developed and implemented.

8.1.4.4 CHEMICAL ANALYSIS METHODOLOGY

- (a) For each significant pollutant identified, an appropriate **chemical** analysis methodology, which complies with internationally **accepted** good practice, must be selected and implemented **e.g. NIOSH methods for Silica crystalline respirable: NIOSH 7500 (XRD); NIOSH 7602 (IR).**
- (b) **The sample analysis must be done by either a laboratory that is accredited in terms of SABS ISO/IEC 17025 of the South African National Accreditation System (SANAS), or a laboratory that is participating in a proficiency testing programme and is in a process of obtaining SANAS accreditation, which latter this laboratory must produce proficiency test certificate to the client before providing a service.**

8.1.4.5 Gravimetric Weighing Facilities

Gravimetric weighing facilities do not require accreditation by SANAS [Refer to SIMRAC Handbook on Mine Occupational Hygiene Measurements for guidance on methodology] ANNEX D contains useful references for air monitoring. ANNEX D is attached for information purposes only.

8.1.4.6 Quality Control

A quality control programme for the sampling methodology must be developed and implemented.

8.1.5 Reporting and Recording

The COP must address the following points:

8.1.5.1 RECORD KEEPING SYSTEM

A record keeping system, which records the mine's exposure history of each HEG, must be kept and be readily available at the mine, including any reasons for deviation on sample results such as:

- (a) Controls not operating effectively
- (b) Events or factors which have influenced the results, e.g., air sampling at surface operations after high rainfall or during excessive winds.

8.1.5.2 MANDATORY REPORTS

Reporting to the DMR must be done as per prevailing legislative requirements.

8.1.6 CONTROL

8.1.6 Hierarchy of Controls initiated (description of method used e.g.)

8.1.6.1 Elimination

- (a)• Substitution
- (b)•Innovation

8.1.6.2 Engineering controls

- (a) Dilute with ventilation
- (b) Total or partial enclosure
- (c) (c)Negative pressure
- (d) Exhaust systems
- (e) Filters installed etc.

8.1.6.3 Administrative controls

- (a) Removal of persons from the hazard
- (b) Safe systems of work
- (c) Reducing exposure time
- (d) Provision of hygiene facilities e.g. changing, washing eating facilities

8.1.6.4 Personal protective equipment (PPE)

- (a) Respiratory protective equipment

Note: Regulation 9.2(7) pertains to mandatory annual personal exposure reports which are required to be submitted to the Regional Principal Inspector of Mines.

8.1.7 LINKING TO MEDICAL SURVEILLANCE RECORDS

This COP must set out a system describing how occupational hygiene measurements will be linked with the medical surveillance records. Additive effects of any significant pollutant must be taken into account.

8.1.8 Training

The cop MUST address the training programme in place for:

- Storage and maintenance of equipment;
- Issuing of the sampling equipment;
- Wearer of the sampling equipment;
- Handling of the sampling equipment;
- Transportation of equipment; and
- Pre and post calibration of the sampling train checks.

8.2 OCCUPATIONAL MEDICAL SURVEILLANCE

8.2.3 MEDICAL SURVEILLANCE ACCORDING TO HEALTH HAZARD

PART D: IMPLEMENTATION

1. Implementation Plan

- 1.1. The employer must prepare an implementation plan for its COP that makes provision for issues such as organisational structures, responsibilities of functionaries and programmes and schedules for the COP that will enable proper implementation of the COP (A summary of and a reference to, a comprehensive implementation plan may be included).
- 1.2. Information may be graphically represented to facilitate easy interpretation of the data and to highlight trends for the purposes of risk assessment.

2. Compliance With The COP

The employer must institute measures for monitoring and ensuring compliance with the COP.

3. Access To The COP And Related Documents

- 3.1 The employer must ensure that a complete COP and related documents are kept readily available at the mine for examination by any affected person. Describe the process for COP access.
- 3.2 A registered trade union with members at the mine or where there is no such union, a health and safety representative on the mine, or, if there is no health and safety representative, an employee representing the employees on the mine, must be provided with a copy on written request to the manager. A register must be kept of such persons or institutions with copies to facilitate updating of such copies.
- 3.3 The employer must ensure that all employees are fully conversant with those sections of the COP relevant to their respective areas of responsibilities.

ANNEX A: ACTIVITY AREAS AND CODES

This ANNEX forms part of the guideline and must be complied with.

Activity	Code
Conventional Mining (coal)	01
Continuous Miner (coal)	02
Longwall Mining (coal)	03
Handgot (coal)	04
Stooping/Pillar Extraction (coal)	05
Rock Mining Coal	06
Opencast	07
Stoping	08
Development (Single shift)	09
Development (Multiblast)	10
Shaft Sinking	11
Raise Boring/Dry Drilling	12
Trackless Mining	13
Scraper Block Caving	14
Ground Handling (Conveyor/Loco's)	15
Shafts & Services	16
Roving Underground	17
U/g workshops	18
Raw material	19
Crushing	20
Milling/Pulverising	21
Screening/Grading	22
Separation Processes	23
Concentrating	24

Heat Process	25
Smelting	26
Chemical Process	27
Refining	28
Final Products	29
Roving Plant	30
Roving Surface	31
Assay/Laboratory	32
Surface Workshops	33
Dumps/Dump Recycling	34
Administration	35
Marine Mining	36
Dimension block mining	37

Note:

Where the above broad descriptions do not define an activity area exactly, select the “best fit “.

ANNEX B: HEG DETERMINATION – EXAMPLE OF STATISTICAL APPROACH

This ANNEX is attached for information purposes only.

Introductory information:

In statistics, a **confidence interval (CI)** is a particular kind of interval estimate of a population parameter. Instead of estimating the parameter by a single value, an interval likely to include the parameter is given. Thus, confidence intervals are used to indicate the reliability of an estimate. How likely the interval is to contain the parameter is determined by the **confidence level** or confidence coefficient. Increasing the desired confidence level will widen the confidence interval.

A confidence interval is always qualified by a particular **confidence level**, usually expressed as a percentage. The end points of the confidence interval are referred to as **confidence limits**.

STEP 1

Action to be performed:

1. Capture sampling data in Microsoft Excel.
2. Determine the descriptive statistics for the data by utilising Microsoft Excel Analysis ToolPak.

To install the Analysis ToolPak:

- On the **Tools** menu, select **Add-Ins**.
- If **Analysis ToolPak** is not listed in the **Add-Ins** dialog box, click **Browse** and locate the drive, folder name, and file name for the Analysis ToolPak Add-Ins, **Analys32.xll** usually located in the **Library\Analysis** folder, or run the Setup program if it isn't installed.
- Select the **Analysis ToolPak** check box.

To use the Analysis ToolPak:

- Before using the analysis tool, you must first arrange the data you want to analyse in one column (e.g. A1 to A40 – if you have 40 values that you want to analyse).
- On the **Tools** menu, click **Data Analysis**.
- In the **Analysis Tools** box, select the **Descriptive Statistics** tool.
- Enter the input range (e.g. A1 to A40).
- Select the **Grouped by Columns** option.
- Select the output range (e.g. B1 to B40).
- Select the **Summary Statistics** option.
- Select the **Confidence Level of Mean** option and enter this value as being **95%**.
- Select **OK**.

Expected result:

**Example of data
entered into
Microsoft Excel**

DATA
1.78
1.87
2.15
2.29
2.54
1.51
2.47
2.45
1.32
2.32
2.48
1.45
0.89

**Expected result after completing actions
as indicated under STEP 1.**

DESCRIPTIVE STATISTICS	
Mean	1.963
Standard Error	0.148
Median	2.150
Mode	#N/A
Standard Deviation	0.535
Sample Variance	0.286
Kurtosis	-0.665
Skewness	-0.689
Range	1.65
Minimum	0.89
Maximum	2.54
Sum	25.52
Count	13
Confidence Level(95.0%)	0.323

STEP 2

Action to be performed:

From the descriptive statistics calculate the following:

- A) 2SD = 2 x Standard Deviation e.g. $2 \times 0.535 = 1.071$
- B) Mean – 2SD = Mean – 2SD e.g. $1.963 - 1.071 = 0.892$
- C) Mean + 2SD = Mean + 2SD e.g. $1.963 + 1.071 = 3.034$
- D) 90th Percentile value by utilizing the following Microsoft Excel formulae:

=PERCENTILE (A1:A40,0.9) = 2.478 (for the data used in this example)

where:

“A1:A40” = Range were data is entered in Microsoft Excel spread sheet

“0.9” = The percentile to be calculated, in this case the 90th percentile

Interpretation:

From the calculation performed above it can already be estimated that this HEG is NOT statistically correct defined, as:

- The mean value falls within the “B Category” and the 90th percentile value falls within the “A Category”. For a HEG to be statistically correctly defined its mean and 90th percentile values will almost always fall within the same classification band.

STEP 3

Action to be performed:

Determine if 95% of the samples taken falls within 2 standard deviations (2SD) from the mean value.

Example:

- 95% of the samples must be between “Mean – 2SD” (0.892) and “Mean + 2SD” (3.034)
- From the data 1 sample (0.89) is smaller than “Mean – 2SD” and 0 samples are larger than “Mean + 2SD”.

Interpretation:

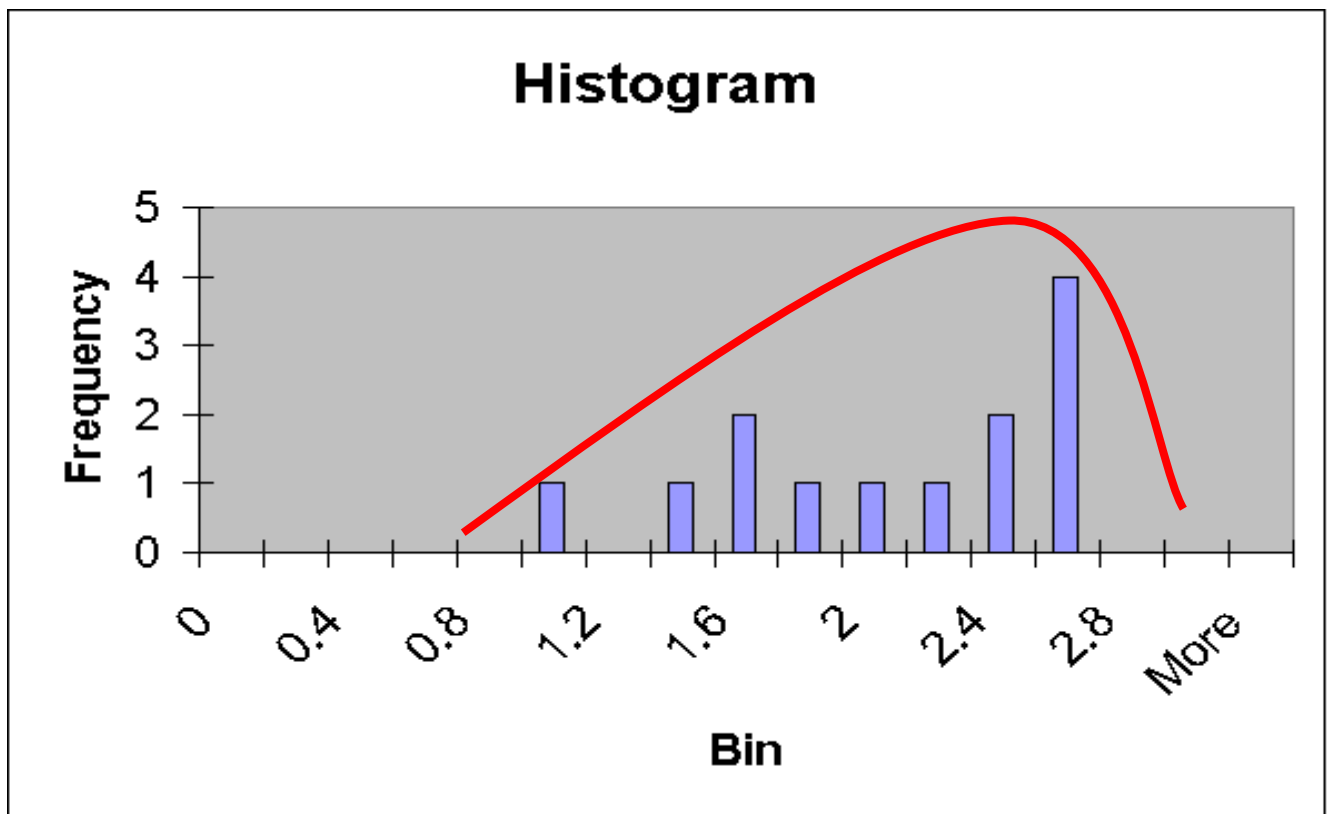
One out of thirteen samples represents 7.69 % of the sample group (i.e. $1/13 \times 100 = 7.69\%$). This is more than the allowable 5% and therefore the HEG cannot be seen as statistically correctly defined.

STEP 4

Action to be performed:

Draw a histogram to graphically indicate the data.

Expected result:



Interpretation:

From the Histogram it is also clear that the HEG is NOT statistically correctly defined (no bell curve). Only 2 things can be done to correct this situation:

- *Obtain more samples to determine the correct distribution of samples within the HEG.* This is currently being forced by the legislated sampling strategy as the "mean" value reported for dose allocations, (for an OEL of 2 in this example) falls within a "B Category" (5% sampled over 6 months) but the 90th percentile value is reported as an "A Category" thus forcing more samples to be taken (5% over 3 MTh's).
- *Conduct an investigation to determine if more than one HEG is being represented by the data*

STEP 5

Action to be performed:

Conduct an investigation to determine if more than one HEG is being represented by the data. This can be done by investigation and following the methodology as explained up to this point (for example):

After investigation the HEG was divided into 2 separate HEGs (Intake side HEG & Return side HEG),

The data collected was then allocated to the 2 HEG's and the statistical analysis revealed the following:

Data allocated to the Intake side HEG
0.89
1.32
1.78
1.87
1.51
1.45

DESCRIPTIVE STATISTICS	
Mean	1.47
Standard Error	0.14
Median	1.48
Mode	#N/A
Standard Deviation	0.35
Sample Variance	0.12
Kurtosis	0.57
Skewness	-0.72
Range	0.98
Minimum	0.89
Maximum	1.87
Sum	8.82
Count	6
Confidence Level(95.0%)	0.36

CALCULATIONS		
2 X SD	=	0.702
Mean - 2SD	=	0.767
Mean + 2SD	=	2.172
90th Percentile	=	1.825

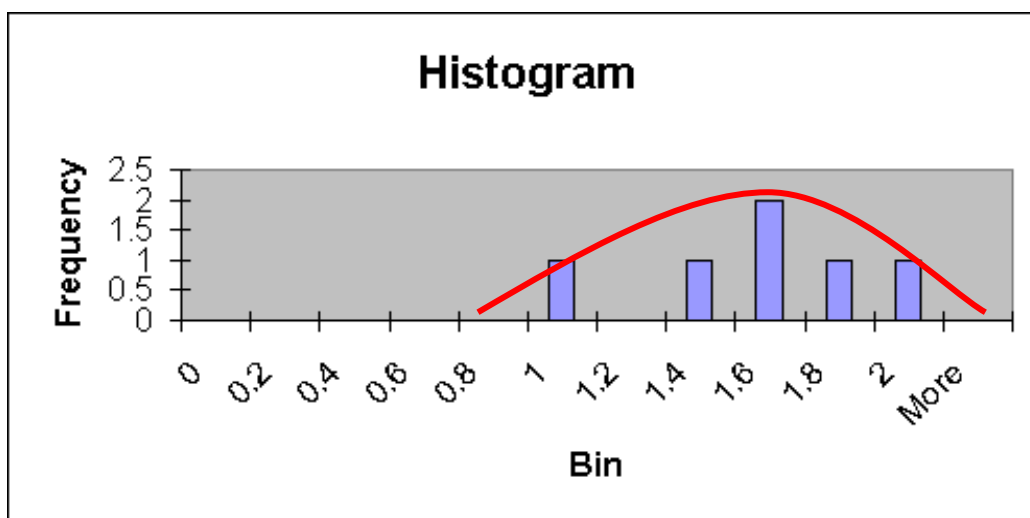
Interpretation:

From above it can already be estimated that this HEG is statistically correctly defined, as the Mean value (1.47) falls within the "B Category" and the 90th Perch value (1.825) also falls within the "B Category".

DOES 95% OF THE SAMPLES FALL WITHIN 2 STANDARD DEVIATIONS (SD) FROM THE MEAN?

- A) 95% of the samples must be between Mean - 2SD (0.7674) and Mean + 2SD (2.173)
- B) From "DATA":0 sample < Mean - 2SD 0 samples > Mean + 2SD
- C) 0/6 = 0%

This is within the allowable 5% and therefore the HEG is statistically correctly defined.



Data allocated to the Return side HEG
2.15
2.29
2.32
2.54
2.47
2.45
2.48

DESCRIPTIVE STATISTICS	
Mean	2.38
Standard Error	0.05
Median	2.45
Mode	#N/A
Standard Deviation	0.13
Sample Variance	0.01
Kurtosis	-0.26
Skewness	-0.80
Range	0.39
Minimum	2.15
Maximum	2.54
Sum	16.7
Count	7
Confidence Level(95.0%)	0.12

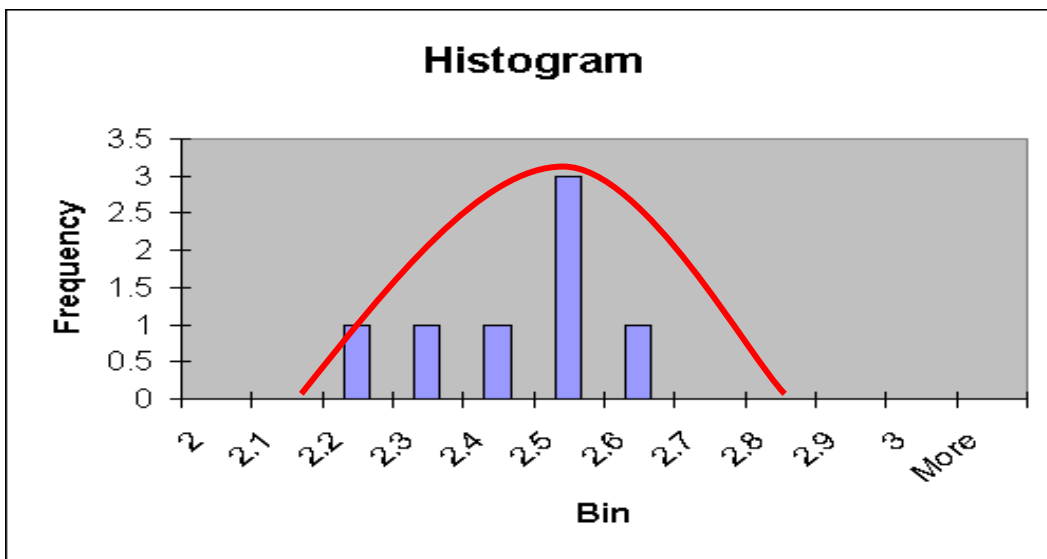
CALCULATIONS		
2 X SD	=	0.274434
Mean - 2SD	=	-2.11128
Mean + 2SD	=	2.660149
90th Percentage	=	2.504

Interpretation:

From the above it can already be estimated that this HEG is statistically correctly defined, as the mean value (2.39) falls within the "A Category" and the 90th percentile value (2.504) also falls within the "A Category".

DOES 95% OF THE SAMPLES FALL WITHIN 2 STANDARD DEVIATIONS (SD) FROM THE MEAN?

- A) 95% of the samples must be between Mean - 2SD (-2.514) and Mean + 2SD (7.286)
- B) From "DATA":0 sample < Mean - 2SD and 0 samples > Mean + 2SD
- C) 0/7 = 0%. This is within the allowable 5% and therefore the HEG is statistically correctly defined.



STEP 6 – Paired T-Test

ANNEX C: CLASSIFICATION BANDS

ANNEX C forms part of this guideline and must be complied with.

CLASSIFICATION BANDS	
CATEGORY	PERSONAL EXPOSURE LEVEL
A	Exposures \geq the OEL
B	Exposures \geq 50% of the OEL and $<$ OEL
C	Exposures \geq 10% of the OEL and $<$ 50% of the OEL

Pollutants (Excluding Toxic Gases & Vapours)

CLASSIFICATION BANDS	
CATEGORY	PERSONAL EXPOSURE LEVEL
A	Exposures \geq the OEL
B	Exposures \geq 50% of the OEL and the OEL

Toxic Gases & Vapours

Please note that an Activity Area e.g. stoping is not a HEG, this Activity Area i.e. stoping, must be subdivided into the classification bands as shown above. These classification bands are the HEGs within that particular Activity Area.

ANNEX D: USEFUL REFERENCES FOR AIR MONITORING

(for information only)

1. [SIMRAC Handbook on Mine Occupational Hygiene Measurements: David W. Stanton, Johan Kielblock, Johan J. Schoeman, John R. Johnston](#)
2. Atmospheric Contaminant Exposure in the Western Australian Mining Industry Presented at the Second International Conference on the Health of Miners held in Pittsburgh, 11-13 November 1995
3. Dust Sampling Strategy on Coalfaces in Relation to Modern Coalmining Methods Institute of Occupational Medicine Ltd., Technical Memorandum Series

4. Guide to Conducting Occupational Health Risk Assessments
Institute of Occupational Hygienists of Southern Africa (IOHSA), 1995

Now the Southern African Institute for Occupational Hygiene (SAIOH)
5. Guidelines for the Gravimetric Sampling of Airborne Particulates for Risk Assessment in Terms of the Occupational Diseases in Mines and Works act No 78 of 1973
Reference: GME 16/2/3/2/3
6. [An Industry Guide to Air Monitoring Strategies for Hazardous Substances: A strategic approach to assessing occupational exposure to Airborne Hazardous Chemical Substances \(including Lead and Asbestos\)](#)
[Southern African Institute for Occupational Hygiene \(SAIOH\), 2000 \(Unpublished\)](#)
7. HSG173 Monitoring Strategies for Toxic Substances
Health and Safety Executive, UK 2006
8. NIOSH Manual of Analytical Methods - 4th edition
DHHS (NIOSH) Publication 94-113, 1994 plus Supplements
9. Occupational Exposure Sampling Strategy Manual
DHHS (NIOSH) Publication No. 77-173, 1977
10. SIMRAC Project GAP 225: Practical Guide to the Risk Assessment Process
SIMRAC, Johannesburg, 1997
11. [South African Mining Industry Guide to Hazard Identification and Risk Assessment \(HIRA\)](#)
[Chamber of Mines of South Africa, 2001](#)
12. Strategy for Assessing and Managing Occupational Exposures, 3rd edition
American Industrial Hygiene Association, 2006
13. "The National System of Scientific Measurement," Hunter, J. S; Science, 210, 869 (1980)
14. Workplace Atmospheres. Guidance for the Assessment of Exposure by Inhalation to Chemical Agents for Comparison with Limit Values and Measurement Strategy
British Standards BS EN 689:1996
15. [Chapter 3 of the Safety in Mines Research Advisory Committee \(SIMRAC\) published "Handbook on Occupational Health Practice in the South African Mining Industry".](#)

Annexure C: Comparison with International Best Practice

Comparison between DMR revised Guideline and International Best Practice

Legend: Addressed - ✓

Not addressed in document - ✗

Item No.	Item Description	Guideline / Standard							Notes Number
		DMR Guideline	OESMM	IRSST	EN689	SafeWork Australia	BOHS/NVVA	ICMM	
1	Indication of Legal Status of Document	✓	✓	✓	✓	✓	✓	✓	H, R, X
	- Legally binding document	✓	✗	✓	✓	✗	✗	✗	A, R
	- Guideline document only	✓	✓	✓	✓	✓	✓	✓	I, R
2	Objective, considering/indicating:	✓	✓	✗	✓	✓	✓	✓	
	- Reduction of employee exposure	✓	✓	✗	✗	✗	✓	✓	Y
	- To verify contamination concentration levels in relation to reference values.	✗	✓	✓	✓	✓	✓	✓	O
	- Provide guidance of a general nature on format and content of a COP.	✓	✗	✗	✗	✗	✗	✗	
	- Provide specific technical background	✓	✓	✗	✗	✗	✓	✗	
3	List of Definitions and Acronyms	✓	✓	✓	✓	✓	✗	✓	
4	Scope, considering/indicating:	✓	✓	✗	✗	✓	✗		
	- When a system of occupational hygiene measurements (personal exposure) must be implemented.	✓	✓	✗	✗	✓	✗	✓	
	- Need to link personal exposure to employees medical records.	✓		✗	✗	✗	✗	✓	
	- Target population (employees) indicated.	✓	✓	✗	✗	✗	✓	✗	B, P
	- Hierarchy of control measures indicated.	✓	✗	✗	✗	✗	✗	✗	
5	Format and content of the COP stipulated, specifying:	✓	✗	✗	✗	✗	✗	✗	
	- Numbering and referencing protocols to be used.	✓	✗	✗	✗	✗	✗	✗	
	- "Title page" content.	✓	✗	✗	✗	✗	✗	✗	
	- Need for a table of content.	✓	✗	✗	✗	✗	✗	✗	
	- Indication of legal status of the COP.	✓	✗	✗	✗	✗	✗	✗	
	- List of the Members of the Drafting Committee.	✓	✗	✗	✗	✗	✗	✗	
	- Additional general information on the mine required.	✓	✗	✗	✗	✗	✗	✗	
	- The need for Risk Management, considering/including:	✓	✗	✗	✗	✗	✗	✗	
	o Description of the risk management system;	✓	✗	✗	✗	✗	✗	✗	
	o Information sources to be consulted during the risk assessment process;	✓	✗	✗	✗	✗	✗	✗	
	o When the COP should be reviewed.	✓	✗	✗	✗	✗	✗	✗	
6	List of the key elements to be considered in the COP, considering/indicating:	✓	✗	✗	✗	✗	✗	✗	
	- Personal exposure monitoring	✓	✗	✗	✗	✗	✗	✓	
	- Hierarchy of controls	✓	✗	✗	✗	✗	✗	✓	
	- Reporting and reviewing.	✓	✗	✗	✗	✗	✗	✓	
7	Aspects of a detailed Occupational Hygiene Programme indicated.	✓	✗	✗	✗	✗	✗	✓	

Item No.	Item Description	Guideline / Standard							Notes Number
		DMR Guideline	OESMM	IRSST	EN689	SafeWork Australia	BOHS/NVVA	ICMM	
8	Need for a Baseline Risk Assessment to be conducted considering/indicating:	✓	✓	✓	✓	✗	✓	✓	
	- Identification of significant airborne pollutants;	✓	✓	✓	✓	✓	✗	✓	Z
	- Route of entry and health effects;	✓	✓	✗	✓	✓	✗	✓	
	- Where pollutants may be present;	✓	✓	✓	✓	✗	✗	✓	
	- Airborne nature of pollutants;	✓	✓	✓	✓	✗	✗	✓	
	- Nature of key workplace operations and activities;	✓	✓	✓	✓	✗	✗	✓	
	- Occupational and number of employees exposed;	✓	✓	✗	✓	✗	✗	✓	
	- Pattern of exposure	✓	✓	✓	✓	✗	✗	✓	
	- Exposures compared to OELs;	✓	✓	✓	✓	✗	✗	✓	
	- Need to use international methods for sample size calculation purposes;	✓	✗	✓	✗	✗	✗	✓	K ₂
	- Specific sample size calculation method indicated;	✓	✓	✓	✓	✗	✗	✓	K ₂ , T
	- List of control measures in place;	✓	✗	✗	✗	✗	✗	✓	
	- Frequency of any ongoing control monitoring program.	✓	✓	✗	✓	✗	✗	✓	Q, V
	- When Baseline Risk Assessment must be reviewed.	✓	✗	✗	✗	✗	✗	✓	
9	Determination of HEG / SEG, considering/indicating:	✓	✓	✓	✗	✗	✓	✗	AB
	- Identification of Sampling Areas;	✓	✗	✗	✗	✗	✓	✓	
	- Identification of Activity Areas;	✓	✗	✗	✗	✗	✗	✗	
	- Need for adequate personal exposure measurement to be done;	✓	✗	✓	✓	✗	✗	✗	C
	- Compare exposure measurements to OELs;	✓	✓	✓	✓	✗	✓	✓	
	- Statistical test to check correctness of HEG, considering:	✓	✗	✓	✓	✗	✓	✗	J, S, W
	o 90th Percentile value;	✓	✗	✗	✗	✗	✓	✗	
	o Standard Deviation value;	✓	✓	✓	✗	✗	✓	✗	
	o Variations (including random errors and systematic errors);	✗	✓	✓	✓	✗	✓	✗	
	o Normalized concentrations	✗	✗	✓	✗	✗	✓	✗	
	o Arithmetic mean	✗	✓	✓	✗	✗		✗	
	o Coefficient of variation	✗	✓	✓	✗	✗	✓	✗	
	o Geometric mean	✗	✓	✓	✗	✗	✓	✗	
	o Geometric Standard Deviation	✗	✗	✓	✓	✗	✗	✗	
	o Sampling precision	✗	✗	✓	✗	✗	✗	✗	
	o Analytical precision	✗	✗	✓	✗	✗	✗	✗	
	o Total coefficient of variation	✗	✓	✓	✗	✗	✓	✗	
	o Confidence limits	✗	✓	✓	✗	✗	✓	✗	
	o Decision of OEL has been exceeded:	✗	✓	✓	✗	✗	✓	✗	
	▪ Lower Confidence Limit (LCL)	✗	✓	✓	✗	✗	✓	✗	
	▪ Upper Confidence Limit (UCL)	✗	✓	✓	✗	✗	✓	✗	
	o Moving Weight Average	✗	✗	✗	✓	✗	✗	✗	
	- Allocation of Classification Bands;	✓	✗	✗	✗	✗	✓	✗	AC
	- Criteria for review of the HEG.	✓	✗	✓	✗	✗	✓	✗	
10	Personal Exposure Monitoring, considering/indicating:	✓	✓	✓	✓	✓	✗		
	- Full shift monitoring;	✓	✓	✓	✓	✓	✓	✓	
	- Randomly spread over full sampling cycle;	✓	✓	✓	✓	✗	✓	✗	
	- Randomly spread over all occupations.	✓	✓	✓	✓	✗	✓	✗	

Item No.	Item Description	Guideline / Standard							Notes Number
		DMR Guideline	OESMM	IRSST	EN689	SafeWork Australia	BOHS/NVVA	ICMM	
	- Sampling Strategy, considering/indicating:	✓	✓	✓	✓	✗		✗	
	o Specific sample category (if <OEL)	✓	✗	✗	✓	✗	✗	✗	V
	o Sample only if ≥ OEL	✗	✓	✓	✓	✓	✓	✗	U
	o Specific sample size to be used.	✓	✓	✓	✓	✗	✗	✗	D, K ₁ , Q
	o Specific sampling frequency to be used.	✓	✓	✗	✓	✗	✓	✗	E, K ₂
	o Use of Professional Judgement to indicate need for more samples.	✓	✓	✓	✓	✗	✓	✗	
	- Appropriate Sampling methodology must be selected and implemented.	✓	✗	✓	✓	✓	✗	✗	F, M
	- Use of TWA for personal exposure if work schedule is 8 hours per shift and 40 hours per week.	✓	✓	✓	✓	✓	✓	✗	
	- Use of adjusted TWA if work schedules other than 8 hours per shift and 40 hours per week.	✗	✗	✓	✗	✓	✓	✗	L, AA
11	Chemical Analysis Methodology	✓	✗	✓	✗	✗	✗	✗	
	- Need for selecting an appropriate methodology, complying with internationally accepted good practices.	✓	✗	✓	✗	✗	✗	✗	M
	- Need for analytical facility to be: SANAS accredited, or	✓	✗	✗	✗	✗	✗	✗	N
	o SANAS accredited (ISO/IEC 17025), or	✓	✗	✗	✗	✗	✗	✗	N
	o In process of acquiring SANAS and currently involved in proficiency testing programme/s.	✓	✗	✗	✗	✗	✗	✗	N
12	Gravimetric Weighing Facility	✓	✗	✗	✗	✗	✗	✗	N
	- No accreditation (e.g. SANAS) required.	✓	✗	✗	✗	✗	✗	✗	N
13	Quality Control	✓	✗	✗	✗	✗	✗	✓	
	- Need for a quality control program to be implemented.	✓	✗	✗	✗	✗	✗	✓	
	- Aspects to be addressed in the Quality Control Program indicated/listed.	✗	✗	✗	✗	✗	✗	✓	
14	Reporting and Recording, considering/indicating.	✓	✗	✗	✗	✗	✗	✗	
	- Internal record keeping;	✓	✗	✗	✗	✗	✗	✓	
	- Legislated records and reports.	✓	✗	✗	✗	✗	✗	✗	
15	Hierarchy of Controls indicated	✓	✗	✗	✗	✗	✗	✓	
16	Link to Medical Records	✓	✗	✗	✗	✗	✗	✗	
	- Specific detailed linking system described.	✗	✗	✗	✗	✗	✗	✗	
17	Need for a training programme described.	✓	✗	✗	✗	✗	✗	✗	
	- Specific training programs listed	✓	✗	✗	✗	✗	✗	✗	G
18	Need to establish an implementation plan.	✓	✗	✗	✗	✗	✗	✗	
19	Use of Environmental / Area Monitoring	✗	✓	✓	✓	✗	✗	✗	
20	List of sampling equipment that can be used.	✗	✗	✓	✗	✗	✗	✗	I
21	List of sampling techniques that can be used.	✗	✗	✓	✗	✗	✗	✗	I
22	Analysis of samples originating from a bulk	✗	✗	✓	✗	✗	✗	✗	
23	Detailed substances table/s provided; considering/indicating:	✗	✗	✓	✗	✗	✗	✗	
	- Pollutant Name;	✗	✗	✓	✗	✗	✗	✗	
	- Pollutant CAS Chemical Abstract Service Registry	✗	✗	✓	✗	✗	✗	✗	

Item No.	Item Description	Guideline / Standard							Notes Number
		DMR Guideline	OESMM	IRSST	EN689	SafeWork Australia	BOHS/NVVA	ICMM	
	Number);								
	- Exposure limits;	x	x	✓	x	x	x	x	
	- List of sampling devices;	x	x	✓	x	x	x	x	
	- Sample flow rate;	x	x	✓	x	x	x	x	
	- Sample volume;	x	x	✓	x	x	x	x	
	- Principle/technique of analysis;	x	x	✓	x	x	x	x	
	- MRV (Minimum Reported Value) on the sampling instrument, as defined in the analytical method.	x	x	✓	x	x	x	x	

GUIDELINE /STANDARD:

DMR Guideline: South Africa. Department of Mineral Resources. Mine Health and Safety Inspectorate. Guideline for the Compilation of a Mandatory Code of Practice for the Assessment of Personal Exposure to Airborne Pollutants. DMR 16/3/2/4-A1.

OESMM: USA. National Institute for Occupational Safety and Health. Occupational Exposure Sampling Strategy Manual.

IRSST: Institut de recherche Robert-Sauvé en santé et en sécurité du travail. Chemical and Biological Hazards Prevention. Studies and Research Projects. Technical Guide T-15. Sampling Guide for Air Contaminants in the Workplace. 8th edition, version 8.1.

EN689: BS EN 689:1996. BS 6069-3.7:1996. Workplace atmospheres – Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy.

SafeWork Australia: Safe Work Australia. Guidance on the interpretation of workplace exposure standards for airborne contaminants. April 2002.

BOHS/NVVA: British Occupational Hygiene Society/Nederlandse Vereniging voor Arbeidshygiëne: Testing Compliance with Occupational Exposure Limits for Airborne Substances

ICMM: International Council on Mining and Metals' Good Practice Guidance on Occupational Health Risk Assessment

NOTES NUMBER:

- A** DMR Guideline: Required in terms of section 9(2) of the Mine Health and Safety Act.
- B** DMR Guideline: Section 5.4, i.e. "Identify employees with a significant exposure and.."
- C** DMR Guideline: No definition for "adequate measurements".
- D** DMR Guideline: Number of samples based on exposure concentration.
- E** DMR Guideline: Frequency based on exposure concentration.
- F** DMR Guideline: No definition for "appropriate".

- G** DMR Guideline: Training requirements limited to the handling of sampling equipment
- H** IRSST: Part 1 (Sampling Strategy) is regulated in terms of the Regulation respecting occupational health and safety (ROHS) and also in the Regulation respecting occupational health and safety in mines (ROHSM).
- I** IRSST: Part 2 (Sampling Instruments and Techniques) is NOT regulated in terms of the Regulation respecting occupational health and safety (ROHS) and also NOT in terms of the Regulation respecting occupational health and safety in mines (ROHSM).
- J** IRRST: Consider a SEG to be correctly defined when "... an individual exposure value greater than half and smaller than twice the arithmetic mean of a group." An example is offered on page 11 as being "... a group of 20 workers whose arithmetic mean of their exposure to a contaminant is 1 mg/m³ is considered as being homogeneous if the exposure value of each individual in the group to this contaminant is between 0.5 and 2.0 mg/m³. Reference is made to the fact that this method is also suggested by the European Community.
- K₁** IRRST: The following sample size determination tables (ranging from 5 to 29 samples to be collected per SEG) is presented in the document: Table A1 (top 10% of the most exposed worker at a probability of 90%), Table A2 (top 10% of the most exposed worker at a probability of 95%), Table A3 (top 20% of the most exposed worker at a probability of 90%), and Table A4 (top 20% of the most exposed worker at a probability of 95%).
- K₂** OESSM (Technical Appendix A): The following sample size determination tables (ranging from 5 to 29 samples to be collected per SEG) is presented in the document: Table A1 (top 10% of the most exposed worker at a probability of 90%), Table A2 (top 10% of the most exposed worker at a probability of 95%), Table A3 (top 20% of the most exposed worker at a probability of 90%), and Table A4 (top 20% of the most exposed worker at a probability of 95%).
- L** IRRST: "*The information applicable to the adjustment of the TWAEV and the resulting interpretation rules are described in the Guide for the Adjustment of Permissible Exposure Values (PEVs) for Unusual Work Schedules published by the IRSST*".
- M** IRRST: Very specific analysis methods prescribed for each listed pollutant.
- N** IRRST: Not indicated if analytical laboratories need to be ISO/IEC 17025 (or similar) certified, or if they should be participating in proficiency testing scheme/s.
- O** OESSM: Reference is made to an "Action Level (AL)". In the Glossary of the document the AL is defined as being "Action level in a 29 CFR 1910 Subpart Z regulation."
- P** OESSM: The "maximum risk employee" must be sampled when there is a possibility that exposure above the Action Level is present. The "maximum risk employee" is indicated as "the employee believed to have the greatest exposure".
- Q** OESSM: Section 3.7 (Interval between days monitored) stipulates that: "The proposed OSHA health regulations developed under the Standards Completion program require the following: 1. The exposure of an employee whose exposure measurement is at or above the action level, but not above the permissible exposure, must be measured at least every 2 months. 2. For an employee whose exposure measurements exceeds the permissible exposure, the employer shall measure that

employee's exposure at least every month until the exposure is reduced to below the standard by appropriate control measures. The above are the proposed minimum legal requirements. More frequent measurements should be made based on professional judgement of the exposure situation.

- R** EN689: The following countries are bound to implement this standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.
- S** **EN 689:1995:** Consider a HEG to be correctly defined when "... if an individual exposure is less than half or greater than twice the arithmetic mean, the relevant work factors should be closely re-examined to determine whether the assumption of homogeneity was correct."
- T** **EN 689:1995:** "... sampling should be carried out for at least one employee in ten in a properly selected homogeneous group."
- U** **EN 689:1995:** Annex D, Section D.3. Depending on the probability of exceeding the limit value, three possibilities can result: a) Green situation if Probability $\leq 0,1\%$; b) Orange situation if Probability $>0,1\%$ and $\leq 5\%$; c) Red situation if Probability $> 5\%$.
- V** **EN 689:1995:** Maximum time intervals between periodic measurements (dependent on previous sample results): a) 64 weeks of OEL $< 25\%$ of OEL; b) 32 weeks if $\geq 25\%$ and $\leq 50\%$ of the OEL, and c) 16 weeks if $> 50\%$ of OEL but not $>OEL$.
- W** **EN 689:1995:** Annex G, Section G.3, paragraph 6) "If the data do not follow a straight line then the underlying distribution may not be log-normally distributed, or may comprise more than one sample population."
- X** **SafeWork Australia:** SafeWork Australia is a national policy body, not a regulator.
- Y** **SafeWork Australia:** Contains a complete list of all exposure standards that apply under the Work Health and Safety (WHS) Regulations. Must be read in conjunction with Safe Work Australia's Workplace Exposure Standards for Airborne Contaminants, available at www.safeworkaustralia.gov.au/AboutSafeWorkAustralia/WhatWeDo/Publications/Pages/Exposure-Standards-Airborne-Contaminants.aspx
- Z** **SafeWork Australia:** List information and exposure standards for various very specific pollutants.
- AA** **SafeWork Australia:** Reference is made to various models for adjusting exposure standards.
- AB** **BOHS/NVVA:** "The method has five stages: selection of similarly exposed groups, a screening test, a group compliance test, and an individual compliance test if an analysis of variance shows that differences between individual exposure patterns makes this desirable."
- AC** **BOHS/NVVA:** Exposure category as per AIHA but very dependent on the occupational hygienist's professional judgment and experience.

Annexure D: Printable Version of the operations manual

(As approved by MOHAC)

Annexure E: Recommended editorial corrections

(As approved by MOHAC and included in operations manual)

Revised guideline text	Recommended correction
<p>This point was deleted:</p> <p><i>“1.6 When determining the HEGs as required in paragraph 8.1.2 of the guideline, regard must be had to the SAMOHP issued by the DME”</i></p>	<p>Re-use in the revised guideline:</p> <p><i>“1.6 When determining the HEGs as required in paragraph 8.1.2 of the guideline, regard must be had to the SAMOHP issued by the DME”</i></p> <p>Change DME to DMR</p>
<p>This definition was deleted:</p> <p>“SAMOHP ” means the South African Mines Occupational Hygiene Programme Codebook;</p>	<p>Re-use definition since SAMOHP will be continued</p>
<p>“significant airborne pollutant” means any airborne pollutant to which any employee is exposed in concentrations equal to or exceeding the OEL contemplated in regulation 9.2.1.;</p>	<p>Align this definition with the scope of the guideline:</p> <p>“significant airborne pollutant” means any airborne pollutant to which any employee is exposed to in significant concentrations that are contemplated in regulation 9.2.1:</p> <ul style="list-style-type: none"> - Particulates \geq 10% of the occupational exposure limit; - Gases \geq 50% of the occupational exposure limit
<p>5.2 “...Section 9.3 a COP...”</p>	<p>Re-use “...of the MHSA...”</p> <p>5.2 “...Section 9.3 of the MHSA a COP...”</p>
<p>5.3 “...Occupational Health Programme...”</p>	<p>5.3 “...Occupational Hygiene Programme...”</p>
<p>Part C 1.3:</p> <p>DMR 16/3/2/4-A11</p>	<p>Typo:</p> <p>DMR 16/3/2/4-A1</p>
<p>Part C Section 8</p> <p>“...Occupational Health Programme...”</p>	<p>“...Occupational Hygiene Programme...”</p>
<p>Section 8.1</p> <p>Step 2 - Determination of Sampling Population</p>	<p>Align with the title of section 8.1.2</p> <p>Step 2 - Determination of Homogenous Exposure Groups (HEGs)</p>
<p>8.1.2 Step 4</p> <p>“These OEL values and Pollutant codes are contained as Schedule 22.9(2)(a) in Chapter 22 of the regulations.”</p>	<p>Pollutant codes are in the SAMOHP Codebook and not in the regulations.</p> <p>“These OEL values are contained as Schedule 22.9(2)(a) in Chapter 22 of the regulations.”</p>

8.1.4.1 Continuing Sampling Strategy (Check sub headings bold/not bold)	8.1.4.1 Continuing Sampling Strategy
Section 8.1.4.1 “The mandatory sampling frequency of this sampling is stipulated on the statutory report forms 21.9(2) (a) and (b) in Chapter 21 of the regulations and in terms of regulation 9.2(7).”	The frequency is specified in SAMOHP. “The mandatory sampling period of this sampling is stipulated on the statutory report forms 21.9(2) (a) and (b) in Chapter 21 of the regulations and in terms of regulation 9.2(7).”
Annex B: Statistical Analysis example	The data in the example is not correct and does not produce the same results in Excel than what appears in the revised guideline. The following changes are recommended (values and text):

Expected result:

**Example of
Platinum Mine
Dust Respirable
Particulate
(Pollutant Code
487) data entered
into Microsoft
Excel**

**Expected result after completing actions
as indicated under STEP 1.**

DATA
0.126
11.300
0.185
0.379
0.239
0.178
0.315
0.144
0.186
0.201
10.302

DESCRIPTIVE STATISTICS	
Mean	2.141
Standard Error	1.293
Median	0.201
Mode	#N/A
Standard Deviation	4.288
Sample Variance	18.386
Kurtosis	2.122
Skewness	1.933
Range	11.174
Minimum	0.126
Maximum	11.300



Sum	23.555
Count	11
Confidence Level (95.0%)	2.881

Note: Platinum Mine Dust Respirable Particulate has an Occupational Exposure Limit (OEL) of 3.0 mg/m³.

STEP 2

Action to be performed:

From the descriptive statistics calculate the following:

A) 2SD = 2 x Standard Deviation e.g. 2 x 4.288 = 8.576

B) Mean – 2SD = Mean – 2SD e.g. 2.141 – 8.576 = -6.434

C) Mean + 2SD = Mean + 2SD e.g. 2.141 + 8.576 = 10.717

D) 90th Percentile value by utilizing the following Microsoft Excel formulae, e.g.:

=PERCENTILE (A1:A40,0.9) = 10.302 (for the data used in this example)

where:

“A1:A40” = Range where data is entered in Microsoft Excel spreadsheet

“0.9” = The percentile to be calculated, in this case the 90th percentile

Interpretation:

From the calculation performed above it can already be seen that this HEG is NOT statistically correct defined, as:

- The mean value falls within the “B Category” and the 90th percentile value falls within the “A Category”. For a HEG to be statistically correctly defined its mean and 90th percentile values will almost always fall within the same classification band.

STEP 3

Action to be performed:

Determine if 95% of the samples taken falls within 2 standard deviations (2SD) from the mean value.

Example:

- 95% of the samples must be between “Mean – 2SD” (-6.434) and “Mean + 2SD” (10.717)
- From the data none of the samples is smaller than “Mean – 2SD” and 1 sample (11.300) is larger than “Mean + 2SD” (10.717).

Interpretation:

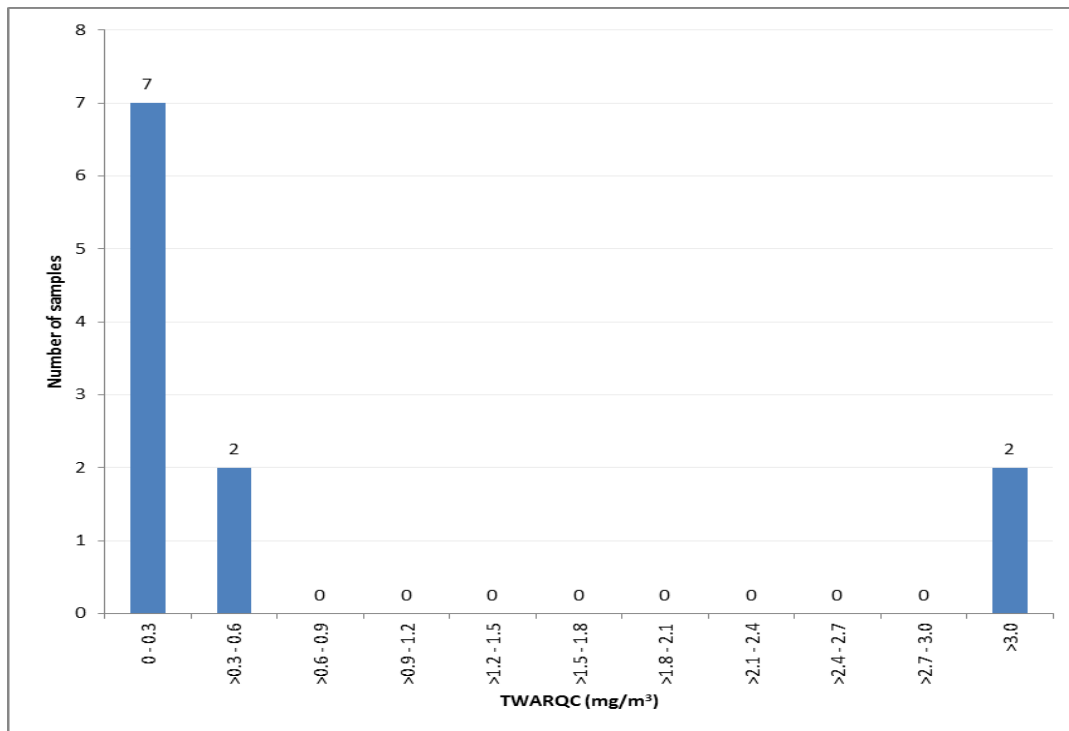
One out of eleven samples represents 9.1% of the sample group (i.e. $1/11 \times 100 = 9.1\%$). This is more than the allowable 5% and therefore the HEG cannot be seen as statistically correctly defined.

STEP 4

Action to be performed:

Draw a histogram to graphically indicate the data.

Expected result:



Interpretation:

From the Histogram it is also clear that the HEG is NOT statistically correctly defined (no bell curve). Only 2 things can be done to correct this situation:

- *Obtain more samples to determine the correct distribution of samples within the HEG.* This is currently being forced by the legislated sampling strategy as the "mean" value reported for dose allocations, (for an OEL of 3 in this example) falls within a "B Category" (5% sampled over 6 months) but the 90th percentile value is reported as an "A Category" thus forcing more samples to be taken (5% over 3 months).
- *Conduct an investigation to determine if more than one HEG is being represented by the data.*

STEP 5

Action to be performed:

Conduct an investigation to determine if more than one HEG is being represented by the data. This can be done by investigation and following the methodology as explained up to this point (for example):

After investigation the HEG was divided into 2 separate groups (Day Shift HEG & Afternoon Shift Group),

The data collected was then allocated to the 2 groups and the statistical analysis revealed the following:

Data allocated to the Day Shift Group
0.126
0.185
0.379
0.239
0.178
0.315
0.144
0.186
0.201

DESCRIPTIVE STATISTICS	
Mean	0.217
Standard Error	0.027
Median	0.186
Mode	#N/A
Standard Deviation	0.082
Sample Variance	0.007
Kurtosis	0.674
Skewness	1.150
Range	0.253
Minimum	0.126
Maximum	0.379
Sum	1.953
Count	9
Confidence Level(95.0%)	0.063

CALCULATIONS		
2 X SD	=	0.1639
Mean - 2SD	=	0.0531
Mean + 2SD	=	0.3809
90th Percentile	=	0.3298

Interpretation:

From above it can already be estimated that this Group is statistically correctly defined, as the Mean value (0.217) falls within the "C Category" and the 90th Perch value (0.3298) also falls within the "C Category".

DOES 95% OF THE SAMPLES FALL WITHIN 2 STANDARD DEVIATIONS (SD) FROM THE MEAN?

- A) 95% of the samples must be between Mean - 2SD (0.0531) and Mean + 2SD (0.3809)
- B) From the reported data: 0 sample < Mean - 2SD and 0 samples > Mean + 2SD
- C) 0/6 = 0%

This is within the allowable 5% and therefore the HEG is statistically correctly defined.

Data allocated to the Afternoon Shift Group	DESCRIPTIVE STATISTICS	
11.300	Mean	10.801
10.302	Standard Error	0.499
	Median	10.801
	Mode	#N/A
	Standard Deviation	0.7057
	Sample Variance	0.4980
	Kurtosis	#DIV/0!
	Skewness	#DIV/0!
	Range	0.998
	Minimum	10.302
	Maximum	11.300
	Sum	21.602
	Count	2
	Confidence Level(95.0%)	6.341

CALCULATIONS

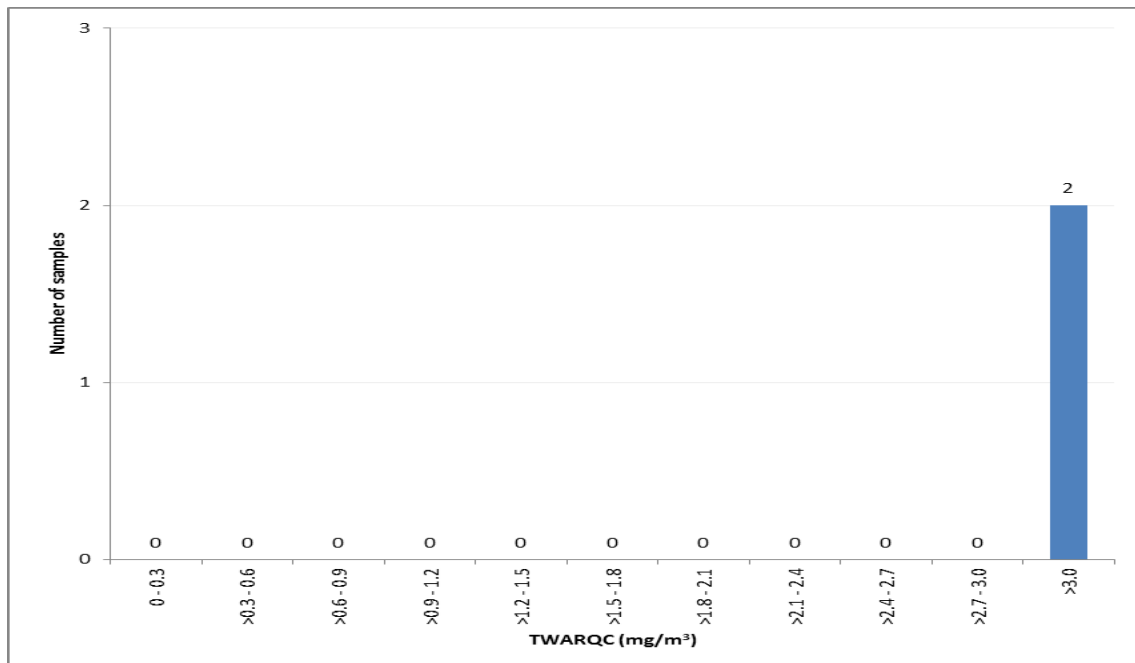
2 X SD	=	1.411
Mean - 2SD	=	9.389
Mean + 2SD	=	12.212
90th Percentage	=	11.2002

Interpretation:

From the above it seems that if it can be estimated that this HEG is statistically correctly defined, as the mean value (10.801) falls within the "A Category" and the 90th percentile value (11.2002) also falls within the "A Category".

DOES 95% OF THE SAMPLES FALL WITHIN 2 STANDARD DEVIATIONS (SD) FROM THE MEAN?

- A) 95% of the samples must be between Mean - 2SD (9.389) and Mean + 2SD (12.212)
- B) From the reported data: 0 sample < Mean - 2SD and 0 samples > Mean + 2SD
- C) 0/2 = 0%. This is within the allowable 5% and therefore the HEG could be assumed to be statistically correctly defined.



However;

The number of available data points (sample results) is inadequate to conduct any meaningful analysis of the data. Additional sampling (minimum 5 successful samples) must

be conducted and the data must then be re-subjected to the statistical test, before any meaningful conclusion can be reached.

Overall Interpretation:

The current HEG consist of 2 Groups, i.e.:

- Group 1 being the Day Shift Group. The results from the statistical analysis confirmed that this group can be defined as a new and separate HEG; and
- Group 2 being the Afternoon Shift Group. The statistical analysis indicated those inadequate samples are available to confirm that this group forms a new and separate HEG. Additional sampling (minimum of 5 samples) is required before this statistical suspicion can be confirmed.