CHAMBER OF MINES
of South Africa

GUIDANCE NOTE FOR NOISE MEASUREMENT OF EQUIPMENT TO ENSURE COMPLIANCE WITH MHSC MILESTONES

FACT SHEET 2016

BACKGROUND

The Mine Health and Safety Council (MHSC) has established the following milestones for limiting occupational noise exposure and eliminating noise induced hearing loss (NIHL):

QUIETENING OF EQUIPMENT

"By December 2024, the total operational or process noise emitted by any equipment must not exceed a milestone sound pressure level of 107 dB(A)."

This milestone of the sound pressure levels will be verified by initiatives under the Centre of Excellence (CoE) and MOSH, and reviewed in 2016."

FOR INDIVIDUALS

"By December 2016, no employee's Standard Threshold Shift (STS) will exceed 25 dB(A) from the baseline when averaged at 2000, 3000 and 4000 Hz in one or both ears."

PURPOSE

To manage the noise hazard effectively, industry focus must be on a strategy to eliminate and control noise at source by implementing an accepted, practical and effective industry-wide "buy and maintain quiet" initiative. This initiative is the outcome of a standing decision taken by mining companies to procure equipment/machinery and maintain existing equipment that conforms to specific noise emission requirements. This document serves as an industry guideline for the implementation of the 2014 noise milestones. It also details the required noise measurement procedure to ensure the employment of uniform measurement procedures under realistic operating conditions.

The guideline has been developed for use by persons who have been found competent to conduct noise measurements by virtue of their knowledge, training and experience.

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NOISE MEASUREMENT FOR INDIVIDUAL PIECES OF EQUIPMENT AND MACHINERY

MEASUREMENT CRITERIA

Noise levels should be measured directly with an integrating sound level meter (ISLM) that meets at least the accuracy requirements for a Class-2 instrument (given in IEC 61672-1 and SANS 61672-1), and is fitted with a windshield specified by the ISLM manufacturer. The following measurement criteria should be applied:

- Criterion level/exposure limit: 85 dB(A)
- Threshold level/low threshold limit: 80 dB(A)
- Energy exchange or doubling rate: 3 dB(A)

The instrument supplier normally sets these measurement criteria prior to delivery, but this should be confirmed before use. For instruments with a facility to alter measurement criteria via onboard software or firmware, the above criteria should be confirmed or corrected using the instrument's set-up mode.

INSTRUMENT SETTINGS

The following instrument settings should be used for $L_{Aeq,\ T}$ measurements:

- A-weighting: **on**
- Time weighting: **"fast" or "impulse"** if the noise is impulsive and the SLM has impulse-integrating capability. If the noise is impulsive but the SLM does not provide for impulse-integration, increase the measured $L_{Aeq,\ T}$ by 5 dB(A) for moderately impulsive noise (e.g. pneumatic rock drill) or 12 dB(A) for highly impulsive noise (e.g. compressed air-driven charging-up of blast holes or hammer blows in an artisan workshop)
- Sound incidence: where applicable, **"frontal"** if the microphone is facing a noise source, or **"random"** if the noise is non-directional/ multi-directional
- Frequency filter: **out** (off)
- Operating mode: **integrate or L_{Aeq}**

GENERAL PROCEDURES

The following general procedures must be followed for $L_{Aeq,\ T}$ measurements:

- Confirm the SLM's acoustic sensitivity with a sound calibrator immediately before and after each series of measurements, usually before commencing a shift and immediately after completion of the shift. This should be done using Class 2 calibrator (minimum) as defined in SANS 60942/SABS-IEC 60942. If the two calibration checks do not coincide to within 1 dB(A) [SANS 10083:2013], results of the intervening measurements must be discarded and the measurements repeated.
- For the purpose of measuring individual pieces of equipment and machinery, measurements should be taken 1m away from the specific noise source.

MEASUREMENT PROCEDURES

Measure $L_{Aeq,\ T}$ for a representative time at a selected microphone position:

- For steady noise, a measurement time of 1 minute is adequate.
- Where the noise varies or is cyclical, the measurement time should be sufficient to capture variations in level and include a reasonable number of work task cycles, to ensure representative results. This $L_{Aeq,\ T}$ measurement for the variation or cyclical noise level will then be recorded as the representative noise level for the individual piece of equipment or machine.

NEW (TYPE/DESIGN) EQUIPMENT REQUIREMENTS

Noise measurements must comply with ISO 3744/SANS3744:2012. As a rule of thumb, the impact of the noise emitted from a new type or design of equipment underground can be estimated by doubling the noise level measured on surface. This is achieved by adding 3dB(A) to the noise level displayed on the manufacturer's certificate to allow for sound reflected from solid boundaries (reverberation).

REPORTING AND RECORDING RESULTS OF NOISE MEASUREMENTS

Data collection

- For equipment noise emissions above 100 dB(A), the data collection will be based on sampling a minimum of 5% (or a minimum of 5 if there is less than 100 pieces of that particular equipment type) of that equipment type total population over a 12-month period (samples should be representative of the various activities)

- The **logarithmic average** must be calculated for reporting purposes per quarter.

The following formula can be used to calculate the logarithmic average (L_{Aeq}):

$$L_{Aeq} = 10 \log \left(anti \log \frac{L1}{10} + anti \log \frac{L2}{10} + anti \log \frac{L3}{10} + anti \log \frac{L4}{10} + \ldots \right)$$

Where: L = the noise levels measured (L_{Aeq}) in dB(A) for equipment.

EXAMPLE: (MINIMUM OF 5% OR A MINIMUM OF 5 OVER A 12-MONTH PERIOD)

Rock drill 1 = L1 = 105.0 dB(A)
Rock drill 2 = L2 = 103.8 dB(A)
Rock drill 3 = L3 = 108.2 dB(A)
Rock drill 4 = L4 = 104.6 dB(A)

$$L_{Aeq} = 10 \log \left(\frac{anti\log \frac{105.0}{10} + anti\log \frac{103.8}{10} + anti\log \frac{108.2}{10} + anti\log \frac{104.6}{10}}{n} \right)$$

L_{Aeq} = 105.8 dB(A) n = number of total samples

CALCULATION OF THE LOGARITHMIC AVERAGE

For quarter 1 the logarithmic average for the quarter is calculated using readings 1, 2, 3 and 4 as indicated below. The same applies to calculate the log average for the quarter going forward.

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Log Average	105.8	105.4	103.9	106.0
Log Average for quarter		105.6	104.8	105.3
Reading (1)	105.0	104.1	105.7	105.0
Reading (2)	103.8	105.6	99.9	103.8
Reading (3)	108.2	106.9	104.2	108.2
Reading (4)	104.6	104.2	–	104.6
Reading (5)	–	–	–	106.9

CALCULATION OF THE ROLLING LOGARITHMIC AVERAGE

To calculate the logarithmic rolling average for quarter 2, readings 1, 2, 3 and 4 of quarter 1 as well as readings 1, 2, 3 and 4 of quarter 2 are used as indicated below. The same applies for the next quarters.

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Log Average	105.8	105.4	103.9	106.0
Log Average for quarter		105.6	104.8	105.3
Reading (1)	105.0	104.1	105.7	105.0
Reading (2)	103.8	105.6	99.9	103.8
Reading (3)	108.2	106.9	104.2	108.2
Reading (4)	104.6	104.2	–	104.6
Reading (5)	–	–	–	106.9

For equipment between 85 dB(A) and 100 dB(A) data collection will be based on the noise risk register as follows:

- Identify the equipment to be measured
- Determine background area for the measurement
- Identify the equipment that can be switched-off safely
- Switch-off the identified equipment
- Record the background noise
- List the equipment that could not be switched off during the recording of the background noise
- Record equipment noise ***(Refer to the example in Appendix 1)***

DATA REPORTING

- Noise data will be reported using rolling log averages on a quarterly basis
- Total number of pieces of equipment type must be reported quarterly

Results should be recorded and documented so as to ensure uniform workplace operating conditions, measurement procedures and microphone positions, thereby allowing meaningful comparisons with future results. The following information must be recorded:

- **Instrument type, serial number (including microphone), calibration date, etc.**
- **Working place, environmental and equipment information such as:**

- Mining company
- Mine/shaft/operation
- Commodity
- Type of mining
- Workplace (use SAMOHP Code e.g. stoping, development, etc.)
- Excavation area (m^2)
- Type of excavation
- Equipment being measured – name and description
- Model/type
- Serial/equipment number
- Equipment category
- Power source (pneumatic/electric/ electro hydraulic/hydro power)
- Manufacturer/supplier
- Activities/processes measured
  - Activities – equipment that runs continuously e.g. pump, compressor, etc.
  - Process – cyclical operations e.g. rock drill collaring, drilling and extracting, etc.
- Silenced/not silenced
- Number of pieces of equipment per shaft
- Noise level (dBA) – (log average to be recorded
- Noise level (dBA) – all scenarios (maximum to be recorded)
- Type of ventilation
- Air velocity
- List background noise levels and the sources that constitute the background noise
- Compressed air pressure for pneumatic-driven equipment
- Date of report

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REFERENCES

IEC 61672-1 – Sound level meters – Part 1: Specifications

SANS 61672-1 – Electro-acoustics – Sound level meters Part 1: Specifications

SANS 60942 – Electro-acoustics – Sound calibrators

IEC 60942 – Electro-acoustics – Sound calibrators

SANS 10083:2013 – The measurement and assessment of occupational noise for hearing conservation purposes

ISO 3744 – Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane

SANS3744:2012 – Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane

Mine Ventilation Society of South Africa, learning material for the Certificate in Mine Environmental Control, workbook 5

APPENDICES

Appendix 1 – Example of equipment noise measurement process