MINING INDUSTRY
OCCUPATIONAL
SAFETY & HEALTH

MINERALS COUNCIL
SOUTH AFRICA

GUIDANCE NOTE

FOR NOISE MEASUREMENT OF EQUIPMENT TO ENSURE CONFORMANCE WITH MHSC MILESTONES

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):

2024 NOISE MILESTONES

By December 2034, the noise emitted by individual pieces of equipment operated by employees and individual process equipment should not exceed a milestone sound pressure level of 104 dB(A). Using current diagnostic methods, by December 2034, there should be no novel cases of noise-induced hearing loss amongst previously unexposed individuals. ("Previously unexposed individuals" are those unexposed to occupational noise prior to December 2024 i.e., Equivalent to a new person who entered the industry in January 2025).

This milestone of the sound pressure levels will be verified by initiatives under the Centre of Excellence (CoE) and MOSH, and reviewed in 2034.

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 as endorsed by MOHAC and the GEE's. This document serves as an industry guideline for the measurement, recording and monitoring of the 2024 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 individuals who have been deemed competent to conduct noise measurements by virtue of their knowledge, training, and experience, such competence should be supported by appropriate verification processes; e.g. PTOs to ensure the quality assurance and integrity of reported noise measurement results.

This Guidance Note should be read in conjunction with other relevant resources.

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:

- **Occupational exposure limit:** 85 dB(A)
- **Threshold level/low threshold limit:** None/Off
- **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 (e.g. pneumatic rock drill or 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}

MEASUREMENT PROCEDURE

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 a Class 2 calibrator (minimum) as defined in SANS 60942/SABS-IEC 60942. Prior to and following each measurement series, the instrumentation shall be verified using an acoustic calibrator. {SANS 10083} The deviation between the pre- and post-measurement calibration levels shall not exceed 1 dB. Where the deviation exceeds this value, the measurements shall be discarded and repeated.
- For the purpose of measuring individual pieces of equipment and machinery, noise measurements should be taken 1m away from the specific noise source, as stipulated in SANS 10083. Where it is not safe or practical to proceed, operational safe distances as established through risk assessment should be outlined in the company's Standard Operating Procedures (SOP); and those should be applied and documented. These positions should be established at the closest safe distance to the source considering reverberation and employee safety.
- Three to four noise measurement readings should be taken around the noise source/equipment where practical, after which the logarithmic average of those readings should be calculated to obtain the average noise level for the individual equipment.
- When the noise level of an individual piece of equipment needs to be measured, the environment in which the measurement will take place must be assessed to determine which other equipment is operating in the vicinity. This is necessary as such background noise will influence the noise measurement results of the piece of equipment to be measured. To obtain the most accurate noise measurement result, it is important to isolate any other operating equipment as far as practicable. Only equipment which can be safely isolated and which will not influence the health and safety of employees should be isolated. The type of equipment which could not be isolated must be recorded and included in the noise measurement report.

REVERBERATION

- Noise measurements shall, as far as practicable, be conducted under conditions that minimise the influence of reflected sound. Where measurements are undertaken in enclosed or confined environments, the potential impact of reverberation shall be considered. Measurement positions shall be determined in accordance with the relevant risk assessment, and any

limitations or deviations from free-field conditions shall be documented in the measurement report.

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. [SANS 10083 refers 3 cycles if practical]

NEW (TYPE/DESIGN) EQUIPMENT CONSIDERATIONS

Noise measurements must comply with ISO 3744/SANS 3744. 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 sound pressure level measured in a free-field. 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

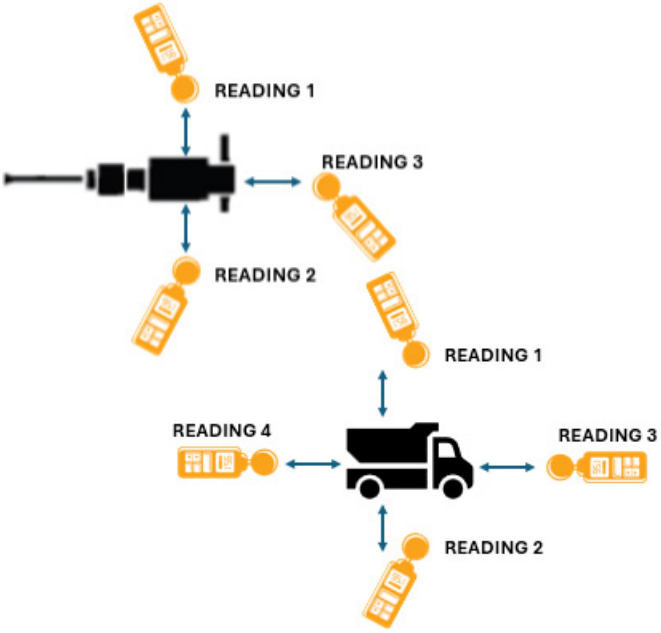
Data collection of the noise sources will be based on sampling a minimum of 5% (or a minimum of 5 if there is less than 100 pieces of that particular equipment type) of that equipment type total population over a 12-month period (samples should be representative of the various activities and processes) as recorded in the Operational Noise Register. (Refer to Annexure E in the MCOP for Noise for a Noise Register template).

(Refer to the example in Appendix 2)

Data collection will be based on the operational 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 as per Measurement Procedure above
- Report Annual rolling logarithmic average quarter on quarter

NOISE MEASUREMENT POSITION(S) EXAMPLES



(Refer to the example in Appendix 1)

DATA REPORTING

- Noise data will be reported as raw values (integrated noise measurements) into the Milestone Reporting System.
- The Milestone Reporting System will calculate the logarithmic average for the equipment type.
- Total number of pieces of equipment type must be reported quarterly.

(Refer to the example in Appendix 2)

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
- Measurement location
- Measurement duration/ period

- 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 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

The Minerals Council developed an electronic Occupational Health Information Management System (OHIMS), which incorporates the quarterly Occupational Hygiene Milestone reporting. The system makes provision for the reporting of equipment noise and is capable of producing an Equipment Noise Register, in conformance with the requirements outlined within the Guideline for a Mandatory Code of Practice for an Occupational Health Programme (Occupational Hygiene and Medical Surveillance) for Noise. Once a Mine/Operation is registered and correctly configured on the Minerals Council OHIMS, the user will log into the system and select the Occupational Hygiene Milestone Reporting and capture raw data accordingly.

MANAGING NOISE EQUIPMENT MEASUREMENT PROCESS

In mining, a machine's noise profile changes over time because of wear and tear and when mufflers degrade. There is a gap between detecting an increase in noise and the maintenance interventions required. To ensure closing the gap and for effective management purposes across the industry, pieces of equipment need to be measured immediately after maintenance is done. This reference to pieces of equipment where regular maintenance is conducted e.g. rock drills. Muffling old technology should be replaced by a demand to Original Equipment Manufacturers (OEM) to design equipment where the human interface is isolated by design and not by retrofitting. Data collected needs to be used for driving the hierarchy of control. A 105dB(A) personal exposure over 8 hours should trigger an engineering re-design.

To account for factors influencing temporal variations in equipment noise emissions, a representative sample of machinery should undergo post-maintenance noise measurements. These measurements should be conducted within a timeframe defined by the Ventilation Engineers or Occupational Hygienist to verify the effectiveness of the maintenance interventions and confirm sustained noise control performance.

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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 – 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

SANS 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

ISO 11200:2014 – Acoustics – Noise emitted by machinery and equipment – Guidelines for the use of basic standards for the determination of emission sound pressure levels at a work station and at other specified positions

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 on page 5

Appendix 2 – Equipment noise reporting guide on page 6

Appendix 3 – Manual calculation of the logarithmic average

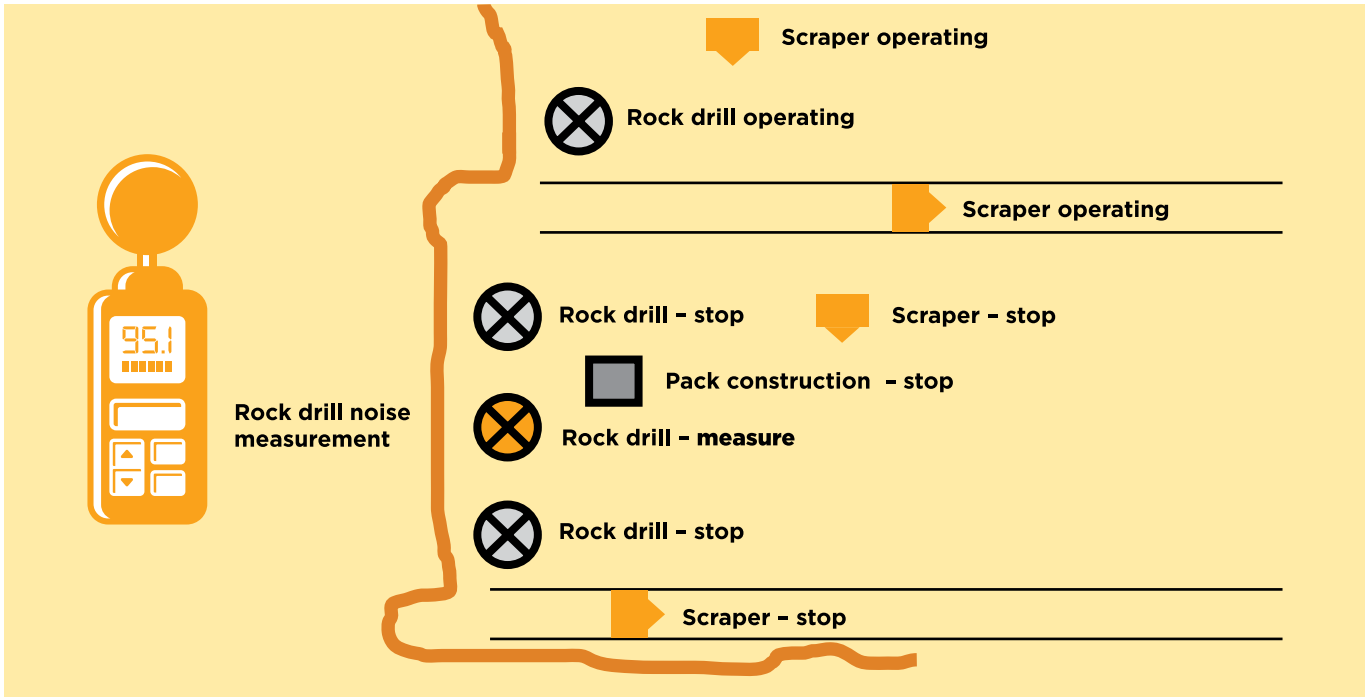
APPENDIX 1

EXAMPLE OF EQUIPMENT NOISE MEASUREMENT PROCESS

When the noise level of an individual piece of equipment needs to be measured, the environment in which the measurement will take place must be assessed to determine which other equipment is operating in the vicinity. This is necessary as such background noise will have an effect on the noise measurement results of the piece of equipment to be measured. In order to obtain the most accurate noise measurement result, it is important to isolate any other operating equipment as far as practicable. Only equipment which can be safely isolated and which will not have an effect on the health and safety of employees should be isolated. The type of equipment which could not be isolated must be recorded and included in the noise measurement report.

BELOW ARE THE STEPS TO FOLLOW PRIOR TO PERFORMING NOISE MEASUREMENT ON AN IDENTIFIED PIECE OF EQUIPMENT:

1	Identify the equipment to be measured
2	Determine the background noise level present in the area to be measured. (Define the distance away from the equipment to be measured e.g. 6m away)
3	Which equipment or activities can be safely stopped or switched off?
4	Isolate the equipment and activities identified in step 3 above, where required
5	Conduct background noise measurements
6	Record the background noise level present, together with the relevant information on the equipment and/or activities which could not be isolated
7	Conduct noise measurements according to steps 3 and 4 above. Measurement of any cyclic equipment must take place from the initial start to the end of such cycle. i.e. a rock drill will be measured from starting the machine, collaring, drilling and withdrawing the machine
8	Once the noise measurement process for the equipment being evaluated is complete, all other equipment and/or activities which constituted the background noise within the area could be restarted and the entire process should be repeated for every other piece of equipment to be evaluated
9	Record all the other relevant information, as specified in the Data reporting section of the guidance note for noise measurement of equipment to ensure compliance with MHSC milestones. (The report should also indicate the microphone positions in relation to the equipment and surroundings evaluated, for future reference)



APPENDIX 2

EQUIPMENT NOISE REPORTING GUIDE

BACKGROUND

The Minerals Council South Africa has published a "Guidance Note on the Noise Measurement of Equipment to Ensure Compliance with MHSC Milestones".

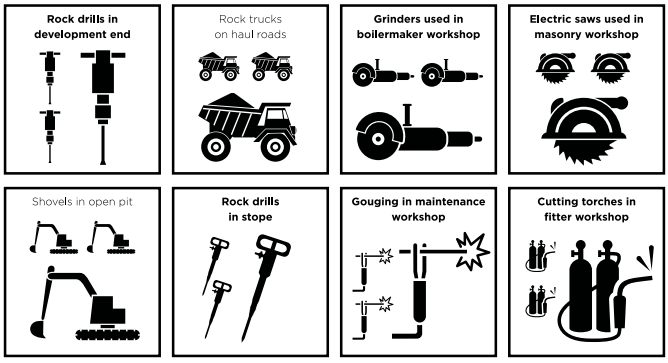
The purpose of this guidance note was to serve as an industry guideline for the implementation of the MHSC noise milestones, and also detail the required noise measurement procedures to ensure the employment of uniform measurement procedures under realistic operating conditions. This would allow for the comparability of the noise measurement data of various mines, as part of the South African mining industry's journey towards compliance to the MHSC noise milestones.

PURPOSE

The purpose of this step-by-step guide is to assist mining companies in grouping (also referred to as equipment populations) of equipment for noise measurement, as well as recording and reporting of individual pieces of equipment. It is envisaged that the implementation of this step-by-step equipment noise reporting guide would allow for comparable equipment noise reporting by mining companies.

STEP-BY-STEP EQUIPMENT NOISE REPORTING GUIDE

STEP 1:
Group equipment according to the equipment type/ model into populations based on the South African Mines Occupational Hygiene Programme (SAMOHP) activity area (e.g. S215 rock drills used in stoping activity area as a population).



STEP 2:
Conduct noise measurements on 5% of the equipment population, as per activity area (e.g. 5 samples with - 15 readings taken for the 5 pieces of equipment (min of 3 readings per source) for an equipment population of 100 S215 rock drills per activity area).
Note: Equipment noise measurements to be conducted in accordance with the "Guidance Note on the Noise Measurement of Equipment to Ensure Compliance with MHSC Milestones"

STEP 3:
Record the raw integrated noise measurement into the Milestone Reporting System. The software will calculate the logarithmic average noise level for the equipment population, making use of the noise measurement results obtained in Step 2.
(Refer to Supporting documentation if Manual Calculations will be conducted)

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

STEP 4:
Noise Milestone tracking and monitoring will be based on the system calculated logarithmic average noise results as calculated by the software in the Milestone Reporting System.

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	105.2	105.4
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**

A: This logarithmic average result of the noise measurements for the entire population of equipment measured will be used for the reporting of noise milestone tracking.

B: This individual piece of equipment within the equipment population should be investigated (Step 5) and not reported as an individual piece of equipment exceeding 104dB.

Note: Should the logarithmic average noise result for the equipment population be greater or equal to 104dB(A), then the entire S215 rock drill population used in the stoping activity area is reported as equipment greater or equal to 104dB(A)

STEP 5:
Investigate any individual noise measurement recorded for the sampled equipment population which was equal to or above the milestone sound pressure limit of 104 dB(A).
Note: The workplace information specified in the "Data reporting" section of the "Guidance Note on the Noise Measurement of Equipment to Ensure Compliance with MHSC Milestones" should inform the investigation process

APPENDIX 3

MANUAL CALCULATION OF THE LOGARITHMIC AVERAGE

The Minerals Council developed an electronic Occupational Health information Management System (OHIMS), which incorporates the quarterly Occupational Hygiene Milestone reporting.

The system makes provision for the reporting of equipment noise and it is recommended that operations report raw data into the system.

If the above mentioned system is not used, the manual calculation of the logarithmic average is indicated in Annexure 3.

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

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

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

Where: L = the noise levels measured L_{Aeq} in dB(A) for equipment
n = number of total samples

CALCULATION OF THE LOGARITHMIC AVERAGE

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Log average	105.8	105.4	103.9	106.0
Log average for quarter		105.6	105.2	105.4
Reading (1)	**105.0**	**104.1**	**105.7**	**105.0**
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Reading (4)	**104.6**	**104.2**	**-**	**104.6**
Reading (5)	**-**	**-**	**-**	**106.9**

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.

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.

These logarithmic rolling averages could then be reported. Quarter 3 would use readings 1,2,3,4 (quarter 1); readings 1,2,3,and 4 (quarter 2) and readings 1,2,3 (quarter 3). The same applies for the next quarters.

An electronic Occupational Health information Management System (OHIMS) was developed by the Minerals Council. The system makes provision for the reporting of equipment noise and is capable of producing an Equipment Noise Register, in conformance with the requirements outlined within the Guideline for a Mandatory Code of Practice for an Occupational Health Programme (Occupational Hygiene and Medical Surveillance) for Noise. Once a Mine/Operation is registered and correctly configured on the Minerals Council OHIMS, the user will log into the system and select the Occupational Hygiene Milestone Reporting and capture data accordingly.

**For more information refer to the MOSH Noise Webpage Supporting Documents on how to capture data.*

APPENDIX 3

MANUAL CALCULATION OF THE LOGARITHMIC AVERAGE

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

EXAMPLE ON QUARTER 1 DATA

Measurement Reading 1 = L1 = 105.0 dB(A)
Measurement Reading 2 = L2 = 103 8 dB(A)
Measurement Reading 3 = L3 = 108.2 dB(A)
Measurement Reading 4 = L4 = 104.6 dB(A)

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

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

For support on OHIMS please contact the HealthSource. **precious.malaza@thehealthsource.org** +27 (0) 13 004 0062