MINERALS COUNCIL
SOUTH AFRICA

28 August 2017

MOSH NOISE TEAM: CRITICAL NOISE EQUIPMENT SCREENING TOOL USER GUIDE CIRCULAR NO. 20/17

Synopsis: *This purpose of this document is to provide the South African Mining Industry with guidance on the appropriate use and application of the Critical Noise Equipment Screening Tool, in order for the results of the Critical Noise Equipment Screening Tool to be representative and comparable between Mining operations within the same Commodity.*

Introduction

The *industry wide buy and maintain quiet initiative (IBMQI)* was developed from a standing decision supported by mining companies, to procure equipment (machinery) and maintain existing equipment in a responsible manner. As part of the *industry wide buy and maintain quiet initiative,* the Procurement subcommittee developed a set of criteria for the identification, measurement, review and selection of equipment which are in use at Mines, in order to facilitate compliance with specific noise emission requirements.

The Mine Health and Safety Act require Mines to assess the noise levels to which employees are exposed to within the working areas. These noise measurements could be considered the most important and key measure for the identification of critical machines for noise management purposes.

The IBMQI Measurement and Standards Subcommittee also concluded that the noise measurement methodology plays a pivotal role in the quantification of the noise emissions of equipment and subsequently developed a guidance note for the measurement of equipment to ensure compliance with the MHSC Milestones, with the main aim of ensuring the employment of uniform measurement procedures under realistic operating conditions.

T +27 11 498 7100 E info@mineralscouncil.org.za W www.mineralscouncil.org.za
5 Hollard Street, Johannesburg, 2001, PO Box 61809, Marshalltown 2107

The IBMQI Committee further recognized that although the noise level emission of equipment is considered to be a significant parameter in the quantification of noise risk, several other important factors also contribute to the quantification of the noise risk of equipment.

In order for the successful facilitation of the noise management criteria set, the “Critical Noise Equipment Screening Tool” was developed within the *IBMQI*. This Tool incorporates the key factors identified within the IBMQI, which influences the noise exposure risk of employees to noisy equipment, which includes the following:

- Noise Measurement Result in dBA
- Number of Persons Exposed
- Number of Machines within the Work Environment
- The Duration of Exposure
- The Acoustical Environment / Confined Work Space
- Machine Vibration
- Equipment Maintenance
- Equipment Improvements and Solutions
- Hearing Protection Devices
- Critical Noise Frequency Range

As a primary output, the Tool assists mines in the identification and selection of the most appropriate machines for use and provides guidance on the following of a process which enables the management of repair and maintenance tasks flowing from the use of equipment and plant. The Tool further possesses the capabilities for the application towards the screening of existing equipment, as well as toward the screening of new technology and/or new equipment to be procured.

This document explains the appropriate use of the Critical Noise Equipment Screening Tool as part of the identification and prioritization of critical machines in terms of noise generation and exposure to individuals.

MINERALS COUNCIL
SOUTH AFRICA

Critical Noise Equipment Screening Tool

Mining Company Name: ABC Mine	**Operation:**		#1	#1	#1	#1	#2	#2	#2	#2	#3
Commodity Group: OTHER			**Equipment Category Screened**								
Responsible Group Environmental Engineer: A.N. Other			Rockdrills	Winches	Pumps (Pneumatic)	Pumps (Electric)	Roof Bolters	Diamond Drills	Winches	Screens	Drill Rigs (Underground)
Team Members Involved in this Screening: Occupational Hygienist; SHE Manager; Engineer; Engineering Supervisor; Maintenance Planner			**Equipment Model Screened**								
	Rating Parameter Weighting %	**Individual Parameter Rating Score**	S215 Rock Drill Stoping	Winch 75kW Bafutec	Wilflo Pump Phneumatic DD50	SPX 111R35 Pump	S215 Rock Drill Stoping - Roof Bolting	Kempe S36 Diamond Drill Development	Winch 45kW Bafutec	Sandvik Tiprock Vibrators	Sandvik 8 Boom Jumbo
Noise Measurement Result in dBA	35		9	9	6	6	9	8	8	9	9
Noise ≥107dBA		10									
Noise ≥104 <107 dBA		9	X	X			X			X	X
Noise ≥101 <104 dBA		8						X	x		
Noise ≥98 <101 dBA		7									
Noise ≥95 <98 dBA		6			X	X					
Noise ≥92 <95dBA		5									
Noise ≥89 <92dBA		4									
Noise ≥85 <89dBA		3									
Noise ≥82.5 <85dBA		2									
Noise <82.5dBA		1									
No. of Persons	10		10	8	9	9	10	8	8	7	7
Exposed persons ≥10		10	X				X				
Exposed persons ≥5 but <10		9			X	X					
Exposed persons ≥2 but <5		8		X				X	X		
One Exposed person		7								X	X
No Exposed persons		0									
No. of Machines	9		10	7	7	7	10	7	7	7	7
Number of machines ≥100		10	X				X				
Number of machines ≥30 but <100		9									
Number of machines ≥10 but <30		8									
Number of machines ≥7 but <10		7		X	X	X		X	X	X	X
Number of machines ≥4 but <6		6									
Number of machines ≥2 but <4		4									
Number of machines = 1		2									

MINERALS COUNCIL
SOUTH AFRICA

Time of Exposure	9		8	8	2	1	8	10	8	2	8
Exposure ≥4Hours		10						X			
Exposure ≥2Hours but <4Hours		8	X	X			X		X		X
Exposure ≥1Hour but <2Hours		7									
Exposure ≥30Minutes but <1Hour		6									
Exposure ≥15Minutes but <30Minutes		4									
Exposure <10Minutes		2			X					X	
Exposure <1Minute		1				X					
Confined Work Space	8		10	8	8	8	10	8	8	8	8
Multiple sources in underground confined space		10	X				X				
Single source in confined space		8		X	X	X		X	X	X	X
Multiple sources inside plant building		6									
Single source inside plant building		4									
Source in open areas		2									
Source in open-pit		1									
Machine Vibration	7		8	4	0	0	8	0	4	2	0
Operator directly exposed to noticable machine vibration		10									
Operator directly exposed to some machine vibration		8	X				X				
Operator indirectly exposed to machine vibration		4		X					X		
Little noticable machine vibration		2								X	
No exposure to machine vibration		0			X	X		X			X
Maintenance	7		3	3	0	0	3	0	3	6	3
Noise levels increase significantly as condition deteriorates		10									
Noise levels increase noticeable as condition deteriorates		6								X	
Noise levels increase marginally as condition deteriorates		3	X	X			X		X		X
No noise variance due to condition		0			X	X		X			
Equipment Improvements & Solutions	6		4	10	10	10	4	4	10	10	4
No action taken / No modification done		10		X	X	X			X	X	
One modification done to improve noise level		7									
More than two modifications were done previously		4	X				X	X			X
Significant effort has been done to reduce noise		1									
Hearing Protection	5		4	4	4	4	4	4	4	4	4
Hearing protection ineffective		10									
Hearing protection reasonably effective		9									
Require special hearing protection devices		8									
Conventional hearing protection devices effective		4	X	X	X	X	X	X	X	X	X
No hearing protection required		0									
Critical Frequency Range	4		9	3	1	1	9	9	3	8	8
No frequency analysis of noise done		10									
Critical 4kHz frequency noise		9	X				X	X			
Critical 3kHz - 6kHz frequency noise		8								X	X
Critical 500Hz - 3kHz frequency noise		3		X					X		
Critical 8kHz frequency noise		1			X	X					
	100		**8,14**	**7,35**	**5,29**	**5,2**	**8,14**	**6,57**	**7**	**6,98**	**6,81**

2. PRIORITISATION OF CRITICAL MACHINERY

The Critical Noise Equipment Screening Tool is a user-friendly Microsoft Excel-based tool, which requires minimal manual input from users. Users would start off by capturing the Name of the Mine, the responsible Group Environmental Engineer, the names of the Multi-disciplinary team involved in the screening process and select the Commodity Group from a drop-down menu. This is followed by the capturing of the Operation name, the model and name of the equipment and the selection of the equipment category from a standardized drop-down menu.

Users are now in a position to screen the captured equipment, by selecting the "X" in the corresponding category cell for each parameter screened. The Critical Noise Equipment Screening Tool will allocate a risk ranking value to each piece of equipment screened, once all the parameters are adequately screened for each piece of equipment. The screening result would then allow the user to prioritize and rank the equipment screened for noise intervention activities, which could also be linked back to the existing noise repositories of companies.

3. SCREENING OF CRITICAL NOISE EQUIPMENT

3.1 Noise Levels Emitted by Equipment:

Based on the importance of the Noise Milestones set for equipment noise, the Critical Noise Equipment Screening Tool appropriately places significant emphasis on the noise emission of equipment, with a 35% risk weighting allocated to this risk parameter, based on the principle of a exposure to higher noise levels constituting in a larger contribution in the noise risk.

The noise emission categories incorporated into the tool includes the following categories:

- Noise ≥107dBA. This category attracts a 100% allocation of the 35% risk weighting.
- Noise ≥104dBA <107dBA. This category attracts a 90% allocation of the 35% risk weighting.

- Noise≥101dBA <104dBA. This category attracts an 80% allocation of the 35% risk weighting.
- Noise ≥98dBA <101dBA. This category attracts a 70% allocation of the 35% risk weighting.
- Noise ≥95dBA <98dBA. This category attracts a 60% allocation of the 35% risk weighting.
- Noise ≥92dBA <95dBA. This category attracts a 50% allocation of the 35% risk weighting.
- Noise ≥89dBA <92dBA. This category attracts a 40% allocation of the 35% risk weighting.
- Noise ≥85dBA <89dBA. This category attracts a 30% allocation of the 35% risk weighting.
- Noise ≥82.5dBA <85dBA. This category attracts a 20% allocation of the 35% risk weighting.
- Noise <82.5dBA. This category attracts a 10% allocation of the 35% risk weighting.

Users of the Critical Noise Equipment Screening Tool would select the appropriate category of the “Noise Measurement Result in dBA” parameter, based on the noise level assigned to the equipment population, in accordance with the measurement and reporting procedures defined within the guidance note for the measurement of equipment to ensure compliance with the MHSC Milestones.

3.2 Number of Persons Exposed

This risk parameter refers to the number of persons in close vicinity to where the machine is operated and might experience similar exposures, when compared to the machine operator. This risk parameter screened by the Critical Noise Equipment Screening Tool accounts for a 10% risk weighting allocation, based on the principle of a larger the number of persons exposed constituting in a larger contribution in the noise risk.

The categories for the number of persons exposed incorporated into the tool includes the following:

- Exposed persons ≥10.
- Exposed persons ≥5, but <10.
- Exposed persons ≥2, but <5.
- One exposed person
- No exposed persons

Users of the Critical Noise Equipment Screening Tool would select the appropriate category of the "Number of Persons Exposed" parameter, based on the categories mentioned above.

3.3 Number of Machines Installed in the Work Environment

When considering a development programme to reduce the noise level of machines, it is important to know the population of the machines in the organisation. More units will give a higher prioritisation to fast-track some research and development. The number of machine is also a multiplier of the number of persons ultimately exposed to noise. This risk parameter screened by the Critical Noise Equipment Screening Tool accounts for a 9% risk weighting allocation, based on the principle of a larger the number of machines in the working place constituting in a larger contribution in the noise risk.

The categories for the Number of Machines Installed in the Work Environment incorporated into the tool includes the following:

- Number of Machines ≥100.
- Number of Machines ≥30, but <100.
- Number of Machines ≥10, but <30.
- Number of Machines ≥7, but <10.
- Number of Machines ≥4, but <6.
- Number of Machines ≥2, but <4.
- Number of Machines = 1

Users of the Critical Noise Equipment Screening Tool would select the appropriate category of the "Number of Machines within the Work Environment" parameter, based on the categories mentioned above.

3.4 Duration of Exposure

The duration of the exposure refers to the effective time the operator or his colleagues were exposed to the noise risk factors. This risk parameter screened by the Critical Noise Equipment Screening Tool accounts for a 9% risk weighting allocation, based on the principle of a longer noise exposure duration constituting in a larger contribution in the noise risk.

The categories for the Duration of Exposure aspect incorporated into the tool includes the following:

- Exposure >4 hours.
- Exposure ≥2 hours, but <4 hours.
- Exposure ≥1 hour, but <2 hours.
- Exposure ≥30 minutes, but <1 hour.
- Exposure ≥15 minutes, but <30 minutes.
- Exposure ≥10 minutes, but <15 minutes.
- Exposure <10 minutes

Users of the Critical Noise Equipment Screening Tool would select the appropriate category of the “Duration of Exposure” parameter, based on the categories mentioned above.

3.5 Acoustical Environment / Confined Work Space

It is known from theory and practice that if more than one source is introduced in the same working area that the sound pressure levels would increase. It is also known that if machines producing noise emissions, the noise level recorded in the environment increases when used in the underground work environment, which is a confined work environment by nature. This risk parameter screened by the Critical Noise Equipment Screening Tool accounts for an 8% risk weighting allocation, based on the principle of a smaller /confined work space constituting in a larger contribution in the noise risk due to the reverberation characteristic of the environment.

The categories for the Acoustical Environment / Confined Work Space aspect incorporated into the tool includes the following:

- Multiple sources in underground confined work space.
- Single source in underground confined work space.
- Multiple sources inside plant building.
- Single source inside plant building.
- Source in open plant areas.
- Source in open-pit.
- Source in open (field) areas.

Users of the Critical Noise Equipment Screening Tool would select the appropriate category of the “Acoustical Environment / Confined Work Space” parameter, based on the categories mentioned above.

3.6 Machine Vibration

Machines that usually emit high noise levels, are also known for inherent vibrations. This is mainly due to the technology used, i.e. percussion technology or reciprocating engines. These vibrations may be harmful as they can resonate or cause unwanted harmonics, coming from noise emitting surfaces. This risk parameter screened by the Critical Noise Equipment Screening Tool accounts for a 7% risk weighting allocation, based on the principle of a noise emissions directly linked to the level of vibration emitted by the equipment, with larger amounts of vibration emissions constituting in a larger contribution in the noise risk.

The categories for the Machine Vibration aspect incorporated into the tool includes the following:

- Operator directly exposed to noticeable machine vibration.
- Operator directly exposed to some machine vibration.
- Operator indirectly exposed to machine vibration.
- Little noticeable machine vibration.
- No exposure to machine vibration.

Users of the Critical Noise Equipment Screening Tool would select the appropriate category of the “Machine Vibration” parameter, based on the categories mentioned above.

3.7 Equipment Maintenance

Most machines are subject to wear as they perform work. It is known that some machines, more than other, start to produce more noise emission as component clearances increase. This is caused by individual parts not being dampened due to excessive clearances and sub-critical lubrication occur. Components starts to rattle within assemblies, causing an increase in sound augmentation. This risk parameter screened by the Critical Noise Equipment Screening Tool accounts for a 7% risk weighting allocation, based on the principle of a noise emissions being directly linked to the deterioration of equipment, with significant increases in noise level due to equipment deterioration constituting in a larger contribution in the noise risk.

The categories for the Equipment Maintenance aspect incorporated into the tool includes the following:

- Noise levels increase significantly as condition deteriorates.
- Noise levels increase noticeably as condition deteriorates.
- Noise levels increase marginally as condition deteriorates.
- No noise variation due to condition.

Users of the Critical Noise Equipment Screening Tool would select the appropriate category of the “Equipment Maintenance” parameter, based on the categories mentioned above.

3.8 Equipment Improvement and Solutions

Over the years numerous developments have been undertaken to reduce emission levels. Some of these developments included the re-design of equipment as a result of technological advancements, but mostly smaller incremental modifications in terms of parts, clearances and the muffling of noise sources.

This risk parameter screened by the Critical Noise Equipment Screening Tool accounts for a 6% risk weighting allocation, based on the principle of no equipment improvement interventions constituting in a larger contribution in the noise risk.

The categories for the Equipment Improvement and Solutions aspect incorporated into the tool includes the following:

- No Action taken / No noise modification done.
- One modification done to improve noise level.
- Two or more modifications were done previously.
- Significant effort has been done to reduce noise (Equipment re-design).

Users of the Critical Noise Equipment Screening Tool would select the appropriate category of the “Equipment Improvement and Solutions” parameter, based on the categories mentioned above.

3.9 Hearing Protection Devices

In most cases it is very difficult to reduce the noise levels emitted by high energy machinery, due to the technology available. In these instances, hearing protection may be the only resolution relied upon to protect the employees from noise, where it is extremely important to ensure that employees are provided with hearing protection devices (PPE) which are able to reduce employee exposure to acceptable levels. This risk parameter screened by the Critical Noise Equipment Screening Tool accounts for a 5% risk weighting allocation, based on the principle of ineffective Hearing Protection Devices constituting in a larger contribution in the noise risk.

The categories for the Hearing Protection Devices aspect incorporated into the tool includes the following:

- Hearing protection ineffective.
- Hearing Protection reasonably effective.
- Require special hearing protection devices & issued to employees.
- Conventional hearing protection devices effective.
- No hearing protection required.

Users of the Critical Noise Equipment Screening Tool would select the appropriate category of the “Hearing Protection Devices” parameter, based on the categories mentioned above.

3.10 Critical Noise Frequency Range

Noise Induced Hearing Loss (NIHL) is a hearing disorder characterized by a gradual, progressive loss of high frequency hearing sensitivity over time, as a result of exposure to excessive noise levels. The typical progression of NIHL usually shows a “notch” that is most often seen at or near 4000 Hz in the screening audiogram. In later stages, the hearing loss may spread to frequencies that are more critical to understanding human speech *(in the range of 500-3000 Hz)*. It is therefore important to develop, design and muffle machines to avoid excessive noise in these band widths. This risk parameter screened by the Critical Noise Equipment Screening Tool accounts for a 4% risk weighting allocation, based on the principle of equipment emitting higher noise levels at the 4kHz frequency constituting in a larger contribution in the noise risk.

The categories for the Critical Noise Frequency Range aspect incorporated into the tool includes the following:

- No frequency analysis of noise emissions done.
- Critical 4kHz frequency noise.
- Critical 3khz to 6kHz frequency noise.
- Critical 500Hz to 3kHz frequency noise.
- Critical 8kHz frequency noise.

Users of the Critical Noise Equipment Screening Tool would select the appropriate category of the “Critical Noise Frequency Range” parameter, based on the categories mentioned above.

4. Critical Noise Screening Tool Outputs

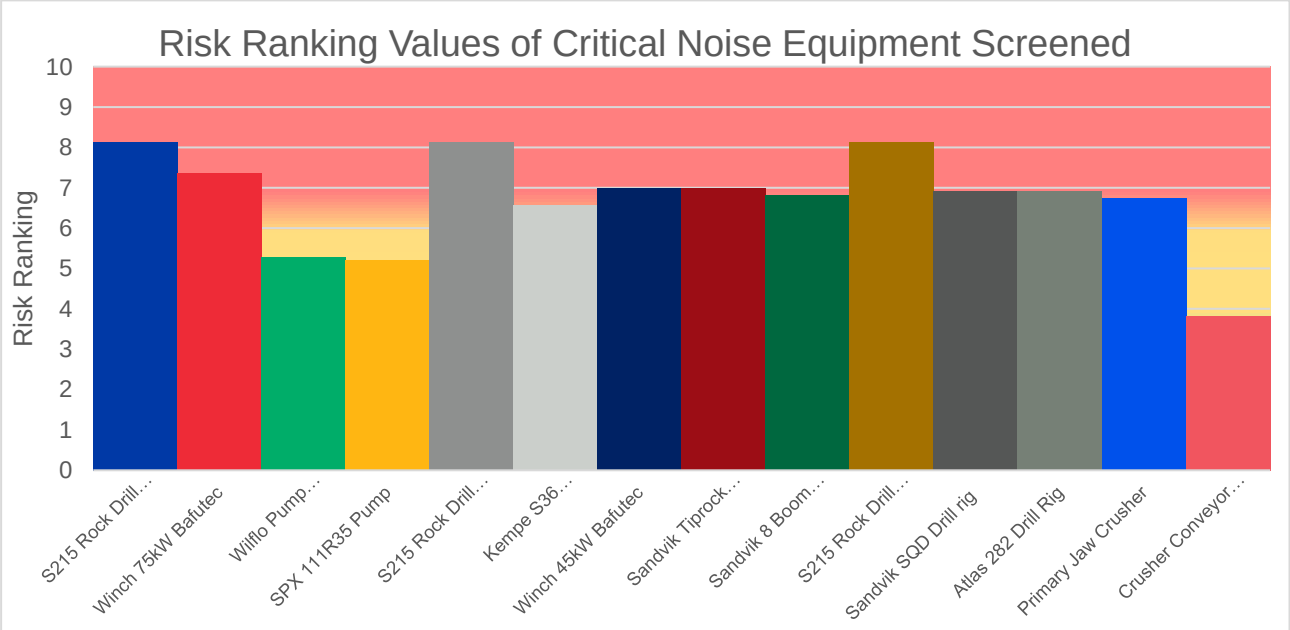
4.1 Risk ranking of Critical Noise Equipment

Once the user completed the screening of the 10 risk parameters mentioned in the previous section, for each piece of equipment, the Critical Equipment Noise Screening Tool would provide the user with an Equipment noise risk ranking for each individual piece of equipment screened. The Tool would also flag the level of risk for each individual piece of equipment screened, according to the defined noise risk categories. This output of the Tool would allow the user to easily identify pieces of equipment with a high risk allocation, facilitating the identification of equipment requiring intervention.

The noise risk categories are defined according to the following legend:

Risk Category	Risk Ranking Range
Low	>0, but <4.0
Moderate	>4.0, but <7.0
High	>7.0, up to 10.0

As an additional output, the Tool also produce a bar chart, which enable the user to compare the risk ranking of the various pieces of equipment screened by the tool, with an example displayed below.

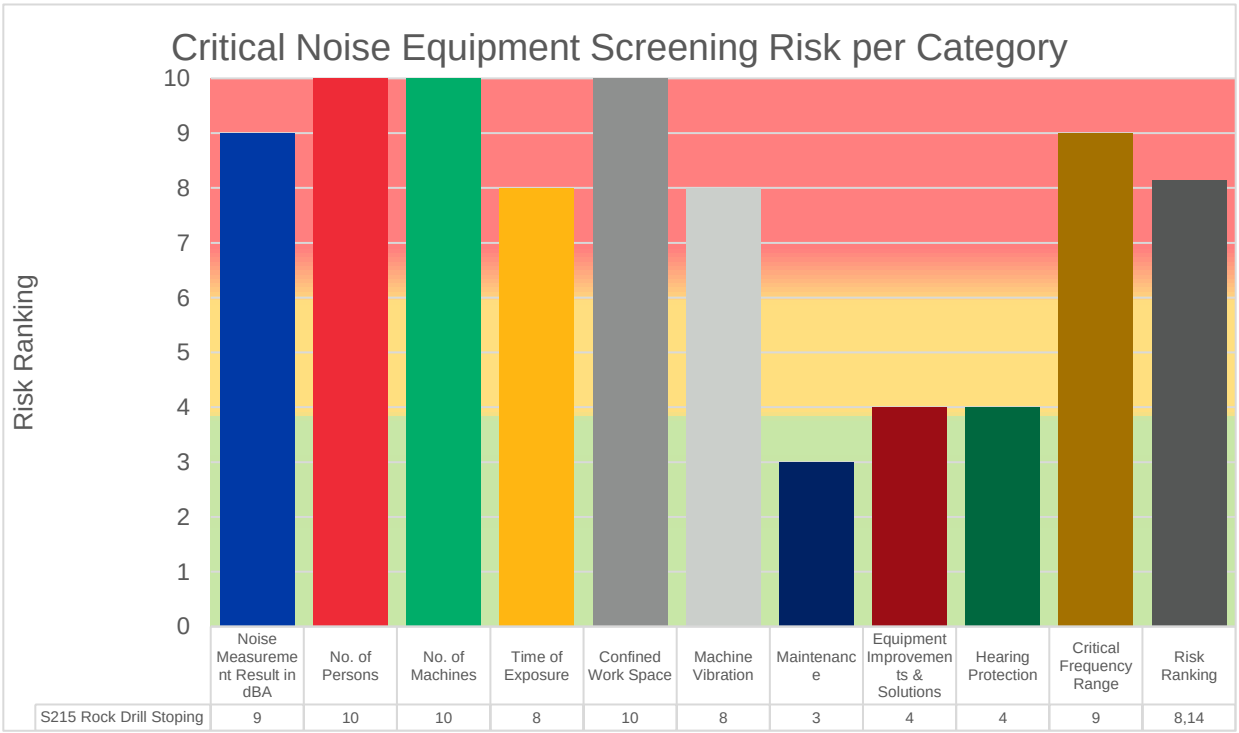


The assignment of a risk ranking to each equipment type would be a valuable contribution to the existing equipment noise repositories of Mining Companies and would complement the existing Equipment Noise Repositories with a structured approach towards the prioritisation of equipment for noise reduction interventions.

4.2 Identification of key Noise Risk Parameters for Reduction of Noise Risk

An additional output produced by the Critical Noise Equipment Screening Tool is a risk ranking for each individual risk parameter screened. This output enables the user to compare the risk ranking of the various risk parameters for each piece of equipment screened and allow for the identification of the high-risk parameters per individual piece of equipment. This output of the Critical Noise Equipment Screening Tool also makes these risk factors now visible to the user which could inform the engineer or procurement specialist to implement measures on the management of equipment supplied by Original Equipment Manufacturers.

An example of this output of the Critical Noise Equipment Screening Tool is depicted in the example displayed below.



	Noise Measurement Result in dBA	No. of Persons	No. of Machines	Time of Exposure	Confined Work Space	Machine Vibration	Maintenance	Equipment Improvements & Solutions	Hearing Protection	Critical Frequency Range	Risk Ranking
S215 Rock Drill Stoping	9	10	10	8	10	8	3	4	4	9	8,14

Conclusion

The Critical Noise Equipment screening process should highlight the key pieces of equipment, together with the key noise risk parameters per equipment, which would be of concern to each Mining Operation.

The Critical Noise Equipment screening would also inform the procurement Team, Engineer and Occupational Hygienist / Ventilation Engineer on the pieces of equipment to be included in an improvement programme on the reduction of the noise risk for machinery. The outputs of the Critical Noise Equipment Screening Tool could also facilitate the development of plans by various OEM's for the reduction of equipment noise risk, leading to each OEM, of critical equipment being in possession of a road map towards the staircase of product development and improvement on meeting noise emission targets for equipment utilized within the South African Mining Industry.