THEME 1: SETTING THE SCENE

Impala Platinum

Competition Act Considerations

Principal Adoption Specialist: Noise
Kagisho Motseme

21 September 2023, Emperor's Palace, Johannesburg

MINERALS COUNCIL
SOUTH AFRICA
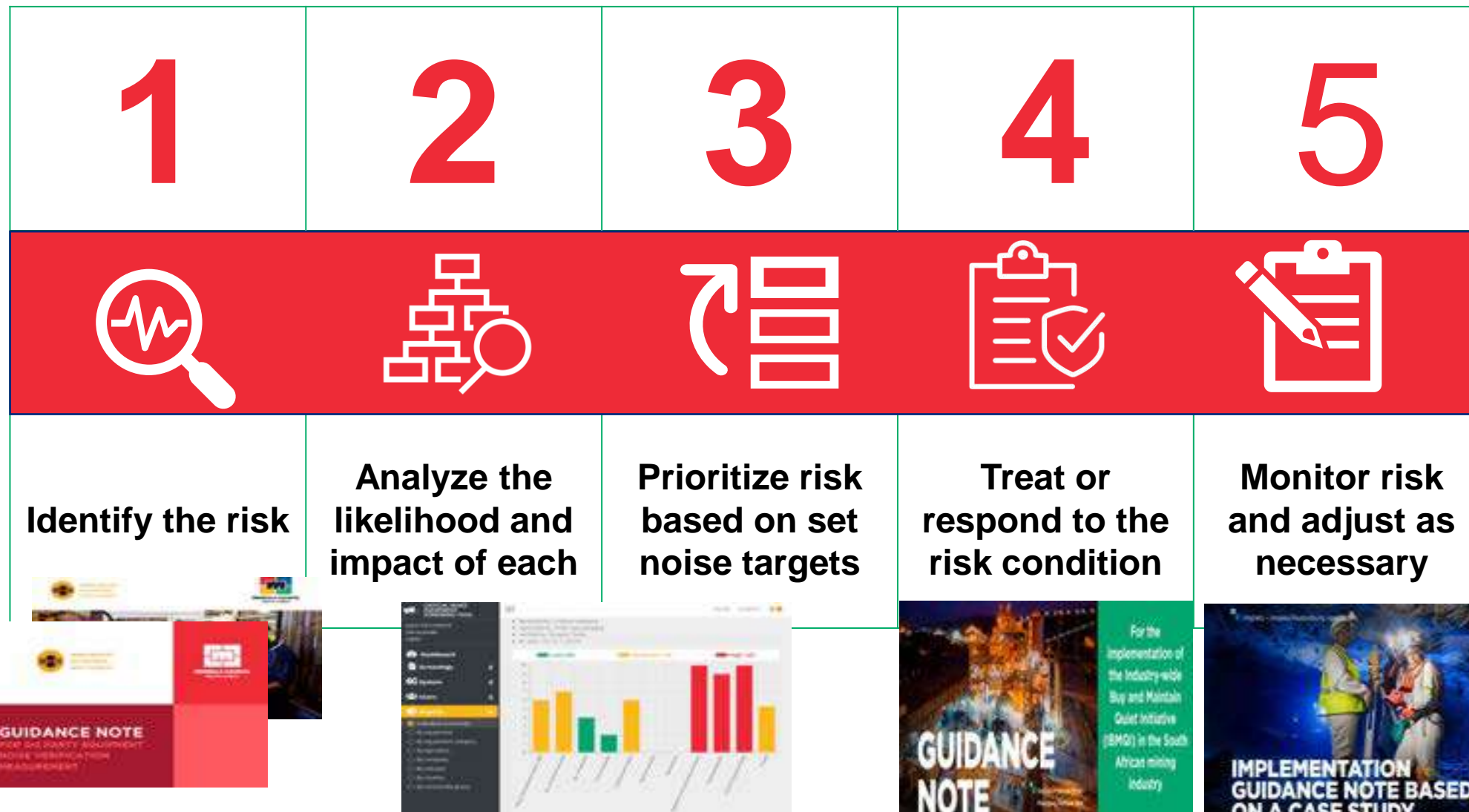
Competition Act, No. 89 of 1998 Compliance

Kindly note that we need to act in accordance with the Competition Act, No. 89 of 1998. In this regard, the Minerals Council and its members, non-members and OEMs agree that they will not engage in any discussion, activity or conduct that may contravene any provisions of the Competition Act.

Members must ensure that they do not, in any respect, engage in or associate with:
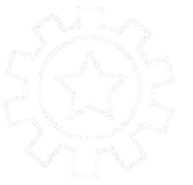
(1) directly or indirectly fixing a purchase or selling price or any other trading condition;

(2) division of markets by allocating customers, suppliers or territories; or

(3) collusive tendering.

In particular, members, non-members and OEMs agree that they will not discuss, communicate or exchange any commercially sensitive information, including non-public information relating to *prices, marketing and advertisement strategy, costs and revenues, volume and discounting, rebate information, trading terms and conditions, purchasing strategies, terms of supply, or distribution strategies*. This applies not only to interactions in the context of formal Minerals Council meetings, but also to discussions, communications or exchanges between members before, during or after Minerals Council meetings

IBMQI SUITE OVERVIEW – IN ACTION

1	2	3	4	5
Identify the risk	Analyze the likelihood and impact of each	Prioritize risk based on set noise targets	Treat or respond to the risk condition	Monitor risk and adjust as necessary

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SOUTH AFRICA
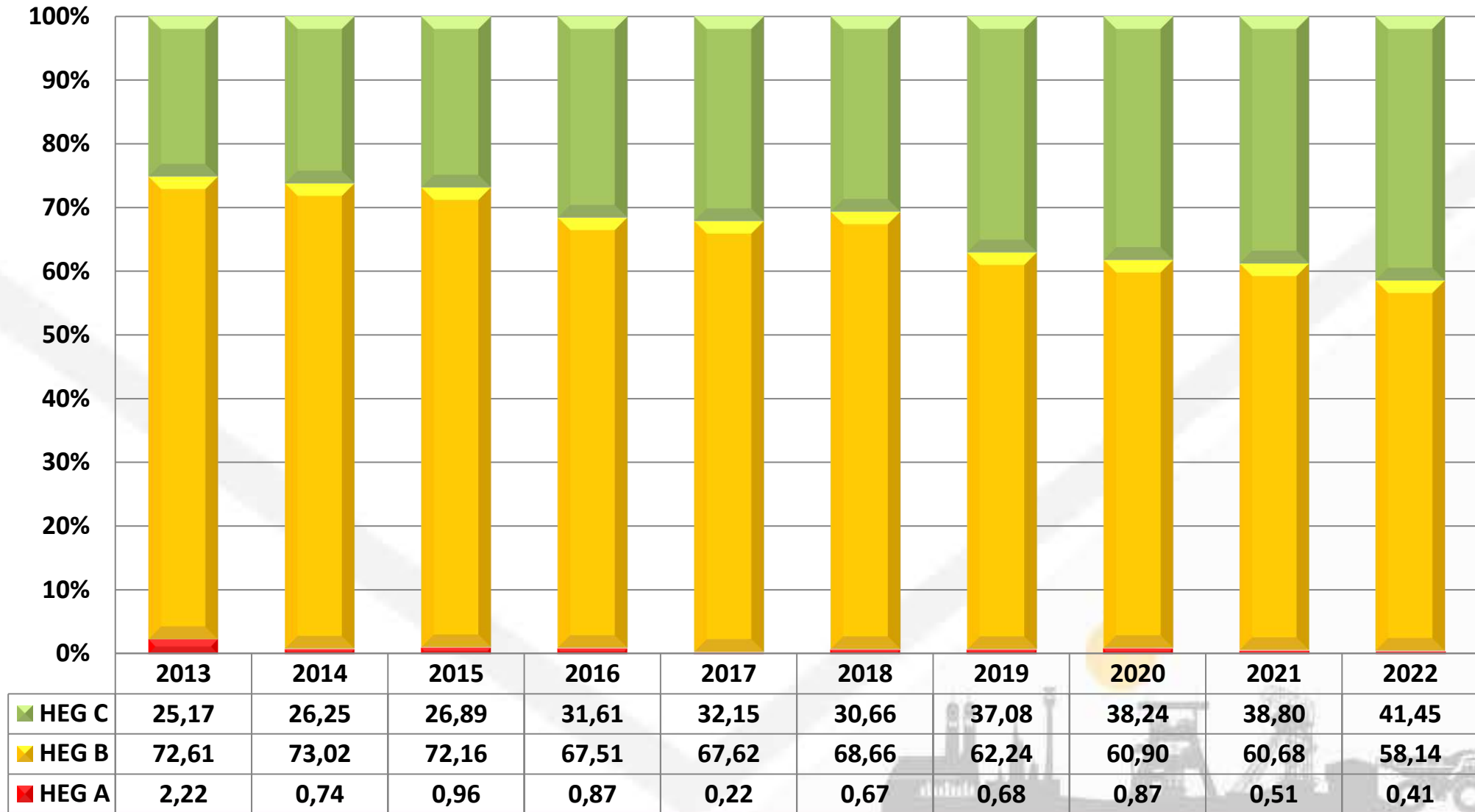
NOISE RISK MANAGEMENT APPROACH

CONTENTS

1. Trends: Employee Exposure to noise

2. Trends: NIHL Cases

3. Challenges

NOISE

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
■ HEG C	25,17	26,25	26,89	31,61	32,15	30,66	37,08	38,24	38,80	41,45
■ HEG B	72,61	73,02	72,16	67,51	67,62	68,66	62,24	60,90	60,68	58,14
■ HEG A	2,22	0,74	0,96	0,87	0,22	0,67	0,68	0,87	0,51	0,41

mineral resources
& energy
Department:
Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

NDP 2030

NOISE

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
HEG A + B	74,83	73,76	73,12	68,38	67,84	69,33	63,11	61,77	61,77	58,55
▉ HEG B	72,61	73,02	72,16	67,51	67,62	68,66	62,24	60,90	60,68	58,14
▉ HEG A	2,22	0,74	0,96	0,87	0,22	0,67	0,68	0,87	0,51	0,41

mineral resources
& energy

Department:
Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

NDP 2030

NOISE ≥ 85dB PER REGION

Legend: 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022

Regions: WC, NC, FS, EC, KZN, MP, LP, GP, NW(K), NW(R)

mineral resources & energy
Department: Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

NDP 2030

NOISE ≥ 85dB PER REGION

Legend: 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022

Regions: FS, MP, LP, GP, NW(R)

mineral resources & energy
Department: Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

NDP 2030

NOISE ≥ 105dB PER REGION

Legend: 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022

Regions: WC, NC, FS, EC, KZN, MP, LP, GP, NW(K), NW(R)

NOISE ≥ 105dB PER REGION

Legend: 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022

Regions: MP, LP, GP, NW(R)

mineral resources & energy
Department:
Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

NDP 2030

NOISE ≥ 85dB PER COMMODITY

Legend: ■ 2013 ■ 2014 ■ 2015 ■ 2016 ■ 2017 ■ 2018 ■ 2019 ■ 2020 ■ 2021 ■ 2022

Commodities: Gold, Chrome, Coal, Copper, Iron-Ore, PGM, Diamonds, Manganese, Other
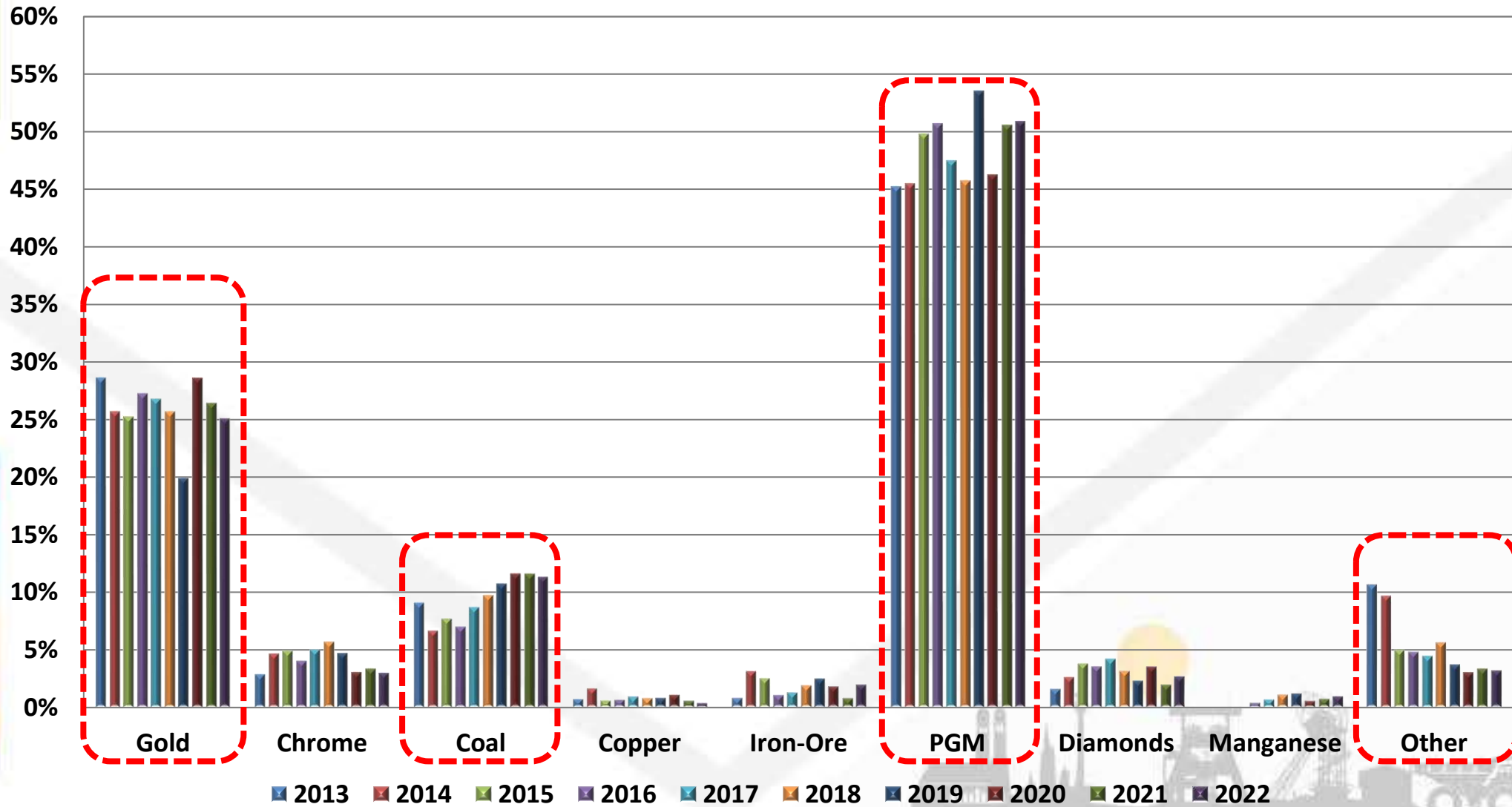
NOISE ≥ 105dB PER COMMODITY
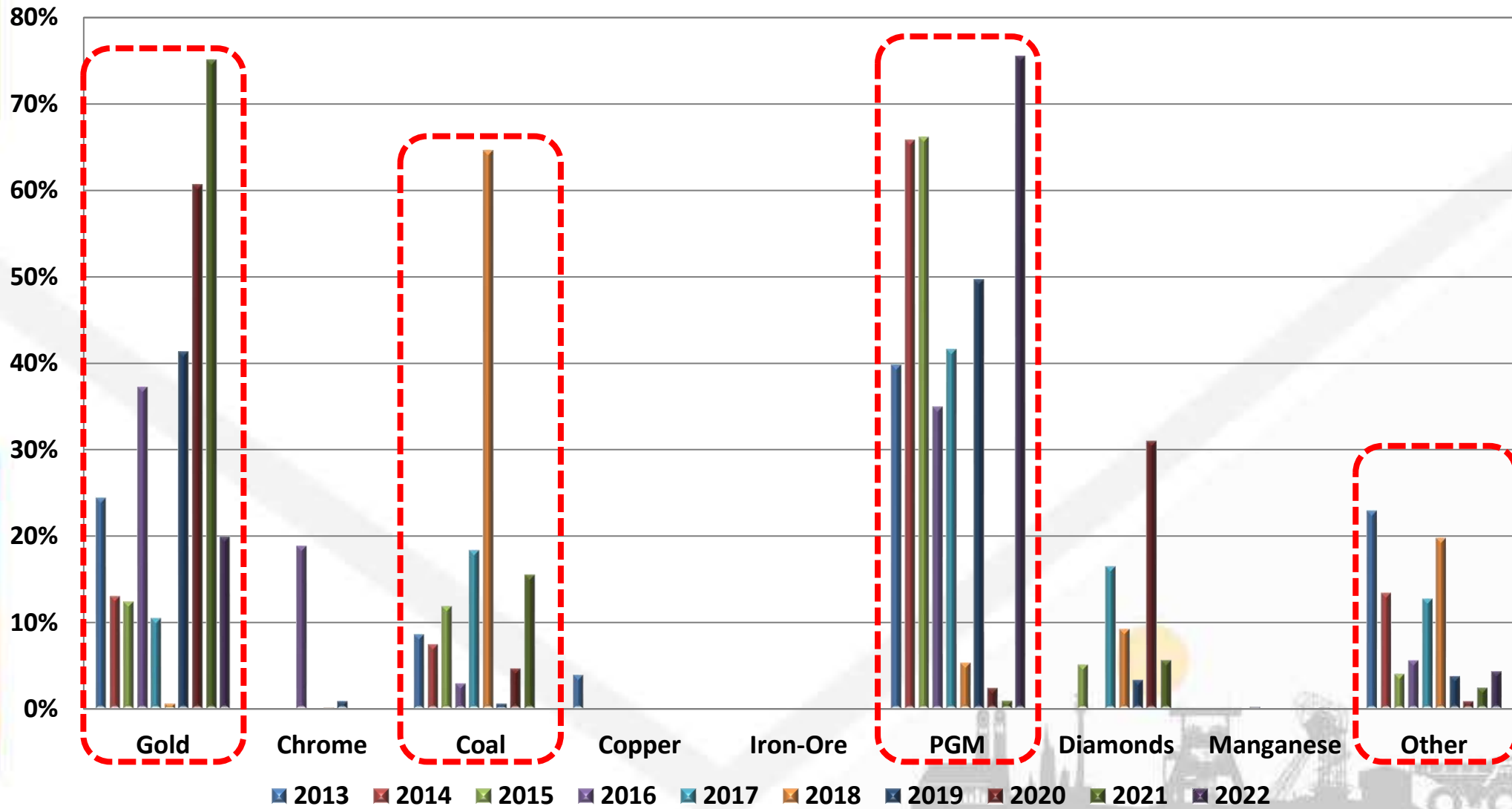
OCCUPATIONS WITH NOISE LEVEL ≥ 85 dB
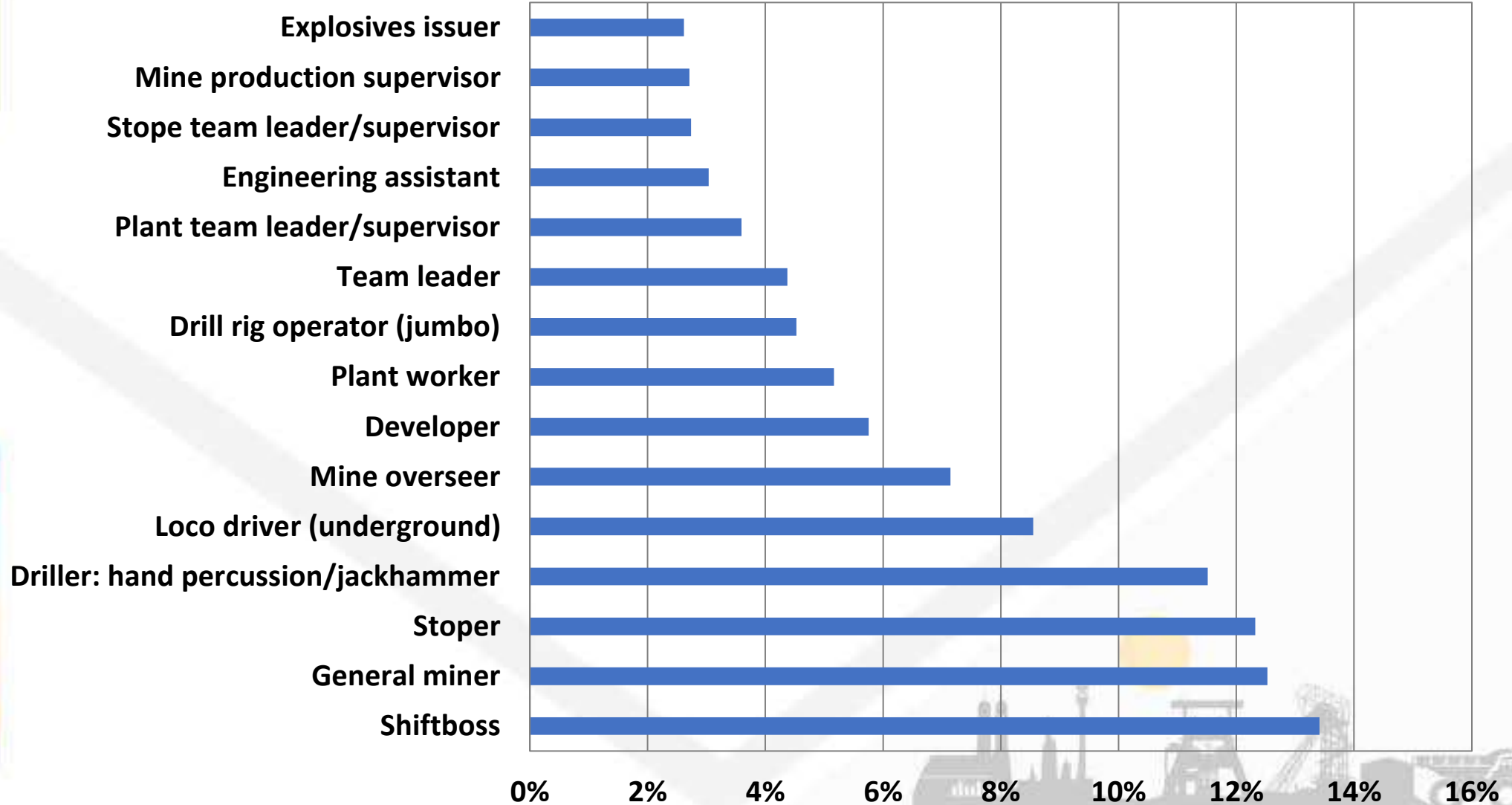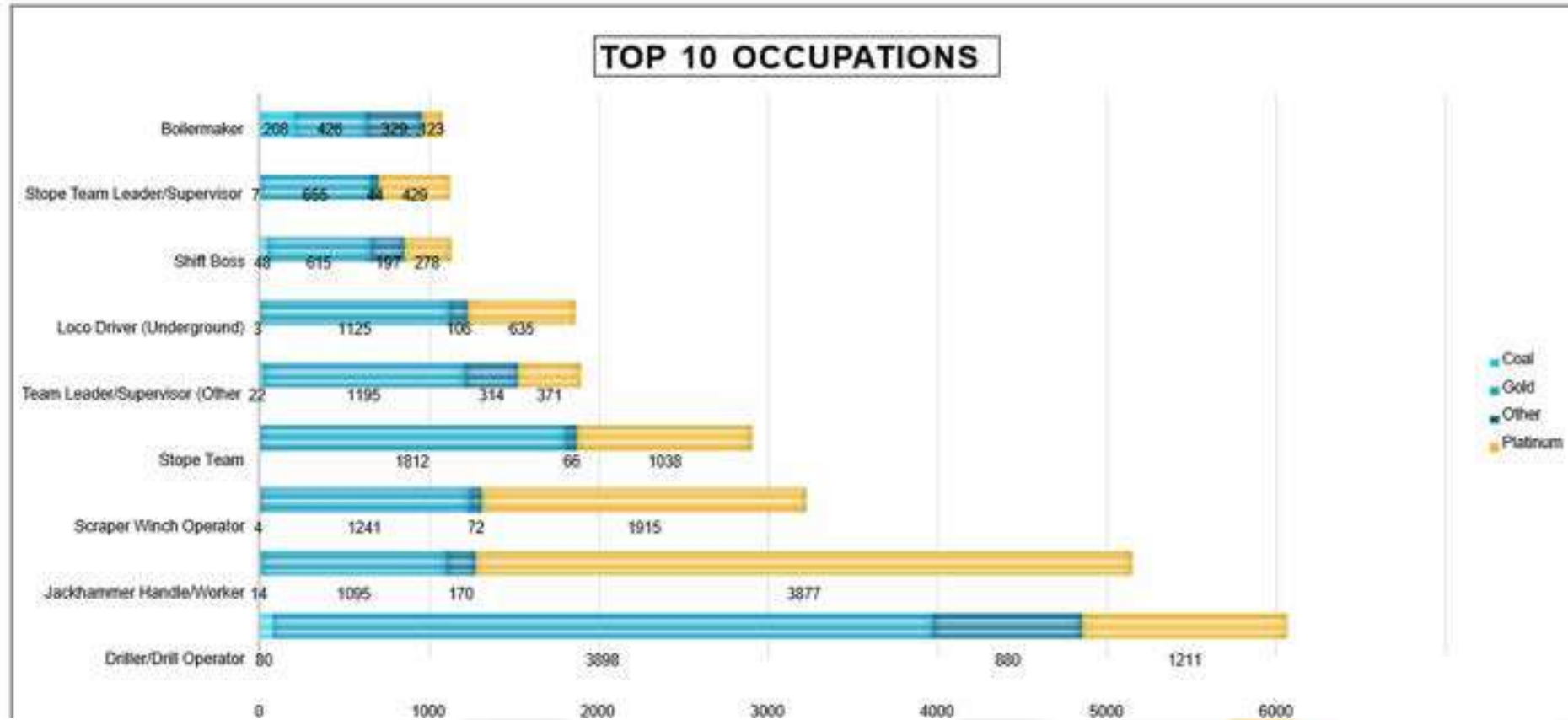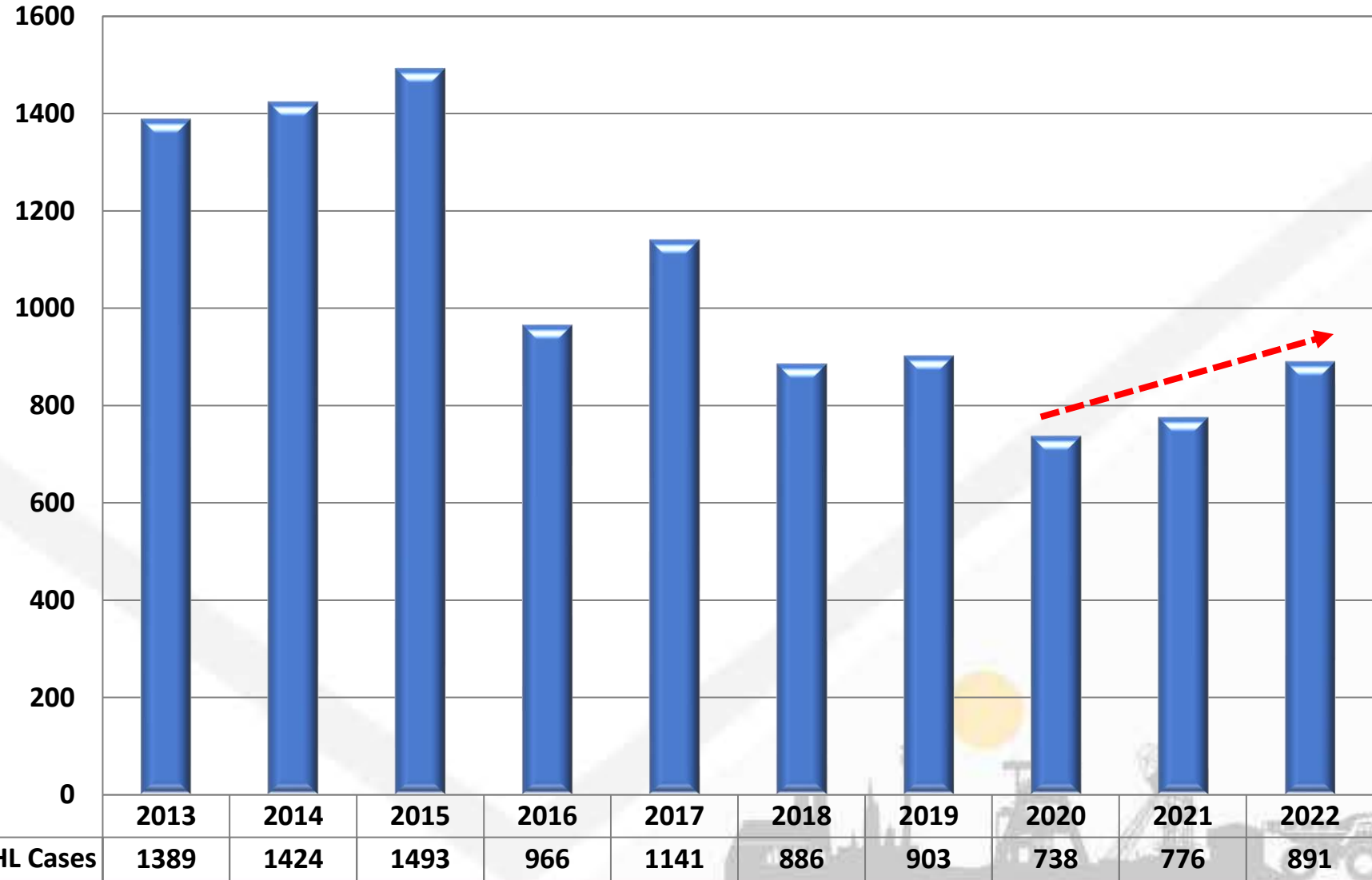
OCCUPATIONAL DISEASES - NIHL

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total No. of NIHL Cases	1389	1424	1493	966	1141	886	903	738	776	891
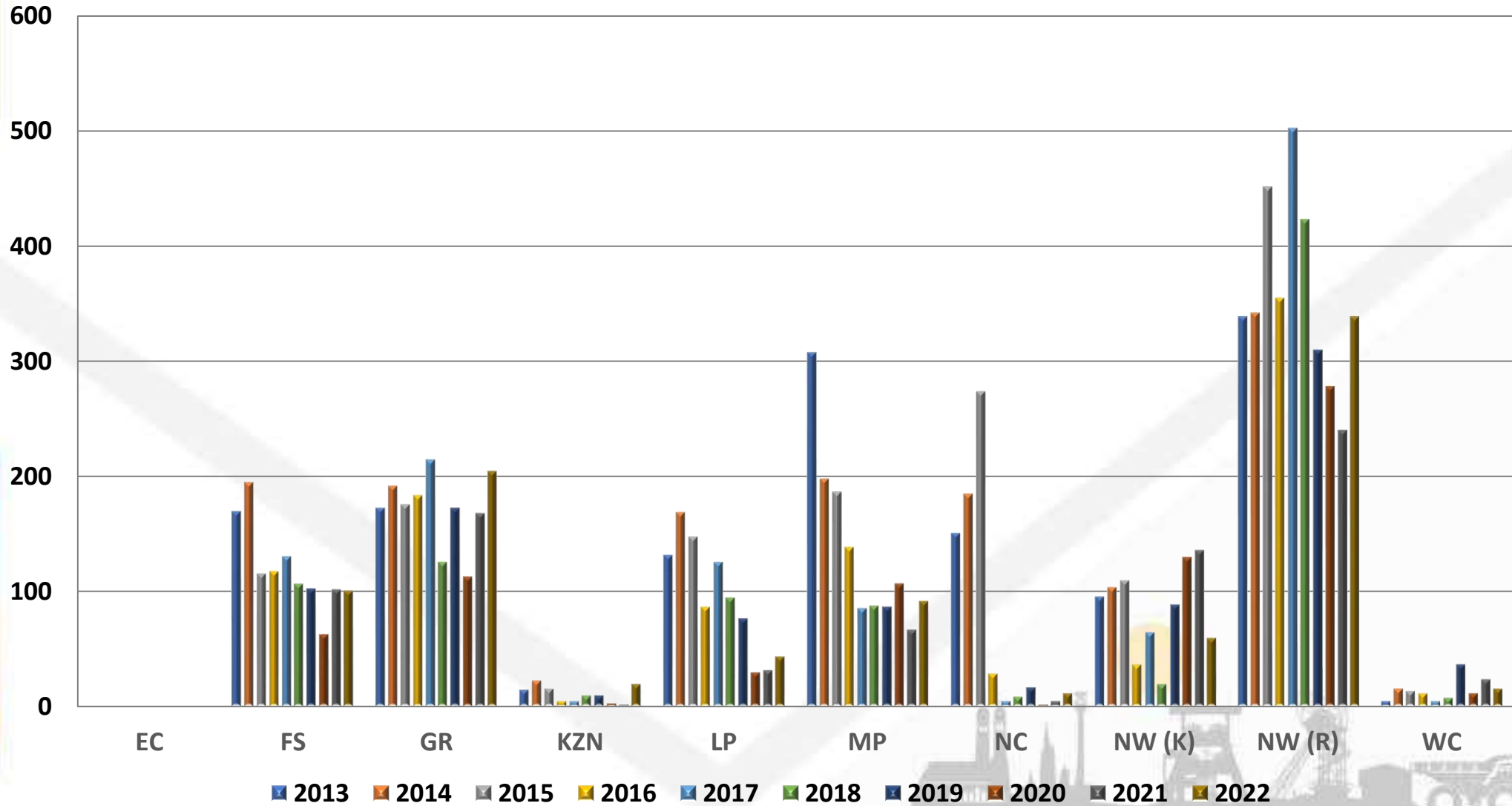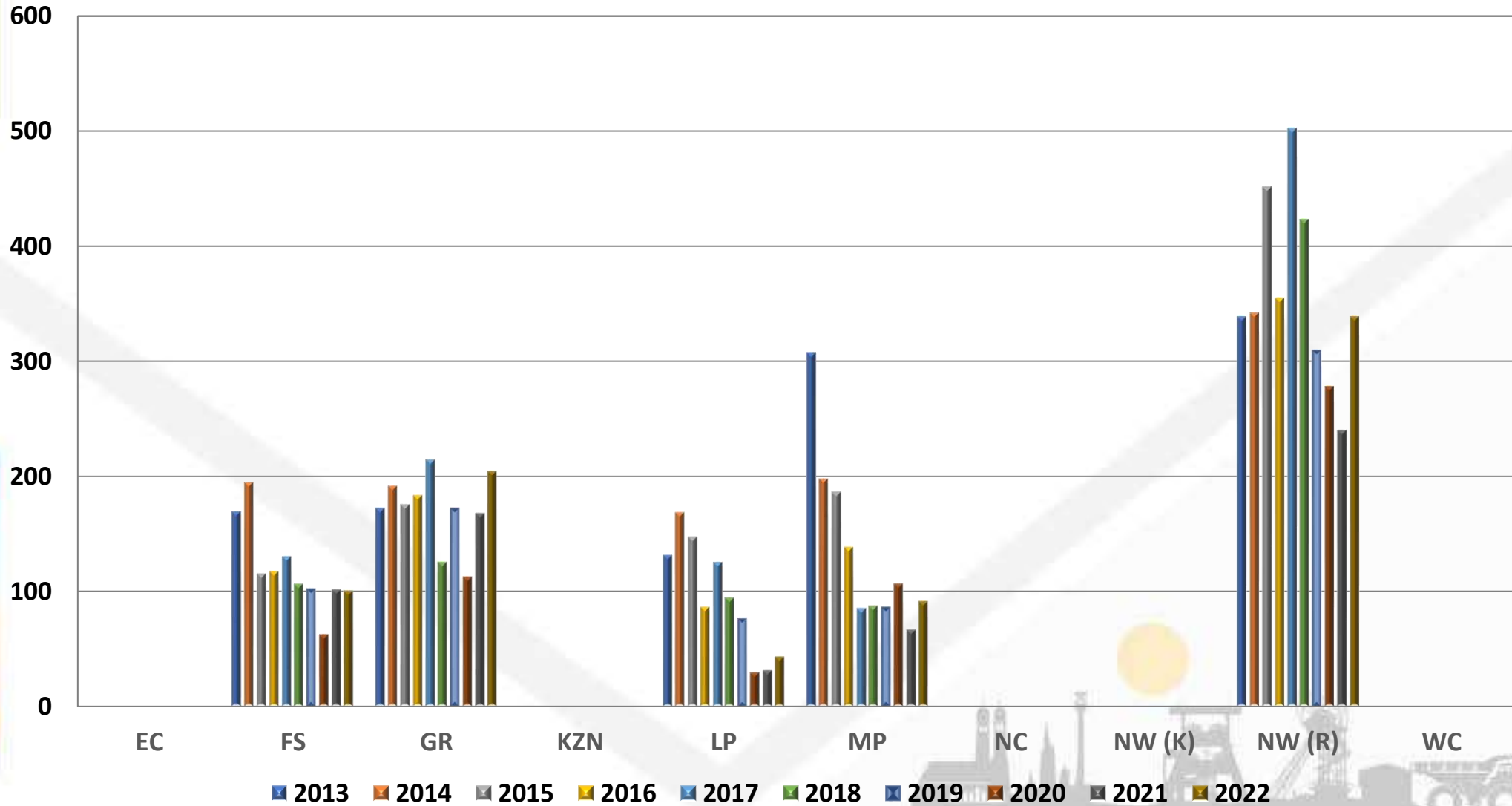
mineral resources
& energy
Department:
Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

NDP 2030

OCCUPATIONAL DISEASES - NIHL

Legend: 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022

Categories: EC, FS, GR, KZN, LP, MP, NC, NW (K), NW (R), WC

OCCUPATIONAL DISEASES - NIHL

OCCUPATIONAL DISEASES - NIHL

OCCUPATIONAL DISEASES - NIHL

Legend: 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022

Categories: Gold, Platinum, Coal, Chrome, Other mines

mineral resources & energy
Department: Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

NDP 2030
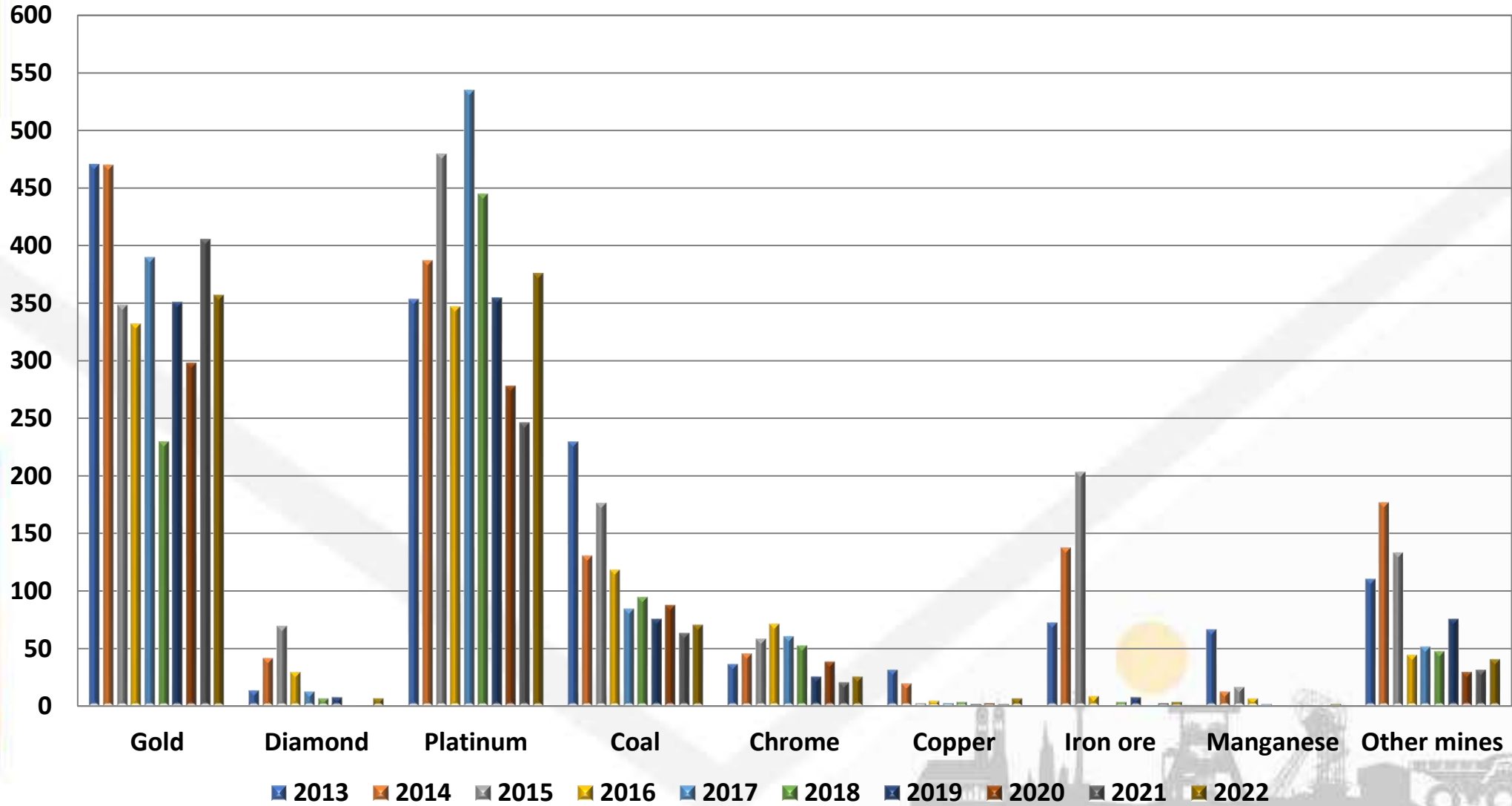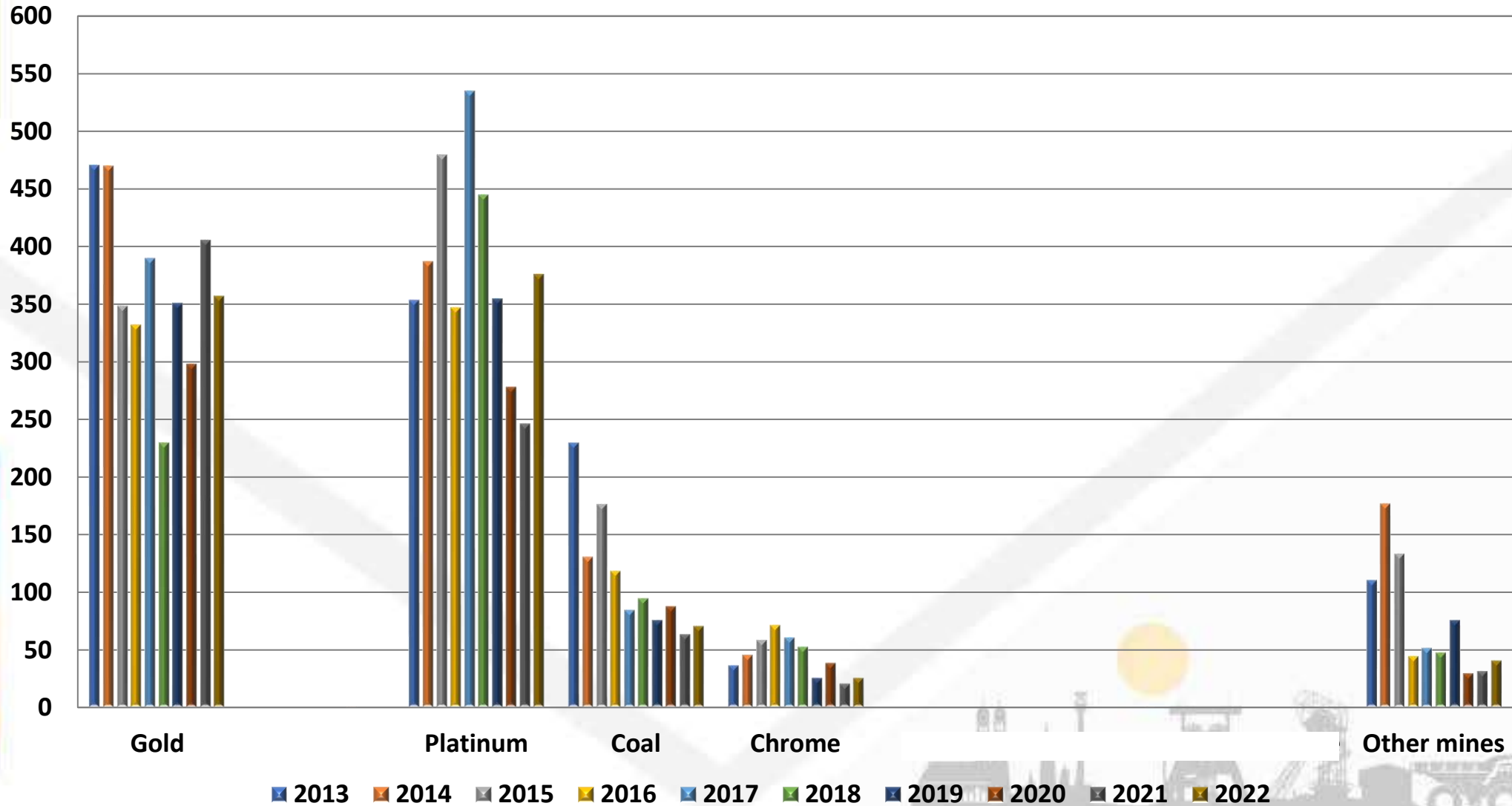
THANK YOU

Sibanye-Stillwater

INDUSTRY EQUIPMENT NOISE MILESTONE REPORTING

INDUSTRY NOISE SHOW & TELL DAY OF LEARNING
21 September 2023

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MINERALS COUNCIL
SOUTH AFRICA

MINERALS COUNCIL EQUIPMENT NOISE MILESTONE REPORTING

NEW EQUIPMENT NOISE MILESTONE REPORTING

NEW EQUIPMENT NOISE MILESTONE REPORTING

NEW EQUIPMENT NOISE MILESTONE REPORTING

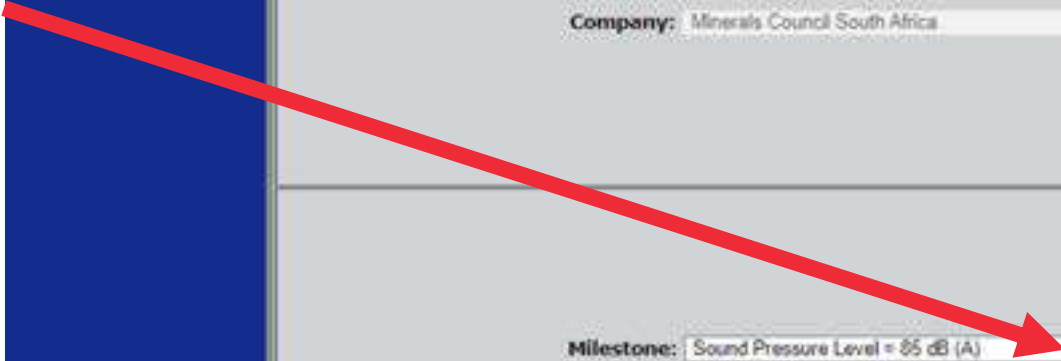# NEW EQUIPMENT NOISE MILESTONE REPORTING

Minerals Council South Africa - NOISE EMITTING EQUIPMENT QUARTER 1

REPORTING AND RECORDING RESULTS OF NOISE MEASUREMENTS Data collection: For equipment noise emissions, 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). Refer to: **Guidance note for noise measurement 2018**

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						...					Delete	

Add Noise Equipment   Export To: PortableDocFormat ▾   Export Equipment Noise Register

Save Noise Equipment   Inherit Noise Equipment from Previous Quarter

NEW EQUIPMENT NOISE MILESTONE REPORTING

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						...					Delete	

Export To: PortableDocFormat ▾ Export Equipment Noise Register

Type of Mining / Mining Method	Activity Area	Type of Equipment	Equipment Model	Power Source	Total number of pieces of equipment/machines forming part of the entire equipment type/model population for the activity area	
Underground Conventional ▾	Development (Single shift) ▾	Rock Drill (Muffled) ▾	Seco S25	▾		Add

Battery
Compressed Air
Diesel
Electric
Electro-Hydraulic
Hand Operated
Hydro Power
Pneumatic
Process
Water

Cancel Add   Inherit Noise Equipment from Previous Q

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						...					Delete	

Export To: [PortableDocFormat ▾] [Export Equipment Noise Register]

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[Underground Conventional ▾]	[Development (Single shift) ▾]	[Rock Drill (Muffled) ▾]	[Seco S25]	[Pneumatic ▾]	[100]	[Add]

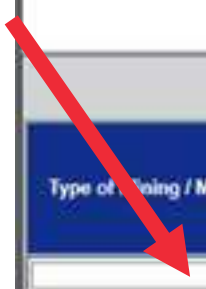[Cancel Add]   [Inherit Noise Equipment from Previous Quarter]

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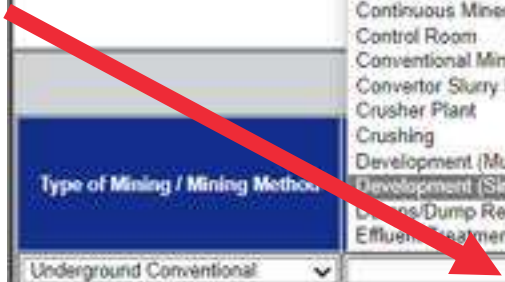| Type of Mining / Mining Method	Activity Area	Type of Equipment	Equipment Model	Power Source	Total number of pieces of equipment/machines forming part of the entire equipment type/model population for the activity area	
Underground Conventional ▼	Development (Single shift) ▼	Rock Drill (Muffled) ▼	Seco S25	Pneumatic ▼		Add

Cancel Add   Inherit Noise Equipment from Previous Quarter

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Underground Conventional	Development (Single shift)	Rock Drill (Muffled)	Seco S25	Pneumatic	100	...					Delete	Q1 results not yet captured

Add Noise Equipment   Export To: PortableDocFormat ⌄   Export Equipment Noise Register

Save Noise Equipment   Inherit Noise Equipment from Previous Quarter

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Save Noise Equipment   Inherit Noise Equipment from Previous Quarter
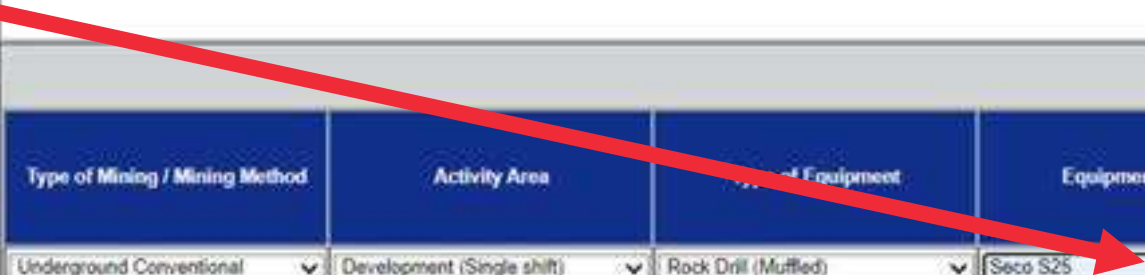
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Underground Conventional	(Single shift)	Rock Drill	Seco S25	Pneumatic	100	...					Delete	Q1 results not yet captured

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Underground Conventional	Development (Single shift)	Rock Drill (Muffled)	Seco S25	Pneumatic	1	...					Delete	Q1 results not yet captured

Add Noise Equipment   Export To: PortableDocFormat ⌄   Export Equipment Noise Register

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Underground Conventional	Development (Single shift)	Rock Drill (Muffled)	Seco S25	Pneumatic	100	...					Delete	Q1 results not yet captured

SAMPLE RESULTS

A Minimum of 5 samples must be captured over a period of 12 months.

Mining Type : Underground Conventional => Activity Area: Development (Single shift) => Equipment Type : Rock Drill (Muffled) => Power source : Pneumatic

No. of Samples	Period	Sample Reading *	Equipment Id / Serial No.	Action
				Add

Cancel Add

NEW EQUIPMENT NOISE MILESTONE REPORTING

Minerals Council South Africa - NOISE EMITTING EQUIPMENT QUARTER 1

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Underground Conventional	Development (Single shift)	Rock Drill (Muffled)	Seco S25	Pneumatic	100	...					Delete	Q1 results not yet captured

SAMPLE RESULTS

A Minimum of 5 samples must be captured over a period of 12 months.

Mining Type : Underground Conventional => Activity Area: Development (Single shift) => Equipment Type : Rock Drill (Muffled) => Power source : Pneumatic

No. of Samples	Period	Sample Reading *	Equipment Id / Serial No.	Action
		105	S215/1	Add

Cancel Add

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NEW EQUIPMENT NOISE MILESTONE REPORTING

Minerals Council South Africa - NOISE EMITTING EQUIPMENT QUARTER 1

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Mining Type : Underground Conventional => Activity Area: Development (Single shift) => Equipment Type : Rock Drill (Muffled) => Power source : Pneumatic

No. of Samples	Period	Sample Reading *	Equipment Id / Serial No.	Action
				Add
1	Quarter 1	105.00	S215/1	Delete

Save & Close Noise Measurement Results

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NEW EQUIPMENT NOISE MILESTONE REPORTING

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Underground Conventional	Development (Single shift)	Rock Drill (Muffled)	Seco S25	Pneumatic	100		105		100		Delete	

Add Noise Equipment   Export To: [PortableDocFormat ▾]   Export Equipment Noise Register

Save Noise Equipment   Inherit Noise Equipment from Previous Quarter

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Underground Conventional	Stoping	Roof Bolter	RBS25	Pneumatic	10	...	107.4			10	Delete	
Underground Conventional	Development (Single shift)	Rock Drill (Muffled)	Seco S25	Pneumatic	100	...	105		100		Delete	

Add Noise Equipment   Export To: [PortableDocFormat ▾]   Export Equipment Noise Register

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Minerals Council South Africa - NOISE EMITTING EQUIPMENT QUARTER 1

REPORTING AND RECORDING RESULTS OF NOISE MEASUREMENTS Data collection: For equipment noise emissions, 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). Refer to: **Guidance note for noise measurement 2018**

Type of Mining / Mining Method	Activity Area	Type of Equipment	Equipment Model	Power Source	Total number of pieces of equipment/machines forming part of the entire equipment type/model population for the activity area	Capture Equipment Noise Samples	Rolling Log Average for Quarter	Total number of individual pieces of equipment < 82 dB (A)	Total number of individual pieces of equipment ≥ 82 dB (A) < 107 dB (A).	Total number of individual pieces of equipment ≥ 107 dB (A).	Action	Comment
Underground Conventional	Stoping	Roof Bolter	RBS25	Pneumatic	10	...	107.4			10	Delete	
Underground Conventional	Development (Single shift)	Rock Drill (Muffled)	Seco S25	Pneumatic	100	...	105		100		Delete	

Add Noise Equipment

Export To: PortableDocFormat ⌄ | Export Equipment Noise Register

PortableDocFormat
Excel

Save Noise Equipment | Inherit Noise Equipment from Previous Quarter

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OUTPUTS AND REPORTS

NEW EQUIPMENT NOISE MILESTONE REPORTING

EQUIPMENT NOISE REGISTER

EQUIPMENT NOISE REGISTER

Mine Group	Minerals Council	Mine Name	Minerals Council South Africa
Main Commodity	Corporate	Reporting Year	2023
DMR Mine Code	-	Print Date	April 25, 2023

Name of the Section 12.1 appointee that signed off on these information

EQUIPMENT INFORMATION

Type of mining	Activity area	Equipment type	Power source (plrentic/electric/eletrohy draulic/hydropwer)	Equipment Model	Noise emission level in dBA (log average)				Number of pieces of equipment per noise emission category											
					Quarter 1	Quarter 2	Quarter 3	Quarter 4	< 85 dBA				≥ 85 but <107 dBA				≥107 dBA			
									Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Underground Con	Stoping	Rock Drill (Muffled)	Compressed Air	Seco S215	104.10				0	0	0	0	100	0	0	0	0	0	0	0
Underground Con	Development (Sing	Rock Drill (Muffled)	Compressed Air	Seco S25	108.10				0	0	0	0	0	0	0	0	50	0	0	0

INDUSTRY OCCUPATIONAL HYGIENE REPORTING COMPLIANCE

SAMI Milestone Reporting Compliance

Legend: ■ % Finalised   ■ % Pending   ■ % Unaccounted
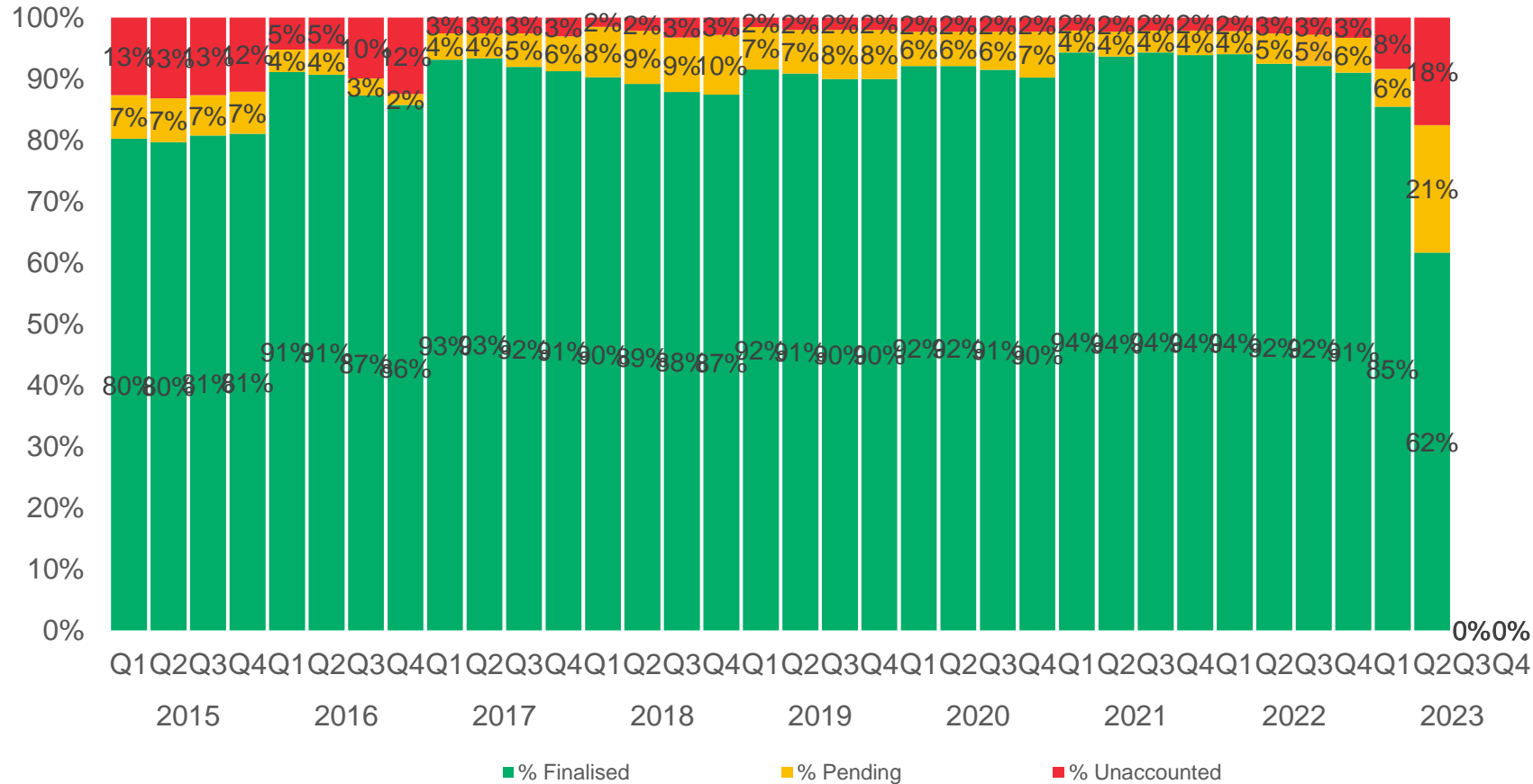
18% of the reports have not been captured for 2023 Quarter 2

○ The Minerals Council Occupational Health Information System was linked to the Mine Health and Safety Council Milestone Reporting Portal and therefore all information saved in the Minerals Council Occupational Health Information System is transferred to the Mine Health and Safety Council Milestone Reporting Portal

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SOUTH AFRICA

INDUSTRY TREND AGAINST THE ELIMINATION OF NIHL MILESTONE

Total number of individual pieces of equipment ≥ 107 dB (A)

Year	Finalised & Pending	Finalised
2015	3221	3134
2016	3079	3071
2017	2577	2576
2018	1709	1708
2019	1622	1604
2020	317	308
2021	343	302
2022	311	273
2023	225	205
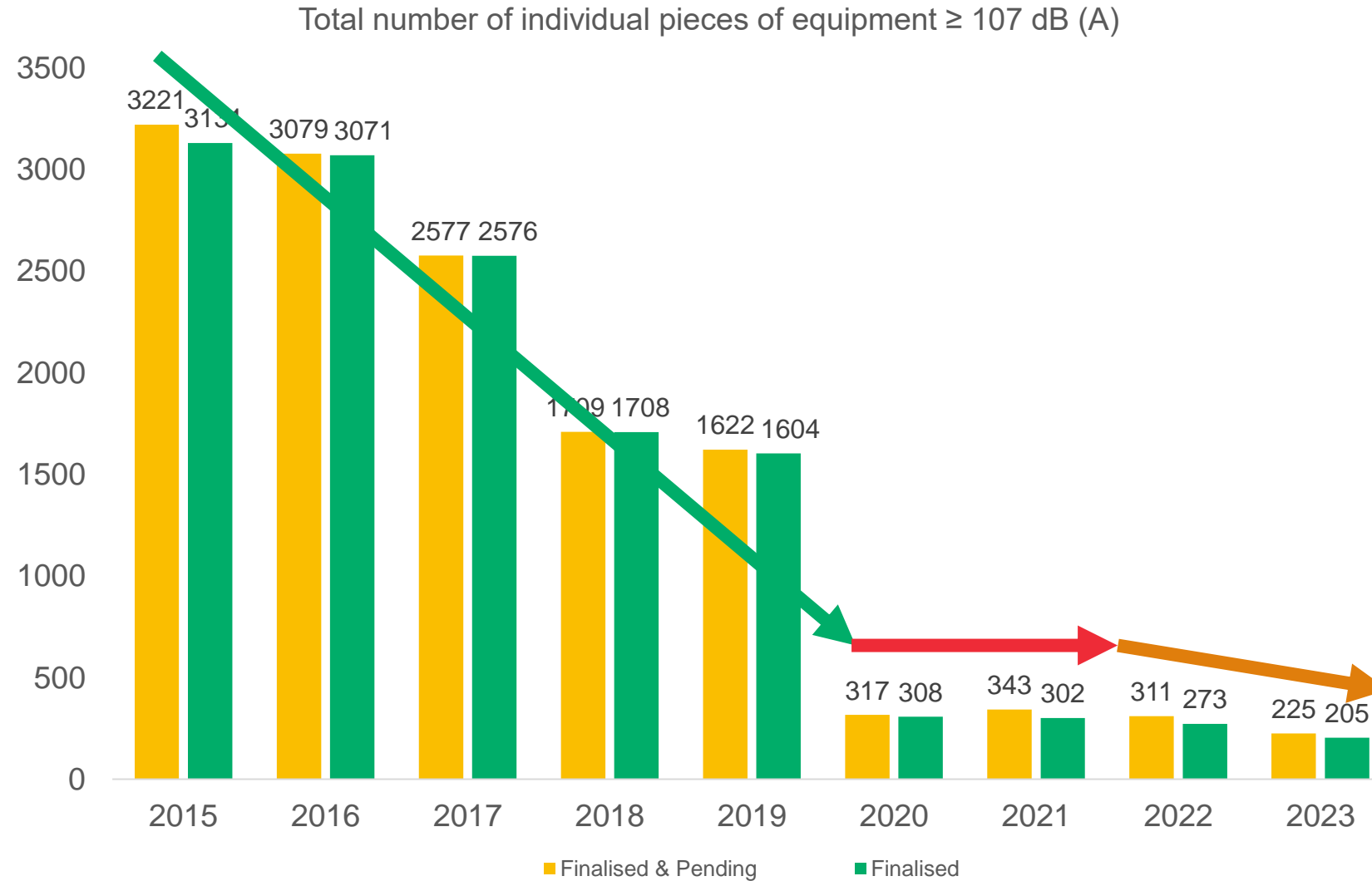
Increased effort is required to eliminate individual pieces of machines ≥ 107 dB (A)

EQUIPMENT POPULATIONS EMITTING NOISE >100dBA

Equipment Population Logarithmic Average Noise Emission Level for Equipment Emitting Noise >100dBA

Equipment	Level (dBA)
Fans (Main)	112,6
Abrasive/Steel Cut-off Machine	110,0
Gouching Tool	108,2
Drill Rig Hydro Power	105,9
Rock Drill (Pneumatic Development)	103,5
Rock Drill (Pneumatic Stoping)	102,5
Shaft Sinking Grab	102,4
Roof Bolter	102,2
Rock Boring (U/G Upside-down)	102,0
Rock Drill (Pneumatic Trackless)	102,0
Rock Drill (Hydro Power Stoping)	101,9
Diamond Drill Machine	101,8
Rock Drill (Hydro Power Development)	101,2
Jackhammer	101,2
Cutting Tools	101,0
Drill Rig Hydro Power	100,8
Crusher - Jaw	100,8
Atomizer	100,7
Scissor Lift	100,6
Compressed air Tools	100,1
Mechanical Loader	100,0

○ During the establishment of the Industry-wide Buy and Maintain Quiet Initiative (IBMQI), equipment emitting noise levels ≥100dBA was prioritised for enrolment into the IBMQI.

THANK YOU

INDUSTRY NOISE SHOW AND TELL

Dr Nothando Moyo, Noise Current and Future Status

21 September 2023, virtual presentation

Introduction to Noise Induced Hearing Loss (Occupational Noise Exposure)

Definition:
Noise-induced hearing loss (NIHL) is defined as an impairment of hearing, resulting from exposure to excessive noise that manifests over several years and results in bilateral and symmetrical impairment of hearing.

The cumulative permanent loss of hearing is always of the sensori-neural type, which develops over months or years of hazardous noise exposure (McBride; 2004; RMA, 2003; ASHA 1996).
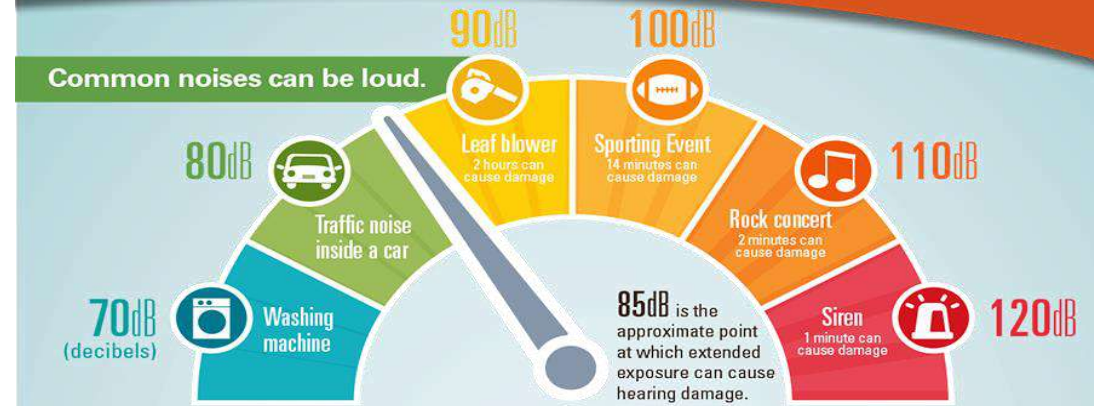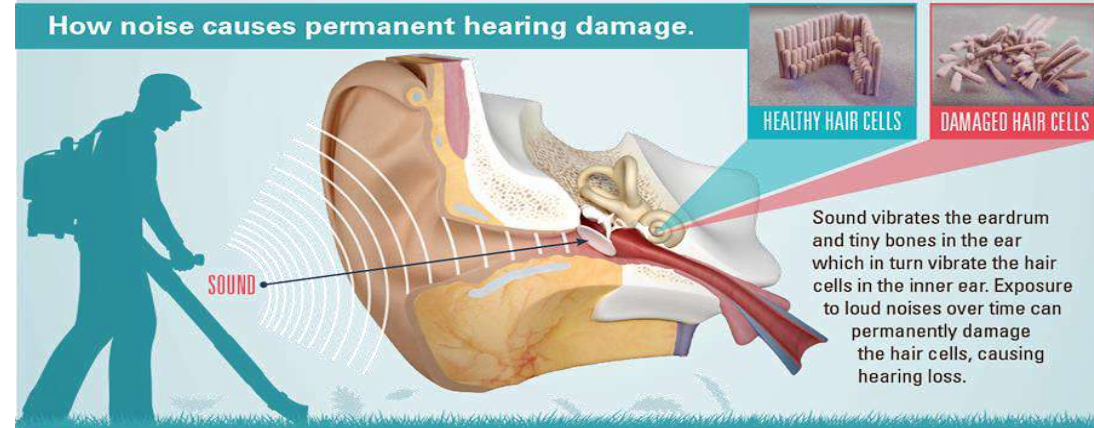
Typical Noise Induced Hearing Loss

Typical Hearing Loss
1. Starts after 5 – 10 years of exposure to noise > 85dB
2. Maximal hearing loss at 3000 – 6000Hz
3. Increase slowly over years of exposure
4. Never more than 40dB at 500Hz or more than 80dB at 4000Hz
5. Symmetrical in 70-85% of cases
   Asymmetrical 15-30% of cases
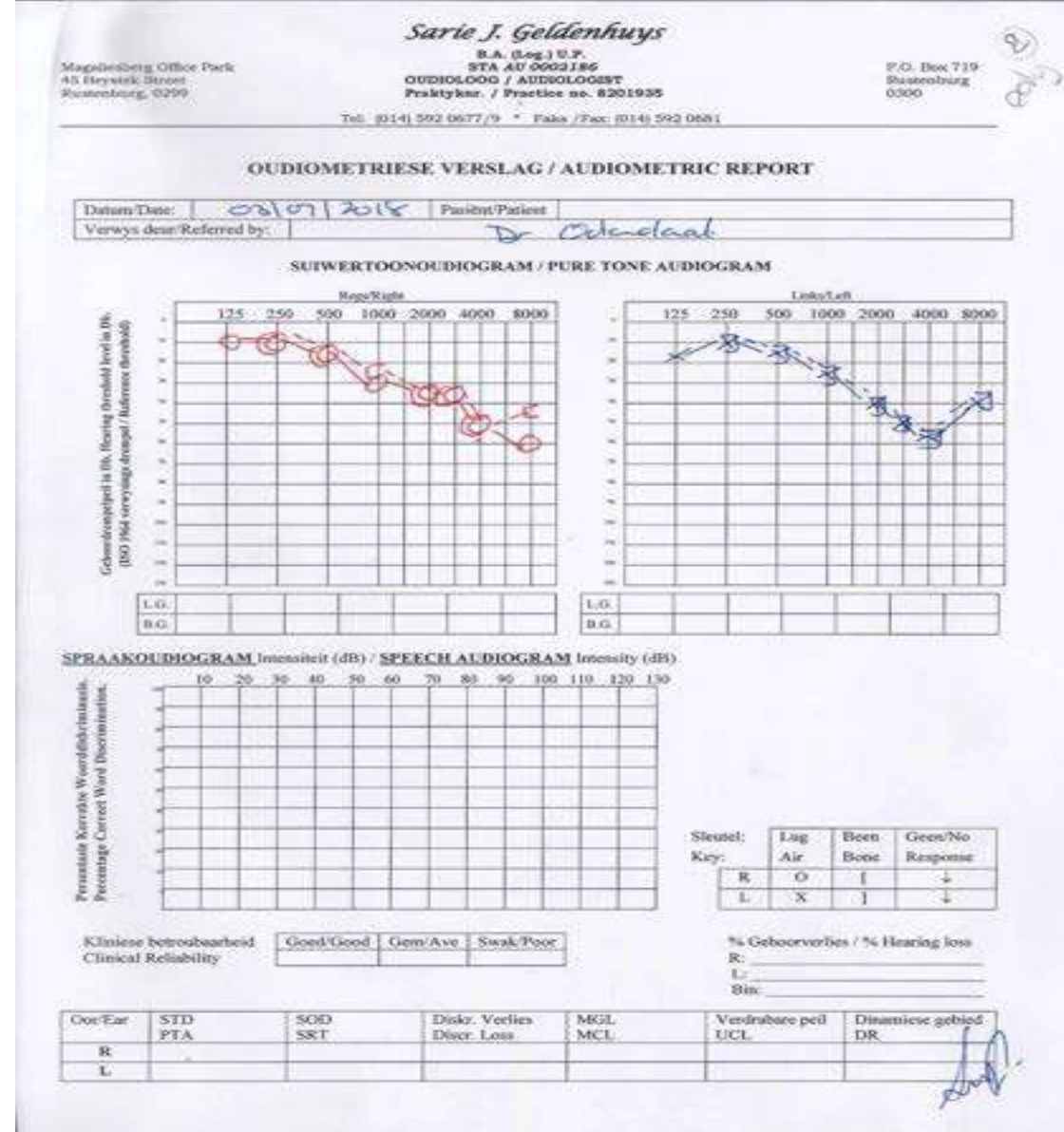
Atypical Noise Induced Hearing Loss

Atypical Hearing Loss

1. Flat Audiograms
2. Low Frequency hearing loss
3. Asymmetrical Hearing loss
4. Unilateral Hearing loss
5. Conductive + Mixed Hearing loss
6. Inconsistent Hearing loss (Pseudo-hypercussis)
7. Sudden or Fast progressive hearing loss

Comorbidities

Comorbidities
1. Trauma   - Direct
                      - Barotrauma
                      - Acoustic Trauma
2. Infections - Otitis media
                      - H.I.V.
                      - TB
                      - Other Viruses
3. Ototoxicity - TB Treatment
                      - ARV

4. Intra – cranial   - Tumours
                           - Myelosclerosis
5. Auto Immune Diseases

Step-by-step approach to eliminating or reducing the workplace hazards (Occupational Noise Exposure)

Hierarchy of Controls

Most effective

Least effective

Elimination — Physically remove the hazard

Substitution — Replace the hazard

Engineering Controls — Isolate people from the hazard

Administrative Controls — Change the way people work

PPE — Protect the worker with Personal Protective Equipment

Image by NIOSH
https://www.cdc.gov/niosh/topics/hierarchy/default.html

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Overview of NIHL in the South African Mining Industry

1. 80% of individuals affected by ONIHL reside in mining countires, such as SA.

2. WHO estimates the burden of NIHL in developing countries (such as SA, 18%) vs developed countries (North America, 9%)

3. Mining as an occupation was identified in the WHO GBD study as an economic sector with a heavy burden of NIHL.

4. Approximately **73,2%** of mine employees in SA were exposed to noise levels above the legislated occupational exposure level of 85 dBA indicating a significant risk of hearing loss for most of the the industry's personnel.

5. Prevalence studies of ONIHL hampered by
   - Data collection & hosting fragmentation
   - Lack of database or repository
   - Migratory nature of miners

Standard Threshold Shift Milestone and its progress

The Situation

We have a puzzle to untangle

- Mining industry legislation (MHSA) approach is different to non-mining (OHSA)
- Both MHSA and OHSA legislation is deficient in many areas, such as for early lag (lead) indicators, recording and reporting
- Regulators have no access to reliable early lag indicators - unable to advise/enforce
- Contractors are particularly vulnerable
- Few (except for certain proactive mines) know the NIHL status of the company.
- The one common area is that of COIDA (CI 171)
- But even with CI 171 there is:
    - No baseline database - which means default to Zero PLH in many
    - Many of those compensated likely already had some deafness before first work exposure but this was never measured and stored

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The Statistics

Standard Threshold Shift and its progress

Years	Number of cases reported where STS exceed 25dB from milestone baseline
2018	4
2019	13
2020	1703
2021	5
2022	19
2023	4

Standard Threshold Shift and its progress

The Need for Review

COIDA Circular Instruction 171 – May 2001
US OSHA STS approach of 2001 – <u>as was attached to the 2016 GN on STS</u>
MHSA Sections 11, 12(2), 13(2), 17
MHSA Regulations 9.2(1) & 9.2(2), 11.4(2)
MHSA Guidance Note – STS in the Medical Surveillance of NIHL – (2016 GN on STS)
MHSA Guide Line for a Mandatory COP for Noise – (2022 GL for a COP on Noise)
SANS 10083:2021
OHSA draft NIHL regulations of Oct 2022 and a COP for the draft regulations

- **Mistakes made in compilation and clarity of GN, GL and Draft Regs and COP**
- **Misunderstanding of STS, as used in US OSHA and MSHA**
- **Misunderstanding of "audiometric zero" in all 4 documents**
- **Results in a poor "early lag indicator" for NIHL (> 25 STS from baseline not audio zero)**
- **2022 GL requires diagnostic audio for > 25 STS, > 5 and > 10 PLH and 11 (5) invest.**
- **OHSA draft regs use STS of > 10dB change from baseline   Internal investigation**
- **OHSA draft regs use STS of > 25dB change from baseline   Chief Inspector**

NB: MHSA and OHSA legislation both use change from baseline not audiometric zero

Employees exposed to Noise by class

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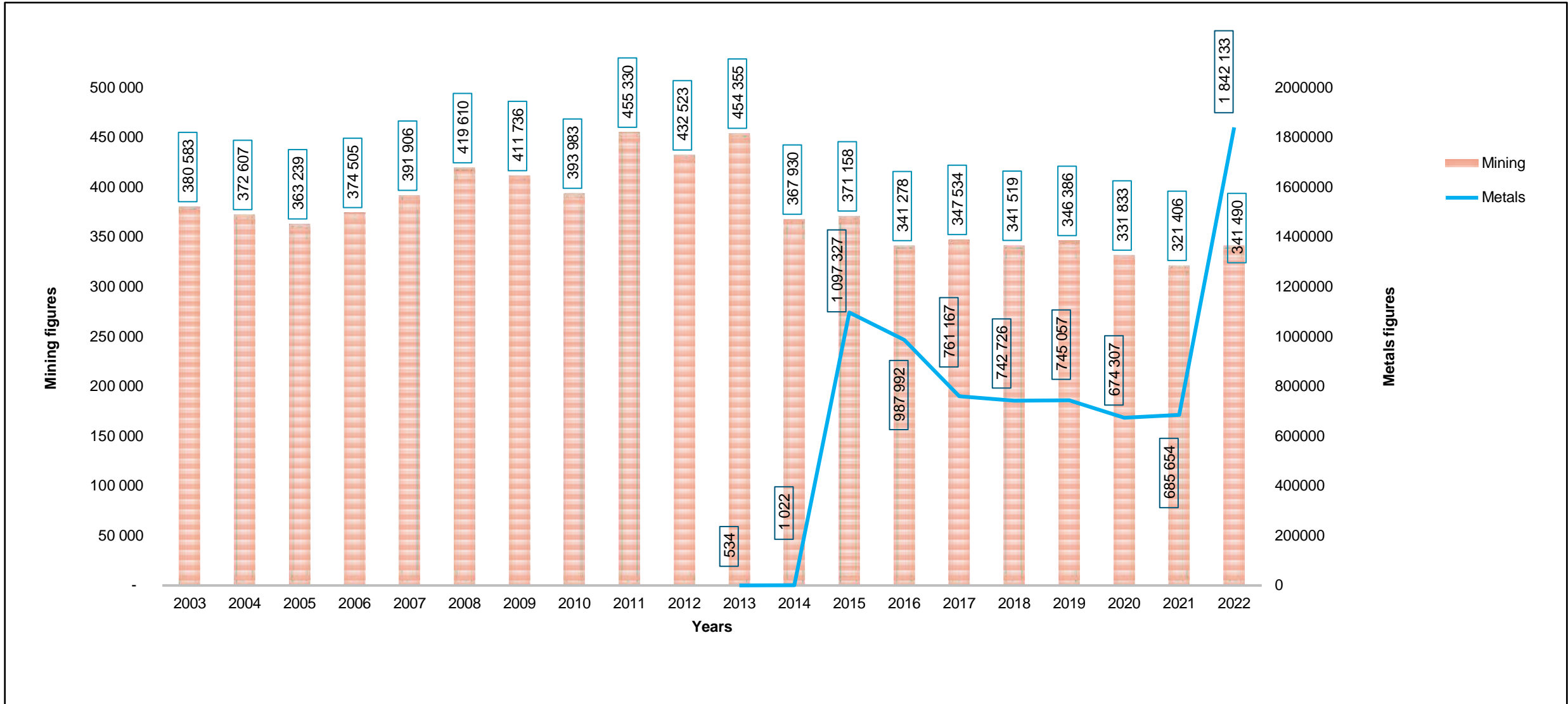
Number of ONIHL Claims Submitted
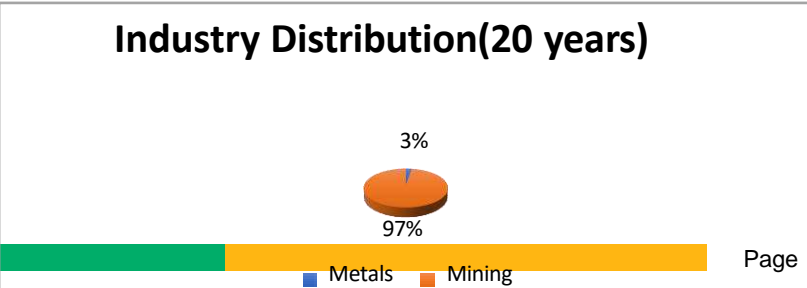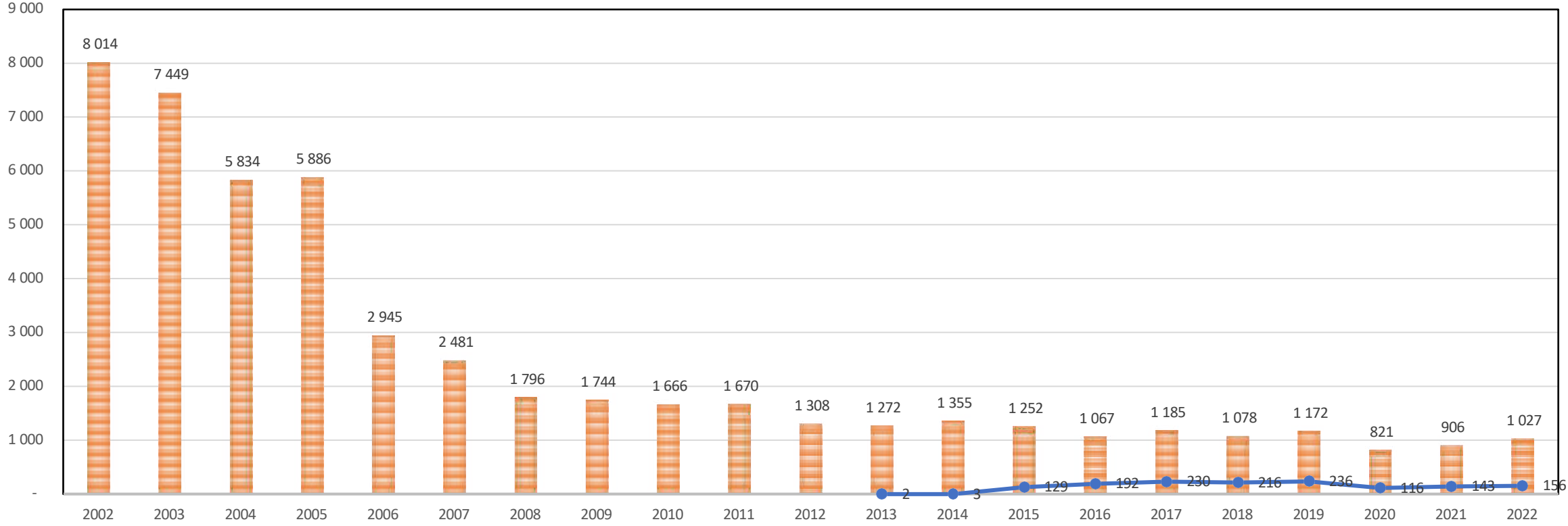
Percentage of Claims by Race

Mining Claims by Race(20 Years)

ASIAN 0,1%
WHITE 13,0%
NULL 11,6%
COLOURED 0,4%
CAUCASIAN 0,5%
BLACK 74,5%

■ ASIAN ■ BLACK ■ CAUCASIAN ■ COLOURED ■ NULL ■ WHITE

Page

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Mining Claims by Subclass

MINING CLAIMS BY SUB CLASS

Subclass	Value
BOPHUTHATSWANA	2
IRON BUTTON,BUCKE,HOOK,EYE,HAIRPIN,VEHICLE	0
ELECTRIC CABLE AND SAFETY RAZOR BLADES	0
MOTOR GARAGING	0
(BLANK)	33
WAGON,COACH,CARRIAGE,MOTOR BODY BUILDING	0
FOUNDRY PRODUCTS AND STOVE MANUFACTURING	1
COAL OPENCAST	62
MOTOR CAR ASSEMBLY INCLUDING ALL OPERATIONS	0
IRON AND STEEL PRODUCTION INCLUDING PROCESSING	0
OFFICES & ADMIN.	199
METAL TUBE,FURNITURE, DOOR ETC MANUFACTURING	2
OPENCAST	1383
SURFACE EMPLOYEES	1868
SHALLOW UNDERGROUND	2979
DEEP UNDERGROUND (GOLD)	21651
DEEP UNDERGROUND (OTHER)	23748

10 Most Affected Occupations

TOP 10 OCCUPATIONS
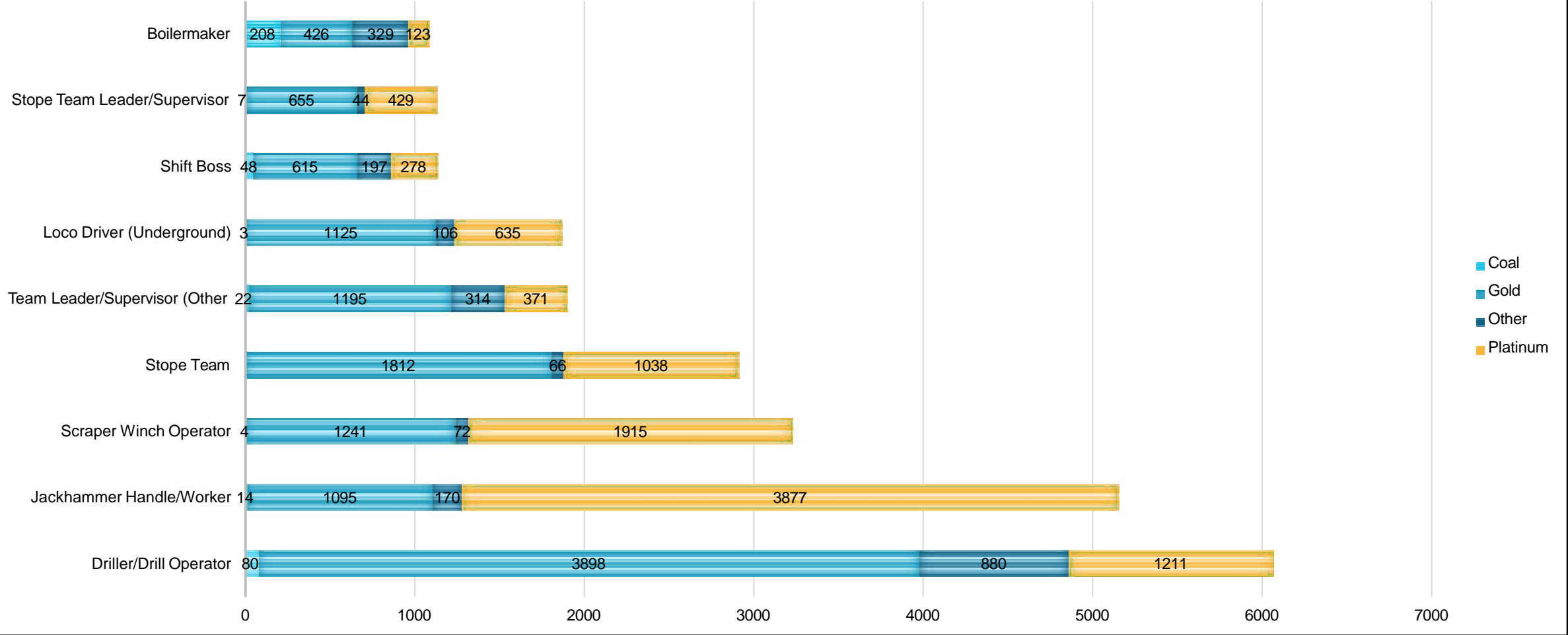
Occupation	Coal	Gold	Other	Platinum
Boilermaker	208	426	329	123
Stope Team Leader/Supervisor	7	655	44	429
Shift Boss	48	615	197	278
Loco Driver (Underground)	3	1125	106	635
Team Leader/Supervisor (Other	22	1195	314	371
Stope Team		1812	66	1038
Scraper Winch Operator	4	1241	72	1915
Jackhammer Handle/Worker	14	1095	170	3877
Driller/Drill Operator	80	3898	880	1211

Burden of NIHL in the South African Mining Industry

1. ONIHL imposes a substantial burden on our economy via productivity loss and the loss of general well-being
2. ONIHL is a financial burden on both employers and employees
3. Interventions to reduce occupational noise exposure are warranted
4. ONIHL, early detection and prevention is paramount
5. At present, ONIHL is an irreversible disease with no effective treatment
6. Prevention remains the best option
7. A safe and healthy work environment is an essential requirement for all workers.

The principal purpose of prevention measures for ONIHL includes:
- Monitoring occupational noise exposures (e.g., periodic noise exposure monitoring),
- Reducing noise exposure in workplaces (e.g., engineering controls, administrative controls, and personal hearing protection)
- Early detection before permanent damage (e.g., routine audiometric examinations, awareness and health education)

Policy implications:
- The national burden of hearing difficulties attributable to noise at work is considerable.
- Preventing these health outcomes is a significant public health priority.
- Adherence to the requirements of the MHSA with regards to investigation and reporting of Noise induced hearing loss (NIHL) cases, cannot be over-emphasized.

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Stakeholders should develop, agree and implement a robust:

- Early lag indicator for NIHL (MHSA and OHSA).
- Regulations to support the above.
- Database or Repository for baselines (COIDA CI 171).

Thank you

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THEME 2: CRITICAL CONTROL MANAGEMENT AND REMOTE OPERATIONS

THEME 2: Critical Control Management and Remote Operations		
The application of Remote Drilling in an Open Cast Mine at Exxaro, Grootegeluk	T Mantjane	10:55-11:15
Noise Control for Impact Wrenches, Sishen Iron Ore Mine	V Mgimeti	11:15-11:35
The application of Remote Rock Breaking in an Underground Mine at Gold Fields, South Deep Mine	F van der Walt	11:35-11:55
Gouging Through Constant Voltage for Noise Reduction at Anglo American, Sishen Iron Ore Mine	V Mgimeti	11:55-12:15
BINGO!	All	12:15-12:35
Lunch Break	All	12:35-13:15

MINERALS COUNCIL
SOUTH AFRICA

TABLE OF CONTENT

GGC Journey

Background

Manual vs Autonomous drilling

Autonomous drilling at Grootegeluk

Engineering and Personal Noise

Physical Stressors (Ergonomics)

Success Stories

User story

North Star: Strategy Drivers

SKILLS

OPERATIONAL EXCELLENCE

INNOVATION / D@E

TOWARDS OUR NORTH STAR

PEOPLE

DRIVE SUSTAINABILITY & RESPONSIBILITY THROUGH MINING

CULTURE

Seamless integration of our value chain to improve and grow in value YoY

Digital solutions to advance our value chain to produce safe tonnes and be operationally excellent

A culture where employees are growing together and take ownership of self to thrive in their roles

Through responsible mining we power possibilities for our stakeholders while enabling and supporting resilient communities

exxaro

Why did we embark on this Journey?

| Improve employees health and safety | Minimize drilling inefficiencies | Improve productivity | Improve standards and norms (Availabilities, Tempos and Diesel) | Financial Improvement (Unit cost reduction) |
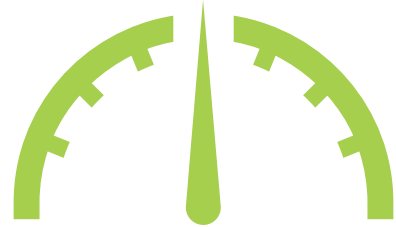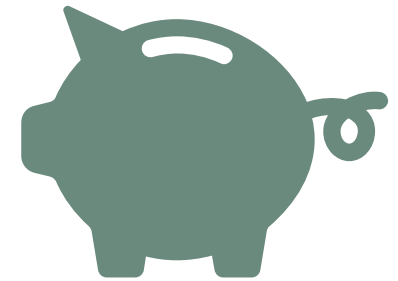
PROJECT STORYLINE

exxaro

1 MANUAL DRILLING

2 COMBO DRILLING

3 AUTONOMOUS DRILLING

➢ **Expose operators to health hazards such as noise, airborne pollutants, thermal stress, ergonomics, vibrations, etc.,**

Fleet Composition

0 Semi - Autonomous Drill in 2022

Adoption of the North-star Strategy

Procured Semi - Autonomous 3 Drill Rigs 2022

Combination of manual and autonomous drills on the larger drills, and manual drills on the smaller drills

Fleet Composition

Manual Composition = 4 Drills

Autonomous Composition = 3 units,

Removing operators from the health and safety hazards

Reduce exposure to respirable dust, thermal stress, vibration, and noise which pose serious health hazards to employees

Manual vs Semi - Autonomous drilling

Conventional Manual Drilling

Controls in Drill Cabin

Operation from Control Room

Operation from Control Room

Engineering Noise (Manual drilling)

Engineering Noise conducted in 2021
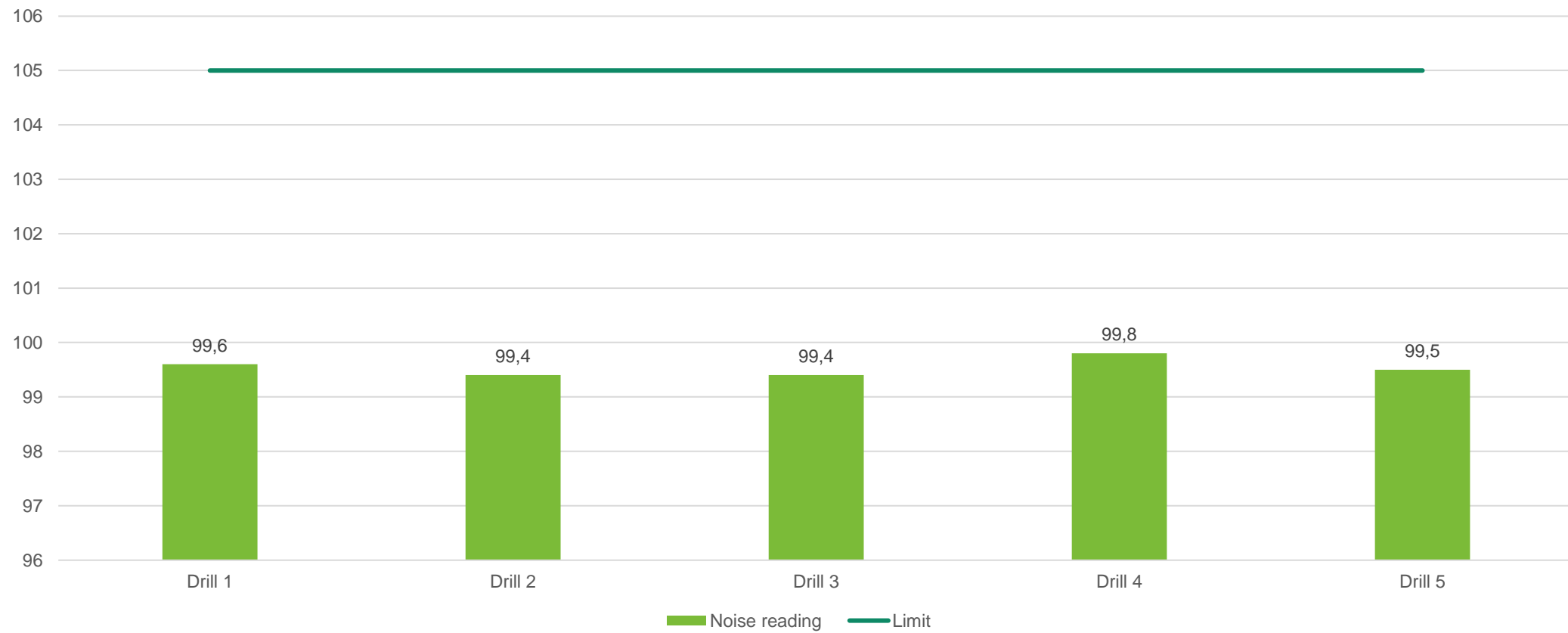
Personal Noise (Manual Vs Semi- Autonomous drilling)

Personal Noise Measurements 2021 and 2022

Data values (Noise reading 2021 / Noise reading 2022):
- Operator Drilling: 88,1 / 73,8
- Operator Drilling: 85,1 / 76,2
- Operator Drilling: 86,1 / 79,5
- Operator Drilling: 85,1 / 81,3
- Operator Drilling: 86,6 / 78,9
- Operator Drilling: 80,5 / 76,8
- Operator Drilling: 82,5 / 68,6
- Operator Drilling: 88,5 / 82,9
- Operator Drilling: 89,7 / 79,1
- Operator Drilling: 84,2 / 79,1
- Operator Drilling: 85,5 / 83,2
- Average Leq: 85,63 / 78,13

Legend: Noise reading 2021, Noise reading 2022, Limit

Ergonomics and Fatigue Survey 2020/2023

Drill Rigs Ergonomics - 2020

Setup Compliance | Furniture Compliance | Drill Risk Score
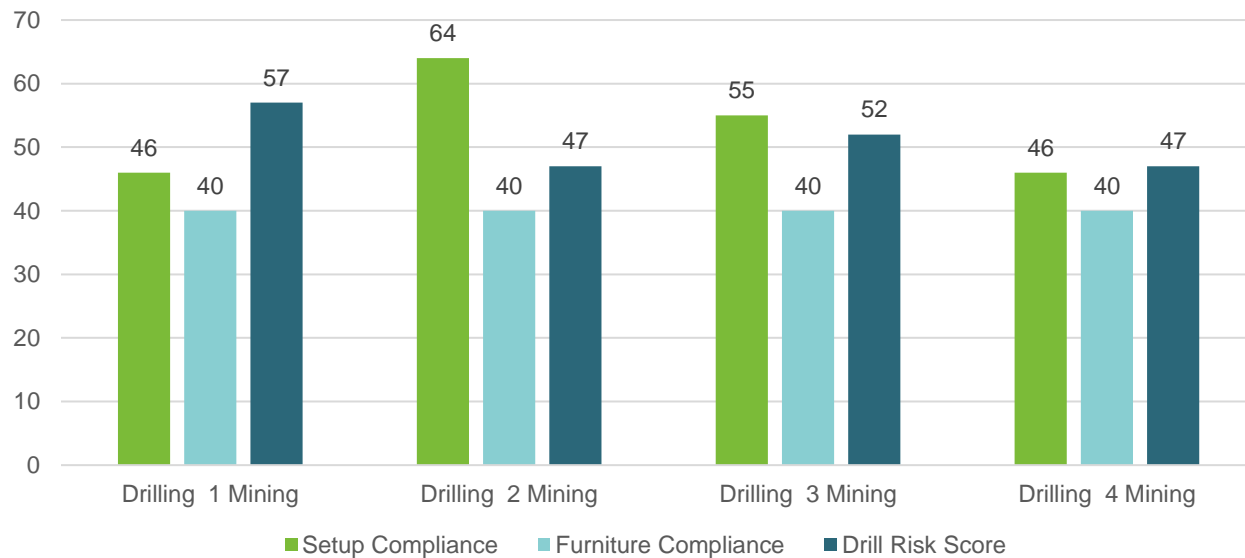
Limited/Rigid mobility

Semi - Autonomous Control Room Ergonomics - 2023
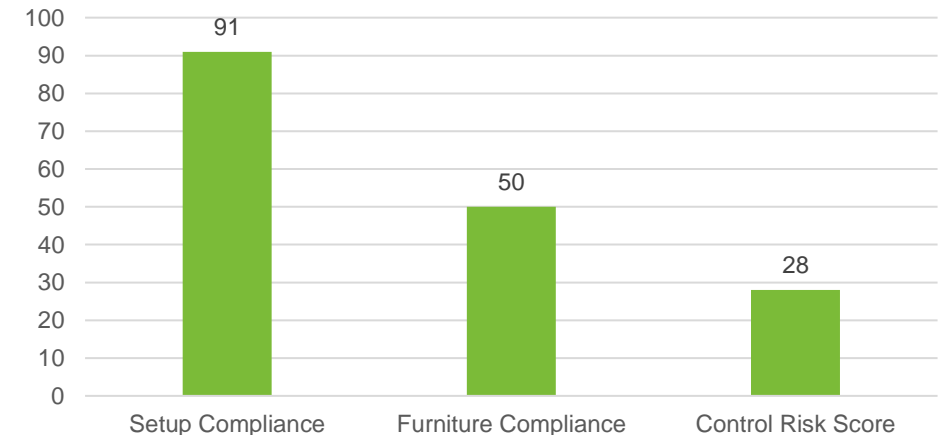
Employees have flexible mobility
Regular breaks encourage
Controlled environment

Success stories

Employee Retention: All employees were retained during process. No jobs were shed in the process

Upskilling: Total of 26 Operators trained to date.

Units: 3 Autonomous Drills on-site

Upskilling: Maintenance training done on Exxaro personnel

Occupational Overexposures: On a tremendous decline in the number of overexposures in the drilling HEG, and continuous monitoring of the engineering controls.

Stakeholder engagements: Inter-departmental collaboration
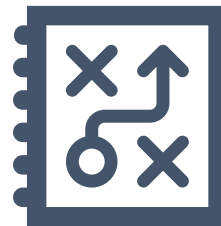
Engagements with impacted drilling stakeholders to understand challenges.
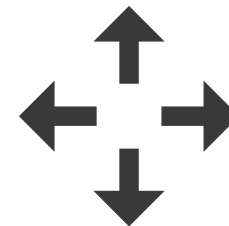
Change Management: HR-job analysis exercise to address concerns about possible job changes and training
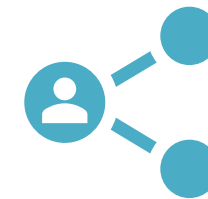
Change Management Plan shared with relevant stakeholders.

End User Testimonials

DRILL FOREMAN

"Having the autonomous drills in operation makes our job easier. We can protect the health and safety of the operators as well as maximize production time, due to minimum breaks in the drill cycle."

DRILL OPERATOR

"In my experience, this is the best drill to work with. There is also a lot we learn during the operation of the drill. I designed different kinds of teeth for table clamps, due to constant wear in the initial stages. Now the table clamps last longer. I am away from the noise, dust, heat, and vibration. The performance of the auto drill is much higher than the manual drills"

THANK YOU

Sishen Mine

Noise Control:
Impact Wrenches and PT Guns

21 September 2023

PT Guns

Tyre Service Department (Otraco)

TYRE SERVICE REQUIREMENTS

- Establish tyre pressure (combined with temperature test)

- Nitrogen Percentage Indication

- Chamber temperature determination

SOLUTION

- The combination of the three units onto a single line for simultaneous testing of all the parameters (pressure, temperature, nitrogen content)

- Gauge Combination Tool

- The gains:
  - ➤ Time saving
  - ➤ Cost saving
  - ➤ Noise exposure reduction

SUMMARY

- Cooperation between stakeholders to improve work conditions and protect worker health resulted in noise exposure reduction from:

105 dB(A)

↓

82 dB(A)

AngloAmerican
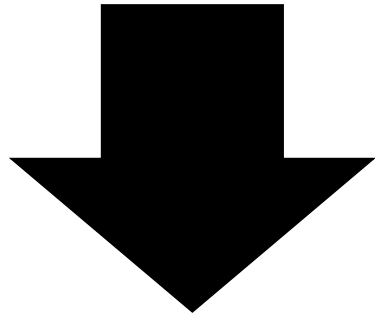
Impact Wrenches

Engineering Maintenance and Services

THEORY

Impact wrenches are used for tightening and loosening of bolts, lug nuts and rusted fasteners

The noise generated by tools is due to:

• Pneumatic exhaust.

• Tool noise: impacts, rotation.

• Tool/workpiece interaction.

The main direct noise from the tool is due to pneumatic exhaust

Control:
• Muffle exhaust noise

outflow through
side handle

compressed air-drive
grinding machine

compressed
air

CONTROL AND RESULTS – IMPACT WRENCH

Noise Rating Levels on Impact wrenches with diffusers/muffler variance

Chart values:
- Without load: CP 6060-P15R (Old) 112,6 ; CP 6060-P15R (New) 104,3
- Under load: CP 6060-P15R (Old) 106,5 ; CP 6060-P15R (New) 102,7
- At exhaust: CP 6060-P15R (Old) 121,5 ; CP 6060-P15R (New) 111,9

Legend: CP 6060-P15R (Old) ; CP 6060-P15R (New)

a) Injection moulded plastic body and thread with sintered plastic or metal membrane

b) Machined metal body and thread with compacted wire wool as silencing material

c) Fabricated and assembled metal body with layers of coarse woven wire cloth as silencing material

CONTROL AND RESULTS – IMPACT WRENCH

CONTROL AND RESULTS – IMPACT WRENCH
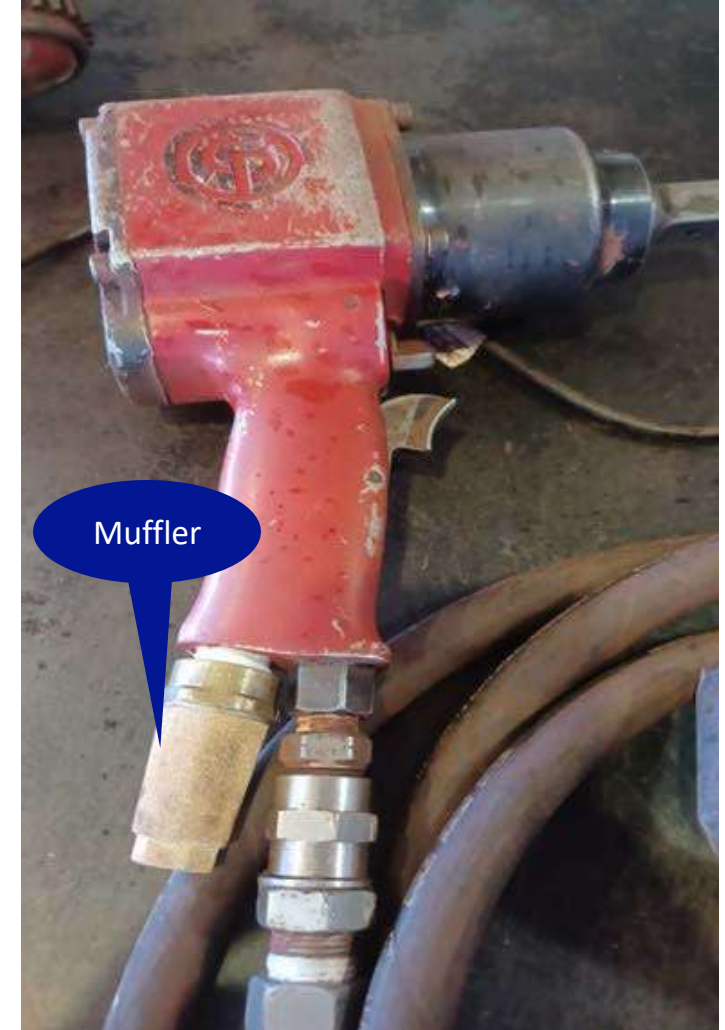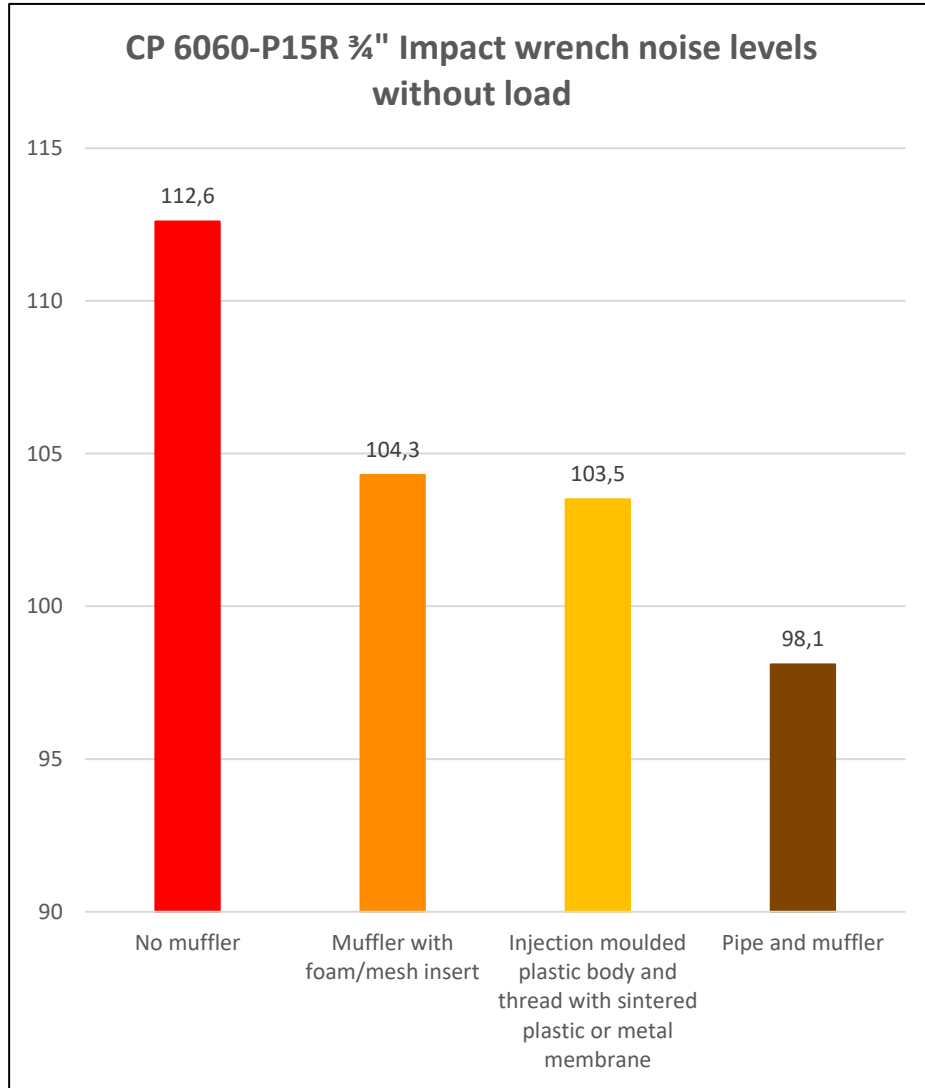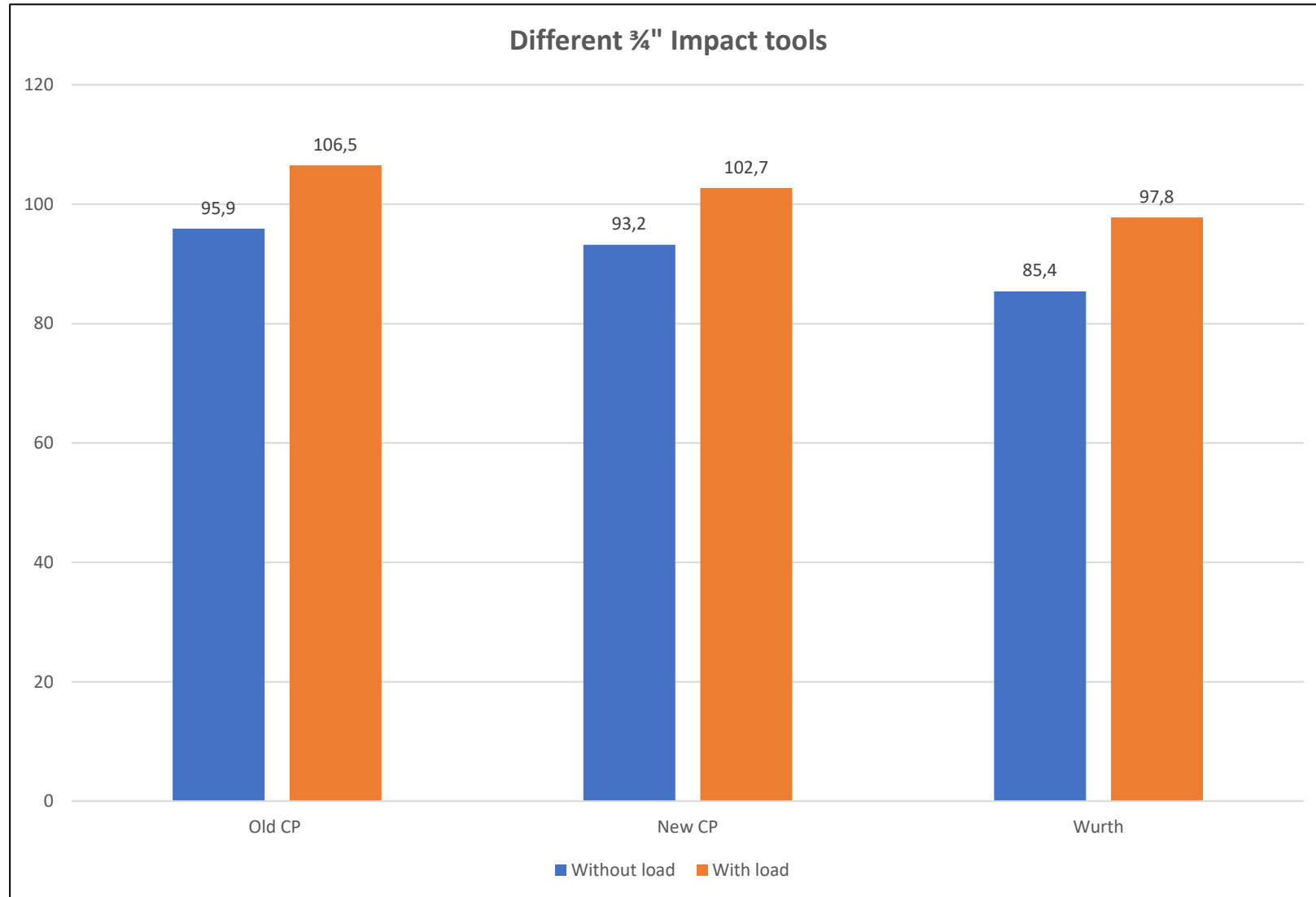
Different ¾" Impact tools

CONCLUSION

Based on the tests conducted Sishen has resolved to undertake the following

- Implementation of IBMQ Policy
- OEM/Supplier engagements
- Adopt a holistic approach on Hierarchy of Controls
- Continous maintenance of equipment
- Training of employees on noise controls
- Continuation of relationship with Engineering departments on technology advancements and control of noise emitting equipment
- Phase-out old impact wrenches and roll-out of the new tested impact wrenches

AngloAmerican

THANK YOU

Remotely Operated Impact Breaker

Gold Fields - South Deep Gold Mine

SALWYNNE VREUGDENBURG

GOLD FIELDS

Remote Operated Impact Breaker

Agenda

- Gold Fields Introduction

- Where the journey started

- Problem Statement and Opportunities

- Risk Management Perspective

- Benefits of utilising remote impact breakers

- Control room setup for remote impact breakers

- System Requirements for remote impact breakers

- Remote impact breaker functionality and expansion

- Exposure Analysis and Comparison

- Safety Precautions

- Next Steps

- Videos and live link (if time allows)

Remote Operated Impact Breaker

South Deep Gold Mine Introduction
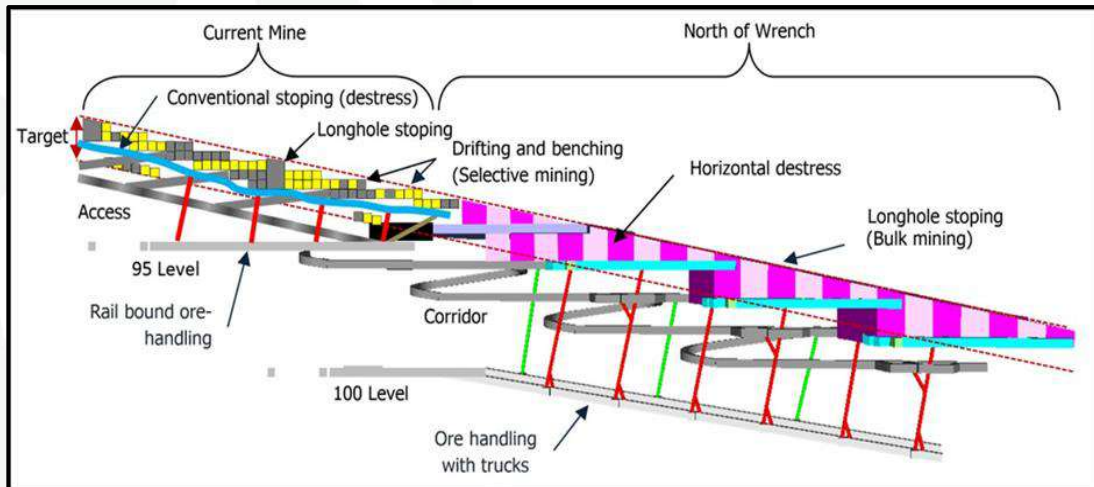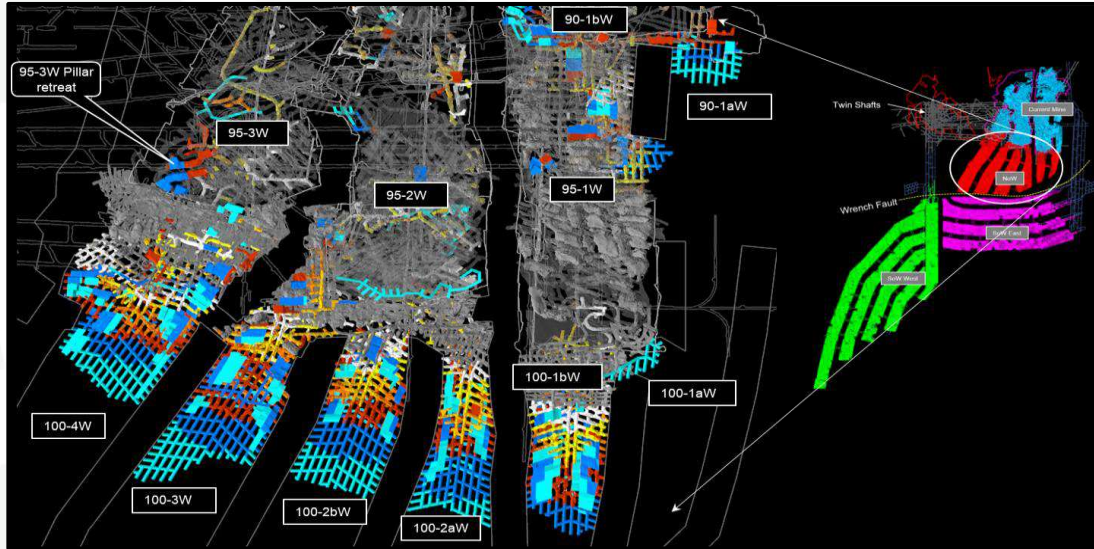
"MINE OF THE FUTURE"

- South Deep Gold Mine is a world-class bulk mechanised mining operation located in the Witwatersrand Basin, near Westonaria.
- The mine has been in development and operation since the 1970s and has one of the largest known gold deposits in the world.
- The current Life-of-Mine is estimated to be 80 years, so it is likely to be the last gold mine in South Africa.
- The mining areas is fully mechanized with integrated mining methods including horizontal development ends, destress development, and long-hole stopping supplemented by scattered drift and benching.
- The current operating trackless fleet consists of 16 drill rigs, 23 LHD's, and 19 dump trucks.
- There are 17 internal tips of which 11 has been converted to remote impact breakers.

Remote Operated Impact Breaker

Where the Journey Started… "Mine of the Future"

Horizon 1

Operational technologies and Internet Of Things

Technology UG:
- Newtrax deployment
- People location tracking
- Machine guidance
- One hole automation (LHS drilling)
- Environmental sensing testing

Studying and POC:
- LTE/5G network
- Alternative high bandwidth network

Establish:
- MineHops Node network

Network backbone

Expansion of:
- Voice radio coverage
- WIFI footprint
- Fiber capacity

Trailing:
- Surface tele remote rock breakers
- Surface tele remote LHD

Establish:
- Digital Control Centre
  - Safety management
  - Water management
  - Backfill monitoring
  - Mining control
  - Maintenance management

Interoperability

Horizon 2

Technology UG:
- Collision avoidance trials and deployment
- Secondary support technology
- Ring drilling automation (LHS)

Deploying:
- LTE/5G network
- Alternative high bandwidth network

Control centre:
- Mining Control Processes development (Optimine)

Interoperability
- MineRP Spatial Integration
- Include integrated processing (IoT Hub)

Expand on:
- Surface Tele remote rock breaking
- Surface Tele remote LHD
- Backfill automation
- Energy management strategy deployment
- Ventilation management

Horizon 3

Technology UG:
- Battery powered TMM
- Haulage automation
- Tramming automation

Technology Plant:
- Advanced process control

Trailing:
- Robotic Process Automation

Establish:
- Augmented decision making

Establish:
- Advance real time analytics and reporting
- Connected and integrated Value Chain analysis

Improve on:
- Real-time dashboards
- Integrated business planning (incl. financial integration e.g. SAP)

Establish:
- Reporting: SQL Server Reporting Services
- PowerBI report development
- Analysis: SigmaXL and ChartRunner

- Energy management strategy development

AUTOMATE
OPTIMISE
FOUNDATION

Digital Control Centre, Application Design & Data Infrastructure | **Integrated platforms, analytics and reporting**

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Remote Operated Impact Breaker

Problem Statement

- Impact breaker operators are exposed to hazardous environmental conditions (noise, dust, diesel particulate matter, thermal stress, and other gasses in their working areas).

- Safety hazard as operators are exposed to trackless machinery and relevant equipment in tipping areas.

- Time lost during movement/ traveling of operators to their respective tips to start working.

- Delays experienced where tips are often blocked on the grizzly that prevents further tipping unless the tipping areas are cleaned.

Opportunity description

- Utilise dead time for continued operators, such as shift changes, travelling time.

- Integrate with autonomous LHD and other remotely operated equipment network.

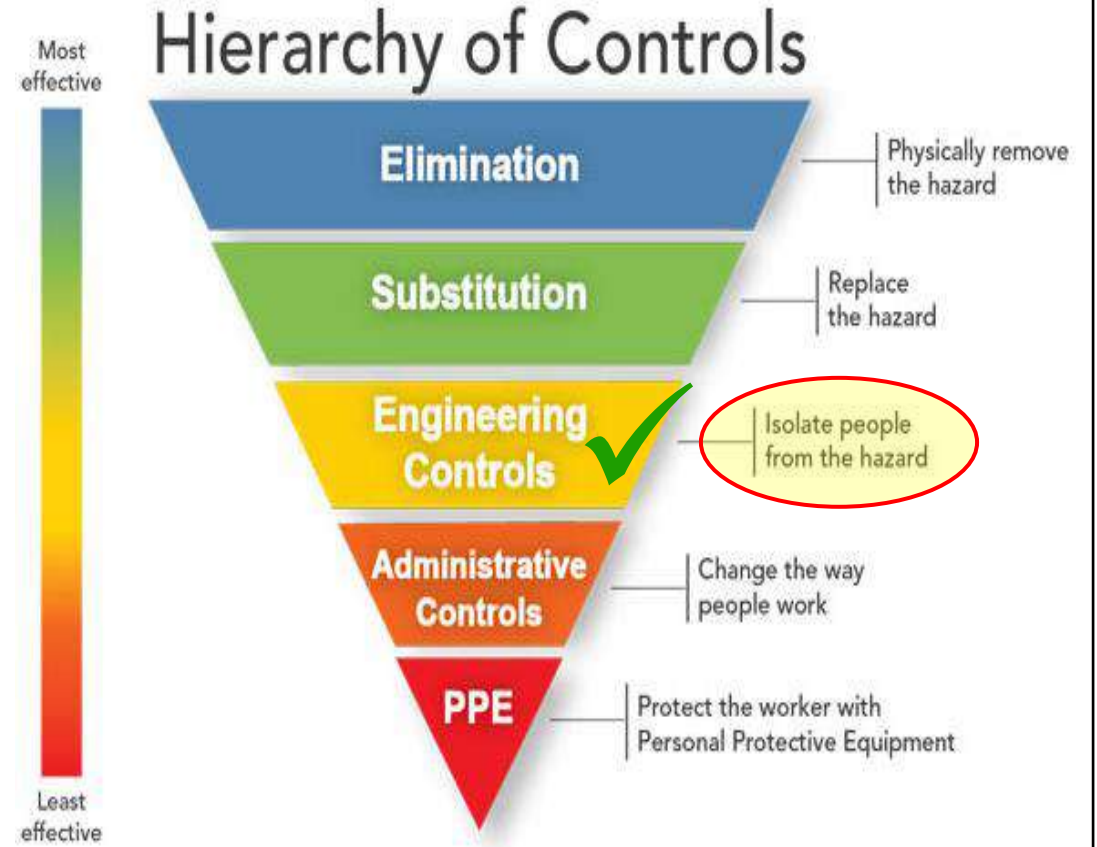- Prepare the tips for the next load to be dumped without delays.

Remote Operated Impact Breaker

Risk Management Perspective

Risk Analysis

		RISK IDENTIFICATION AND ANALYSIS		RISK ASSESSMENT			RISK TREATMENT	
NO	RISK	CONTEXT AND SUB RISKS	RISK OWNER	S	P	R	FURTHER MITIGATING ACTIONS	RESPONSIBLE PERSON
1	Safety	Tip and Impact breakers failure endangering people's lives	Engineering	6	9	54	• Upgrade the Impact breakers to operate remotely	Vuyo Shumani
2	Health	Exposure to dust, noise, fumes, and thermal stress	Occ Hygiene	6	9	54	• Reduce personal exposure to Occupational Hazards by removing employees from te environment	S Vreugdenburg
3	Productivity	Tips not operating cause production losses Tip not operating or are not enabled prevent remote loading	Innovation & Technology	4	9	36	• Condition monitoring • Roll out program aligned with remote loading program	Vuyo Shumani Johan Sliep
4	Quality	Reputable suppliers- cost over quality Poor installation of tips	Engineering	4	9	36	• Adhere to specifications and uphold standards, reputable workmanship of installation	Louis Oosthuizen
5	Cost	Operational cost will rise if maintenance or upgrades is not up to standard	Engineering	3	9	27	• Adhere to specifications and uphold standards, reputable workmanship of installation	Louis Oosthuizen
6	Resources	Lack of skilled resources to execute the tele remote automation process	Engineering	3	9	27	• Local supplier of solution with availability of support • Involvement in execution of product transfer skills	Louis Oosthuizen

Hierarchy of Controls

Most effective

Elimination — Physically remove the hazard

Substitution — Replace the hazard

Engineering Controls — Isolate people from the hazard

Administrative Controls — Change the way people work

PPE — Protect the worker with Personal Protective Equipment

Least effective

Remote Operated Impact Breaker

Benefits of using Tele-remote Impact Breakers

Safety - Overall reduction of risk in terms of safety:
- Reduced human/ machine interaction.
- Reduced incidents and injuries.

Health - Overall reduction in occupational exposures:
- Reduced exposure to occupational hazards (noise, dust, DPM, thermal).
- Improved ergonomics.
- Reduced fatigue.

Business Improvement - Improved efficiencies:
- Reduction in delays.
- Reduced travel time to start operating
- Multiple tips/ impact breakers can be operated by one operator.
- Tips/ impact breakers can be operated uninterruptedly during blasting times.

Unlocking Peoples Potential – Attract skills and Talent
- Attract talented and skilled people – future generation seeks modern, clean and futuristic working environments and occupations,
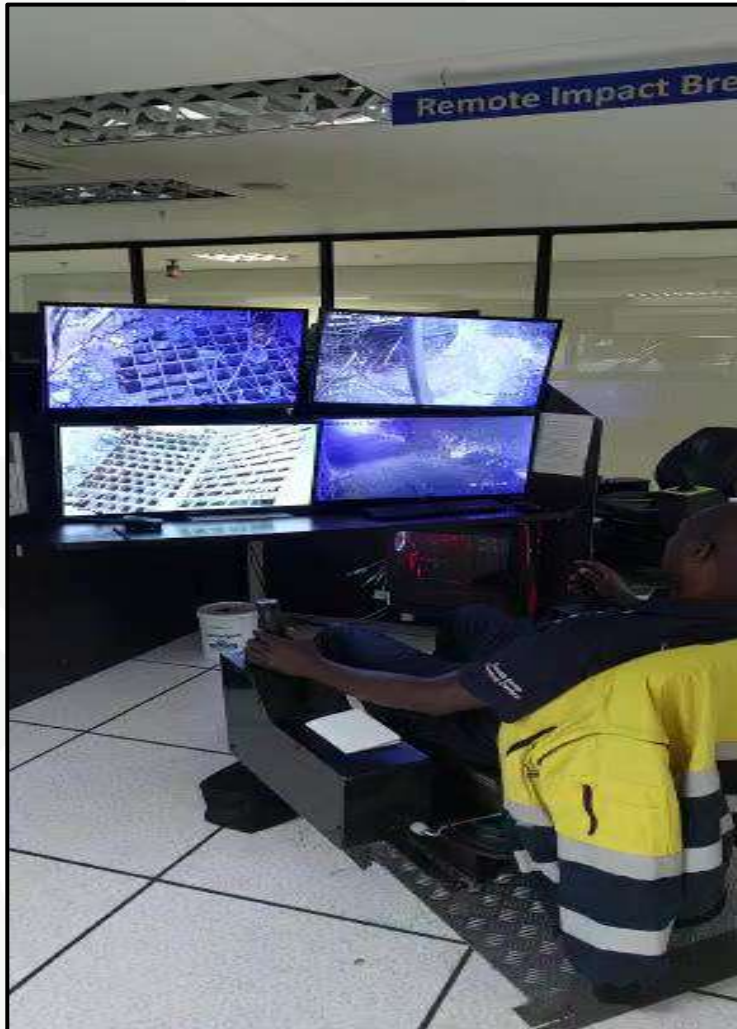- Employ people with mobility limitations/ restrictions.

① Safety Leadership

④ Optimised Delivery

⑤ Business Modernisation

② Unlocking Our People's Potential
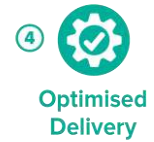
Gold Fields Strategic Framework

Remote Operated Impact Breaker

*Control Room Setup for Remote Impact Breakers*

- South Deep Mine has deployed 4 rock impact breaker operator stations that can operate any of the eleven impact breakers underground from the surface Central Control room.
- Software development on the video feed allows switching the cameras between tips seamlessly without affecting the latency of the feed.
- The next steps (Horison 3):
  - Rock Impact Breaker Automation through Machine Learning and Artificial Intelligence (AI).

Remote Operated Impact Breaker

Remote Impact Breaker System Requirements
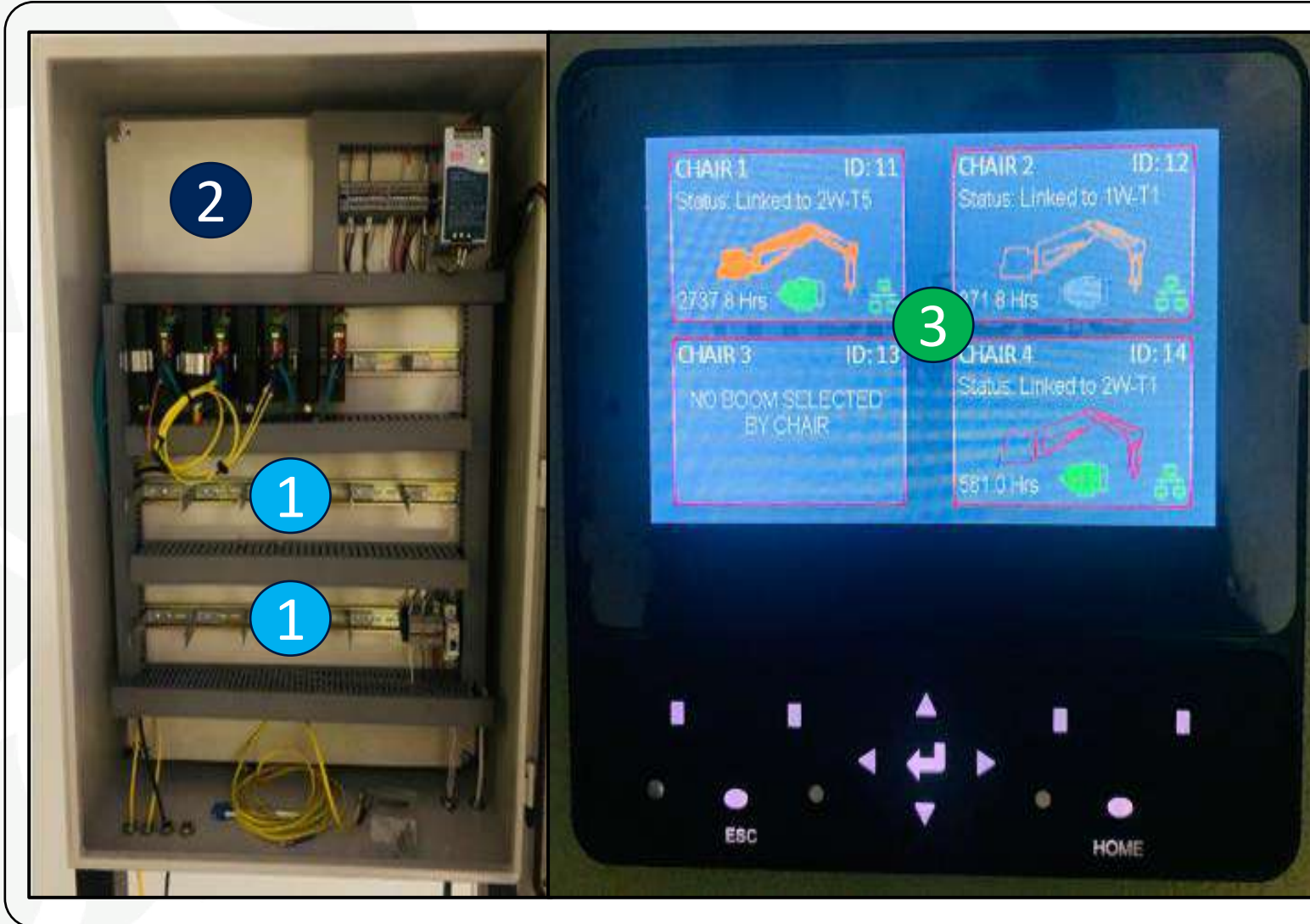
1 Panels for additional tips

2 Requires a splice box for multi boom chair and ruggedized patch leads to splice box

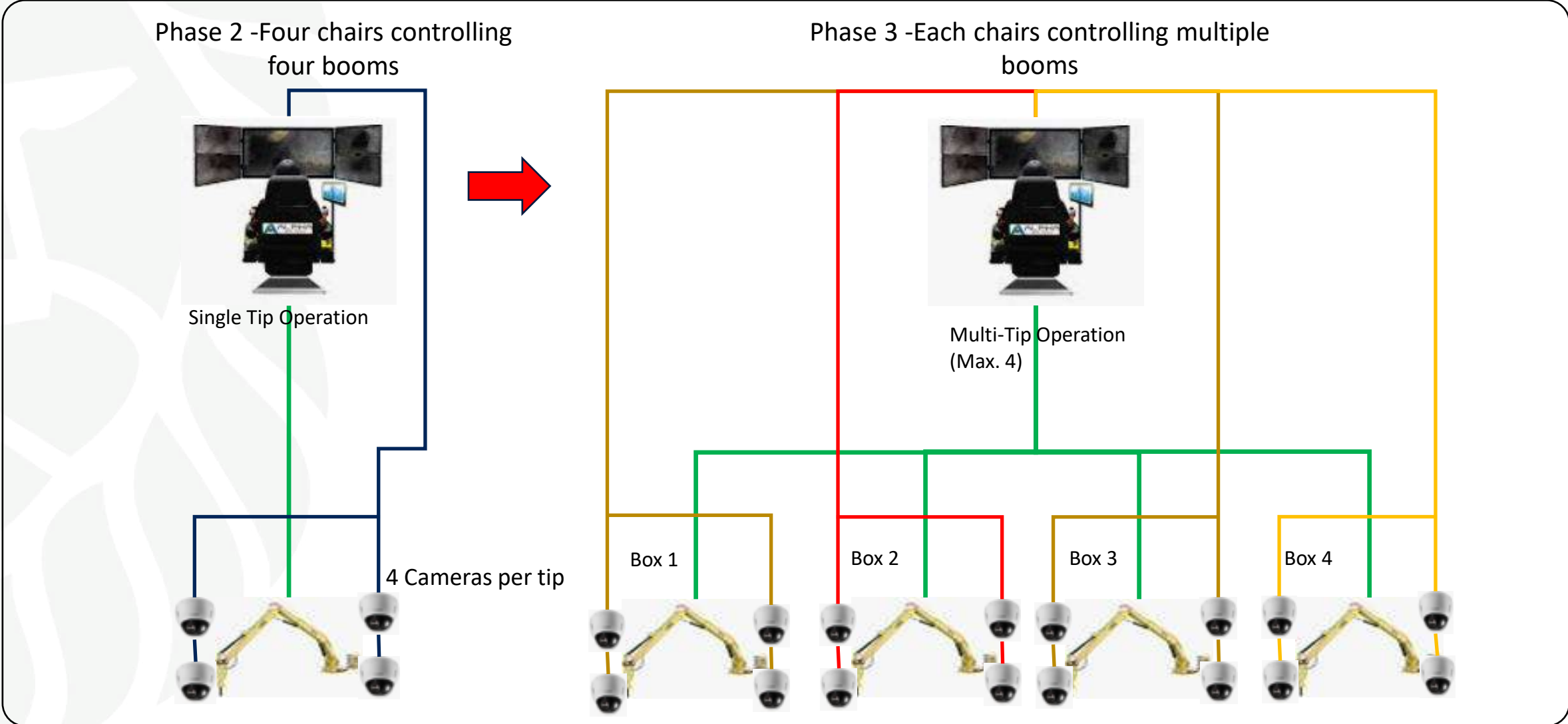3 Currently a 4 x DM430 unit that requires replacement with a 1 x DM1200 HMI unit

Requirements for Remote Operating System:
- Dedicated fibre network system connecting to underground workings. One line for chair to impact breaker, one line for camera to control room.

Remote Operated Impact Breaker

Tele-remote Impact Breaker Functionality - Expansion

Phase 2 -Four chairs controlling four booms

Single Tip Operation

4 Cameras per tip

Phase 3 -Each chairs controlling multiple booms

Multi-Tip Operation (Max. 4)

Box 1   Box 2   Box 3   Box 4

Remote Operated Impact Breaker

Impact on Personal Exposure - Comparison

Personal Sampling Comparative Results – Noise, Silica Dust, and DPM

Underground to Surface exposure comparison	Noise	Dust		DPM
	10*log Average	Dust TWA	TWARQC mg/m³	Total carbon TWA mg/m³
Impact Breaker	89.1	0.349	0.106	0.099
Tele-Remote Impact Breakers	78.1	0.016	0.002	Not Applicable
% Improvement	**12%**	**95%**	**98%**	
LHD Operators	91.8	0.306	0.070	0.128
Tele-Remote LHD Operators	78.1	0.016	0.002	Not Applicable
% Improvement	**15%**	**95%**	**97%**	

Remote Operated Impact Breaker

Safety Precautions

NB: Control between "Surface" or "Underground" use can only be changed physically at the underground installation.

Remote Operated Impact Breaker

Next Steps

- Expand into full automation for impact breakers.
- Rock Impact Breaker Automation through Machine Learning and Artificial Intelligence (AI).

Deep learning on Actuation Angles including Slew for optimized impact breaking
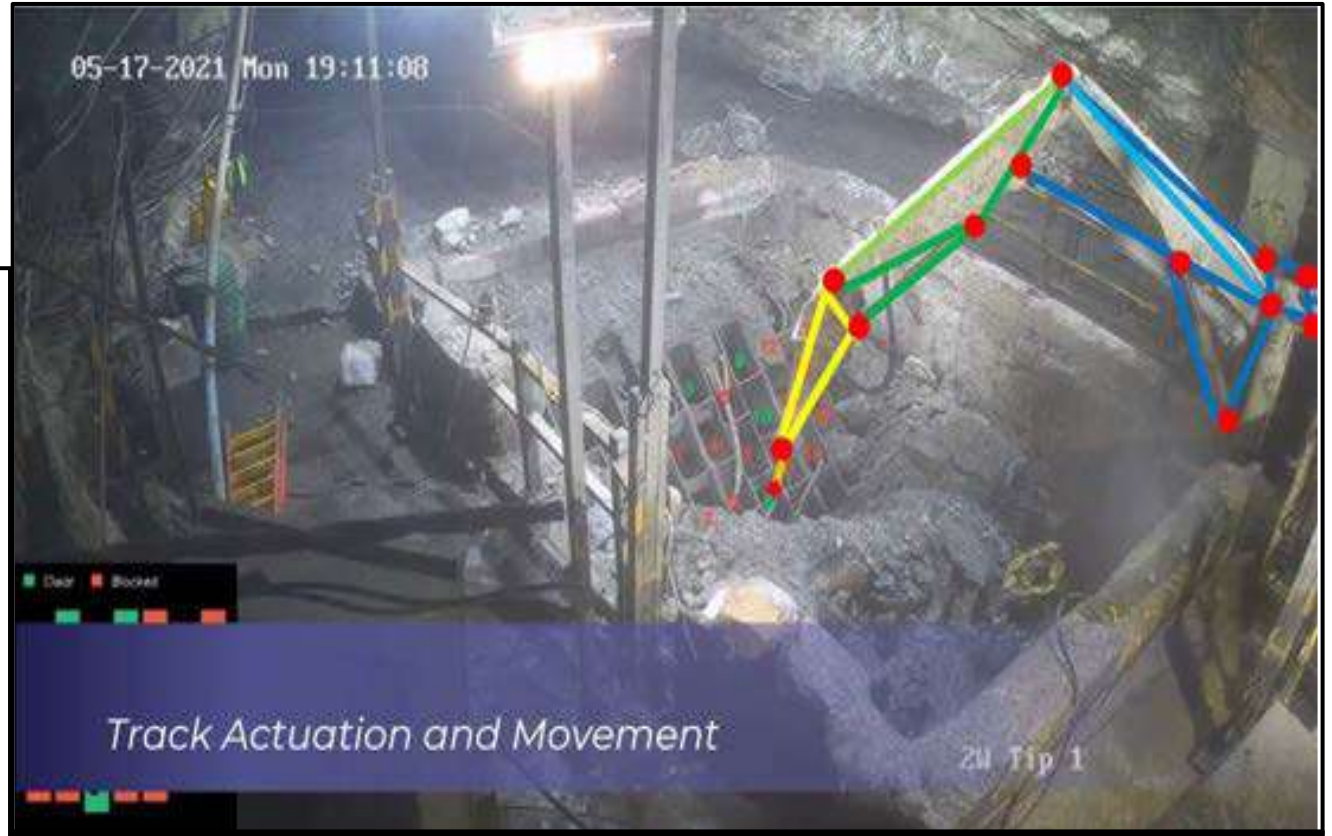
Visualmind AI: Detect and track impact breaker tip location and pose & 3D Actuation using multiple cameras

Track Actuation and Movement

Remote Operated Impact Breaker

Other Tele-remote operations of Equipment – LHD Operating Autonomously

THANK YOU

Questions?

Sishen Mine

Noise Control: Gouging

21 September 2023

Gouging

HME Engineering Maintenance

WHAT IS GOUGING?

- Melting operation for <u>removal</u> of metal using current (power supply), electrodes (carbon) and high-pressure air, mainly in connection with welding

CARBON ELECTRODE

AIR JET

Air carbon arc gouging.

Anglo American
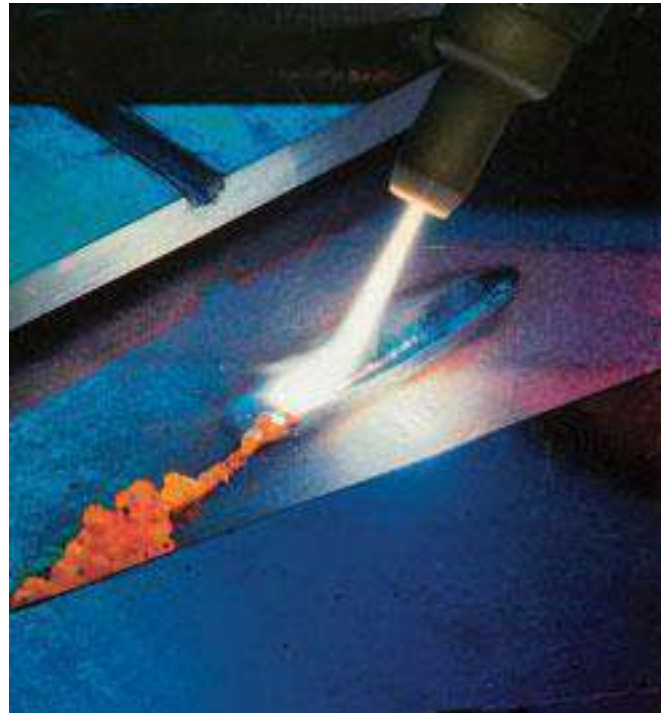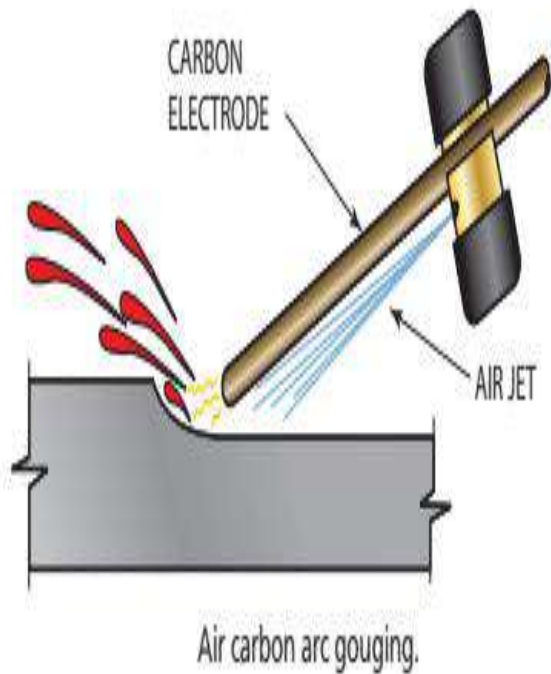
THEORY

Variable factors	Indicated Highest Efficiency
Reduce Air Pressures	90 Psi / 620 kPa
Selection of power supply	CV
Process (SAW/MIG/etc)	MIG
Selection of voltage	35 V
Selection of rod sizes	Smaller rod diameter

LEARNINGS

Noise Rating Levels using Transformer type welding machine on Constant Current
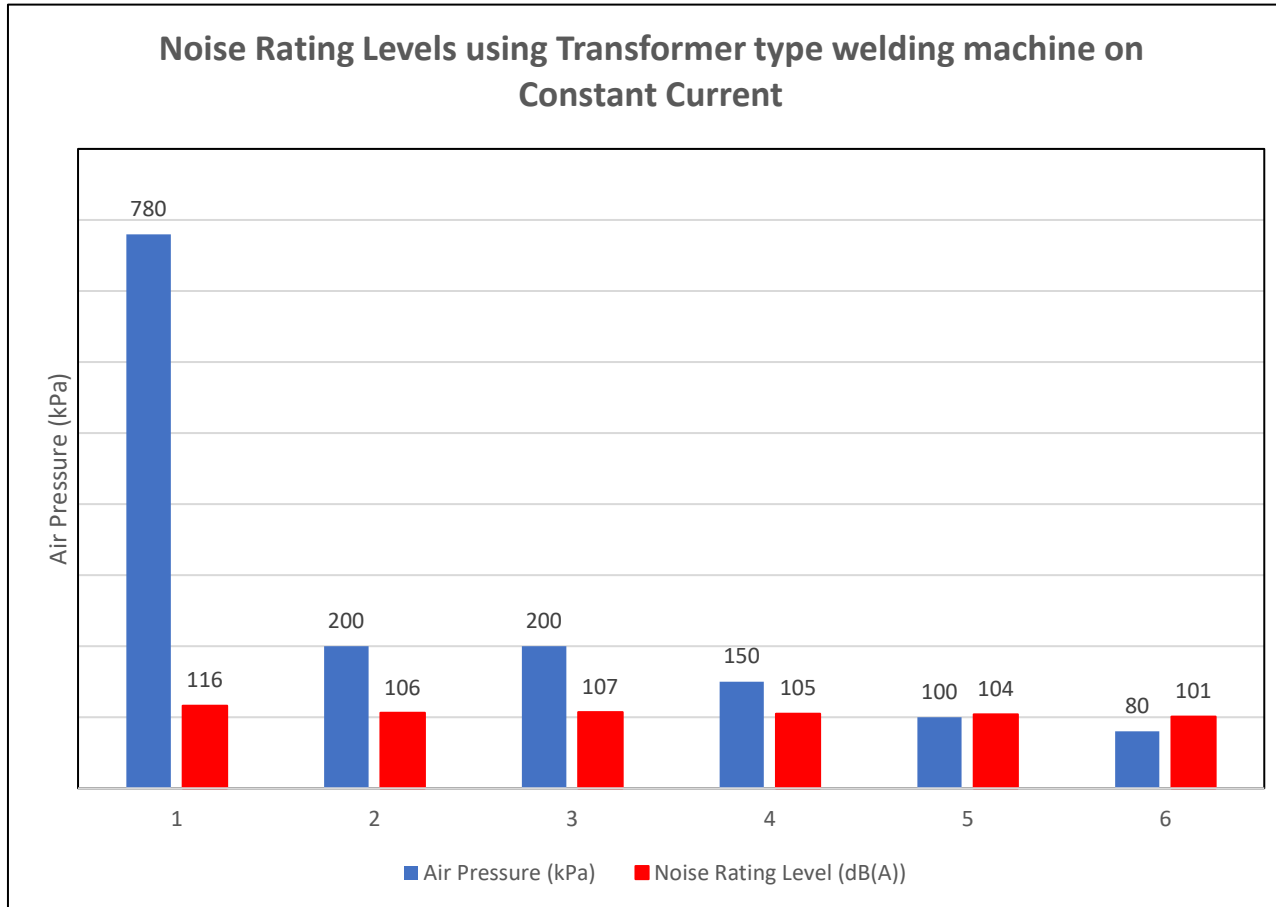
PROS:
- Noise reduction to ≤ 107 dB(A)

CONS:
- Insufficient air pressures
- Behavioural factors
- Poor quality finish
- Low air supply pressure impacted on other tools

Breaking down the barriers – If it is not noisy, it is not working

TESTING RESULTS – INVERTER TYPE WITH SAW PROCESS

**Noise Rating Levels at 65 V
Open airline vs Regulated airline**

	827	758	758
	109,8	103,9	111,9
	1	2	3

■ Air Pressure (kPa)   ■ Noise Rating Level (dB(A))

Noise rating levels at different Voltage settings

	109,8	106,4	105,7	109,9	106,5	106,7
Voltage	65	60	55	50	45	40
	1	3	4	5	6	7

■ Voltage   ■ Noise Rating Level (dB(A))
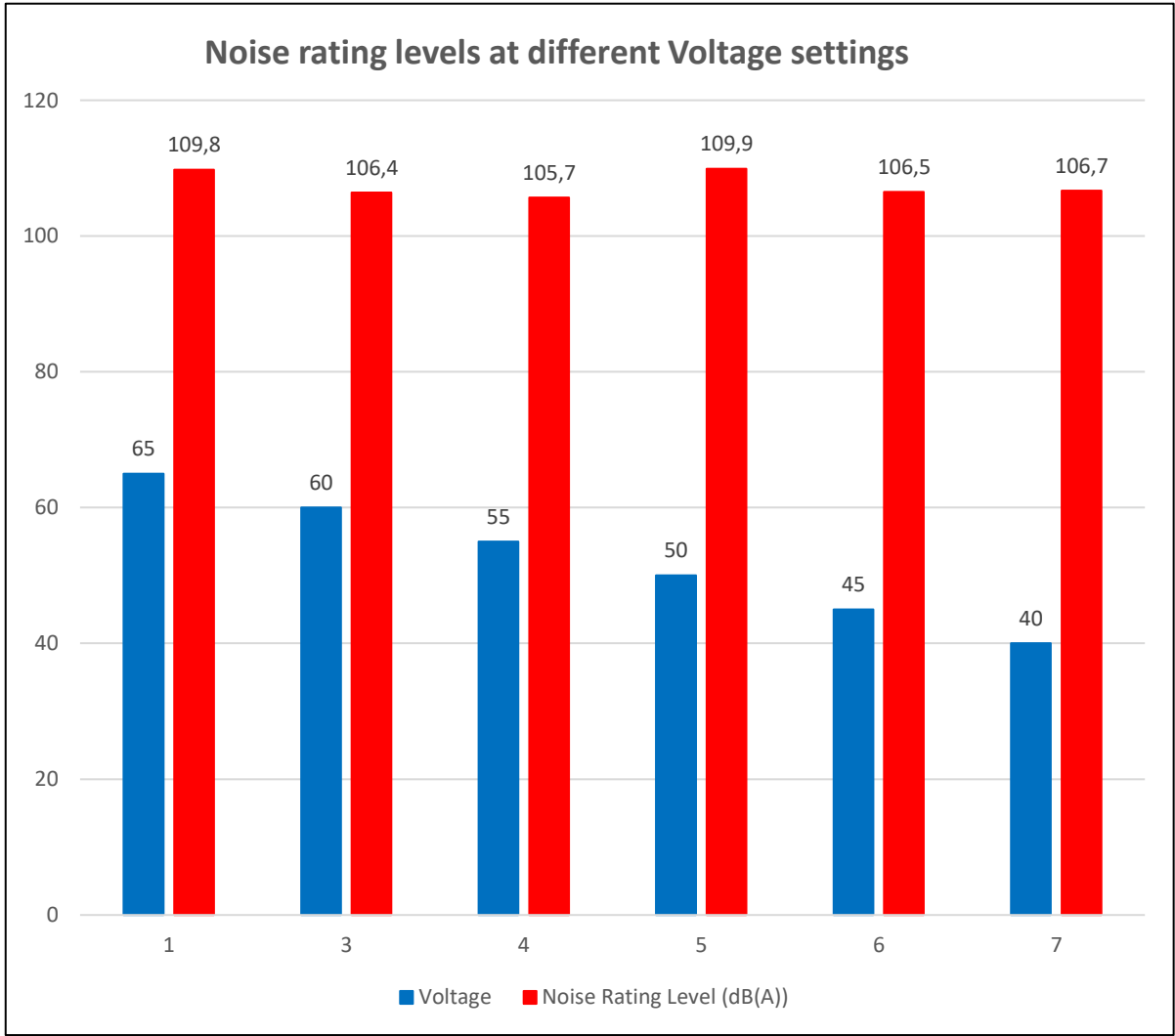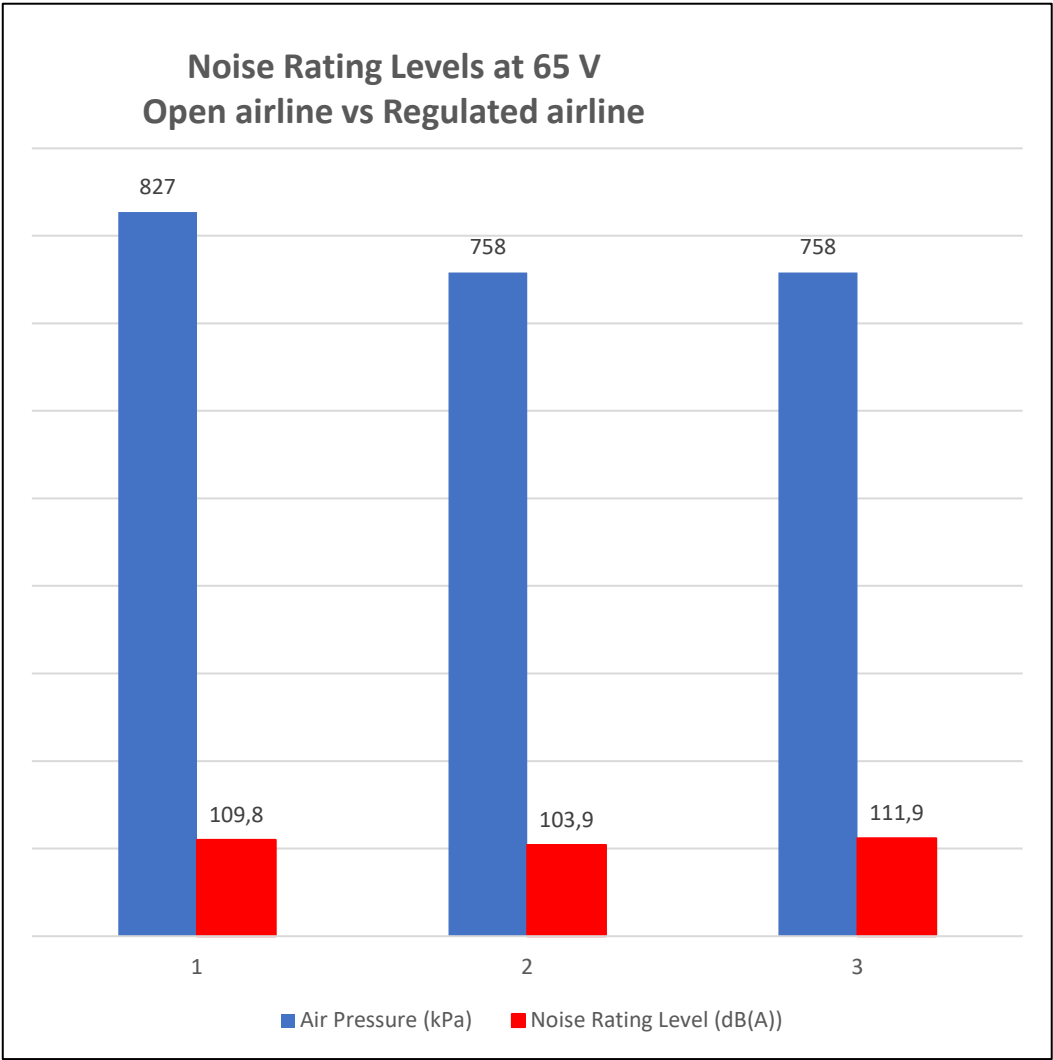
TESTING RESULTS – INVERTER TYPE WITH MIG PROCESS

Noise Rating Levels at 620 kPa with various voltage settings using 8 mm Rod

Setting	Voltage	Noise Rating Level (dB(A))
1	45	108,6
2	44	106,5
3	42	107,3
4	40	104,1

■ Voltage ■ Noise Rating Level (dB(A))

Noise Rating Levels at 552 kPa with various voltage settings using 9.5 mm Rod

Setting	Voltage	Noise Rating Level (dB(A))
1	44	110,6
2	40	106,7
3	38	102,6

■ Voltage ■ Noise Rating Level (dB(A))
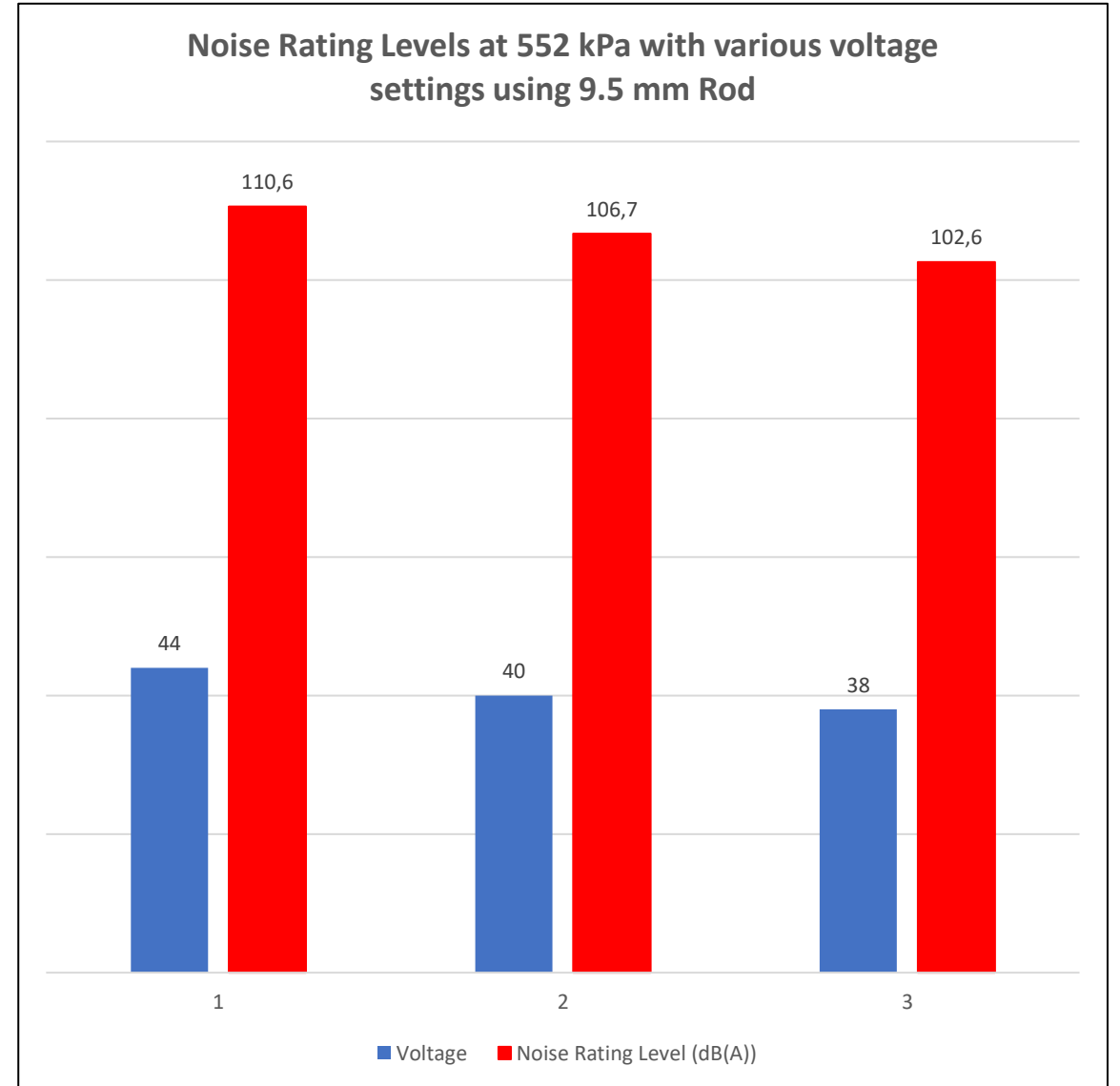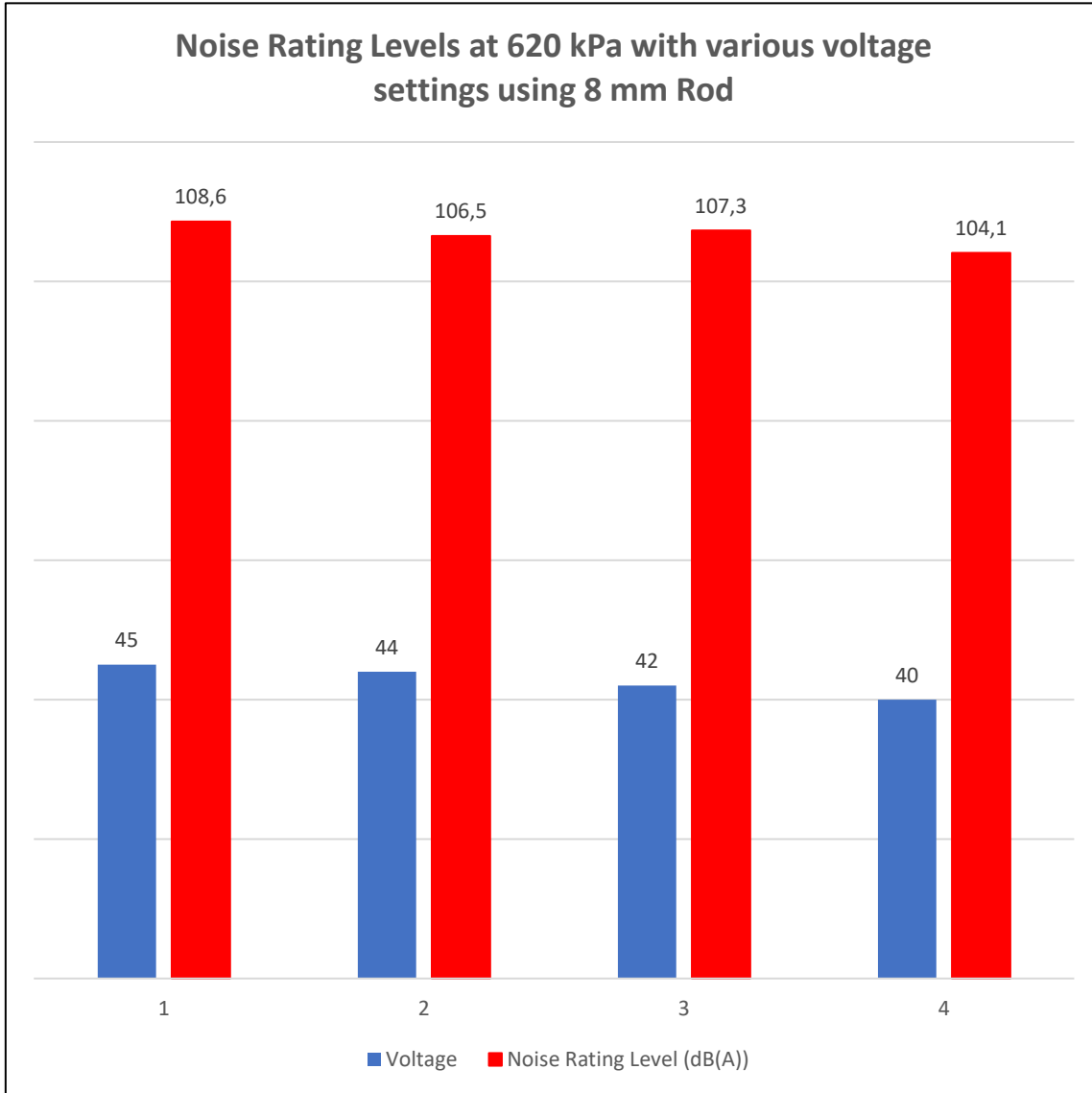
SUMMARY

1. SAW process selection reduced noise but remained > 110 dB(A)

2. MIG process selection had the desired noise reduction with the following settings:
   a) For 8 mm gouging rods:
      - 40V @ 90 Psi / 620 kPa = **101.3 dB(A)**
      - Increasing voltage to 42 V resulted in noise levels not conforming to the 107 dB(A) milestone level (measured levels at 107.3 dB(A))

   b) For 9.5 mm gouging rods:
      - 38 V @ 80 Psi / 552 kPa = **100.9 dB(A) to 103.8 dB(A)**
      - Increasing voltage to 40 V resulted in noise levels not conforming to the 107 dB(A) milestone level (measured noise levels at 106.7 dB(A))

CONCLUSION

Based on the tests conducted Sishen has resolved to undertake the following

- Implementation of IBMQ Policy to foster and enhance
- OEM/Supplier engagements
- Adopt a holistic approach on Hierarchy of Controls
- Continuation of relationship with Engineering departments on technology advancements and control of OH stressors
- 3 month trial on new inverter MIG gouging process
- Review and document new gouging procedures
- Training of employees on reviewed gouging procedure
- Phase-out old gouging techniques/tools and roll-out of the new inverter MIG gouging process

AngloAmerican

THANK YOU

THEME 3: NOISE QUALITY MANAGEMENT

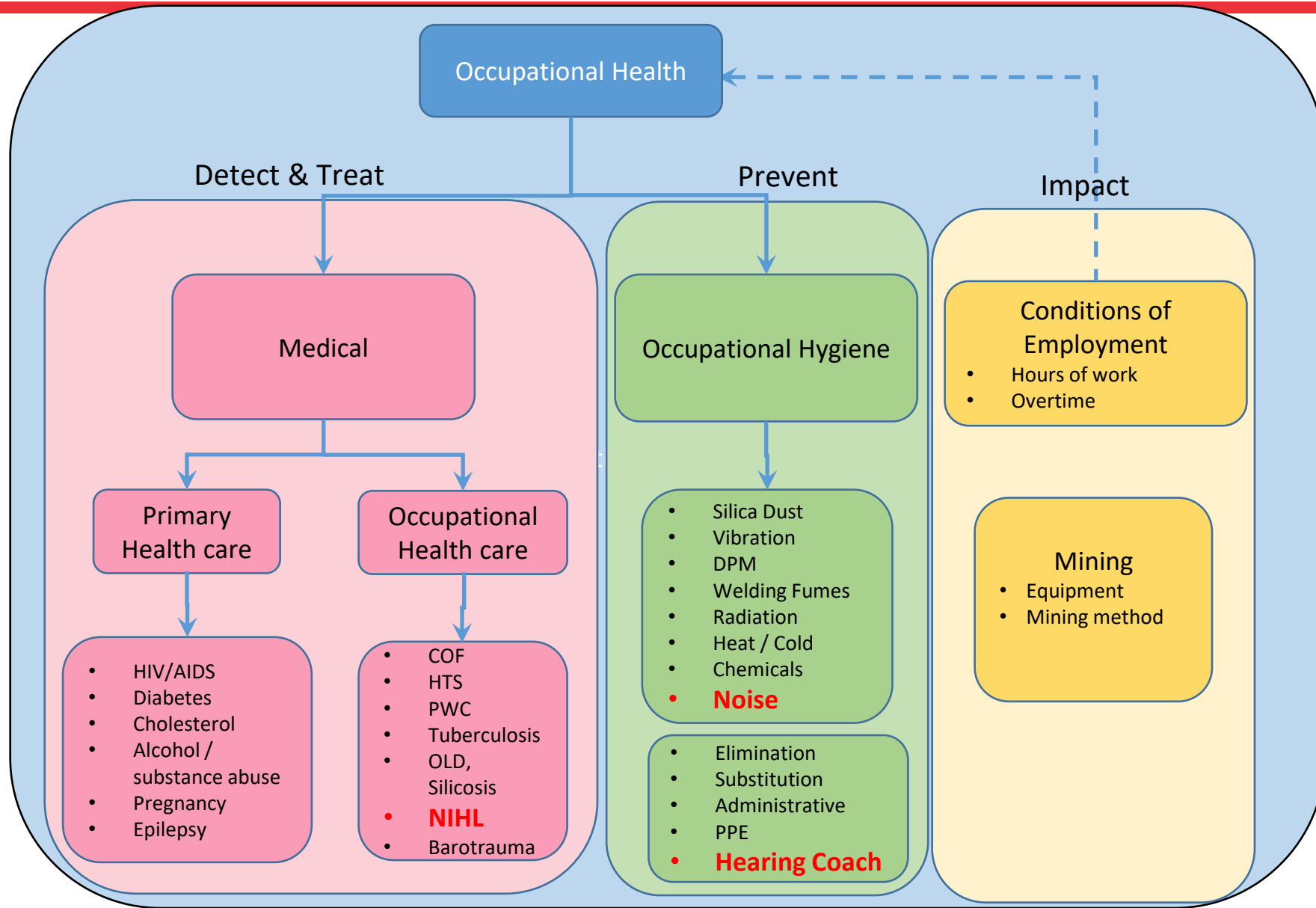| THEME 3: Noise Quality Management		
Oto Acoustic Emission Testing in Noise Risk Management at Harmony Gold	D Labuschagne	13:15-13:35
In Ear Fitment Testing Application at Seriti Resources, Middelburg Mining Services	N Mgwenya	13:35-13:55
The application of Continuous Real-Time Monitoring for Quality Assurance at Glencore Alloys: Audiometric Assessments	L Prinsloo	13:55-14:15
Team Quiz	All	14:15-14:30

MINERALS COUNCIL
SOUTH AFRICA

**Otoacoustic Emission Testing in Noise
Risk Management - Hearing Conservation
at HARMONY GOLD MINE**

21 September 2023

Hearing Conservation

Occupational Health

Detect & Treat

Medical

Primary Health care
- HIV/AIDS
- Diabetes
- Cholesterol
- Alcohol / substance abuse
- Pregnancy
- Epilepsy

Occupational Health care
- COF
- HTS
- PWC
- Tuberculosis
- OLD, Silicosis
- **NIHL**
- Barotrauma

Prevent

Occupational Hygiene
- Silica Dust
- Vibration
- DPM
- Welding Fumes
- Radiation
- Heat / Cold
- Chemicals
- **Noise**

- Elimination
- Substitution
- Administrative
- PPE
- **Hearing Coach**

Impact

Conditions of Employment
- Hours of work
- Overtime
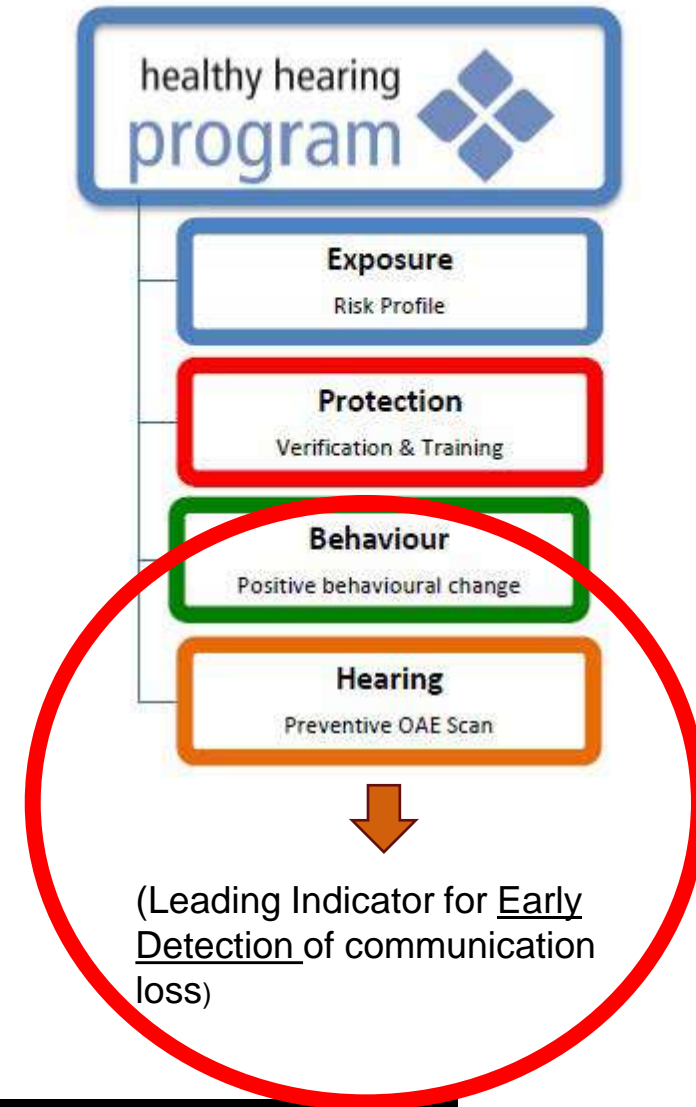
Mining
- Equipment
- Mining method

HARMONY

Why Hearing Conservation?

   CHANGING BEHAVIOUR!
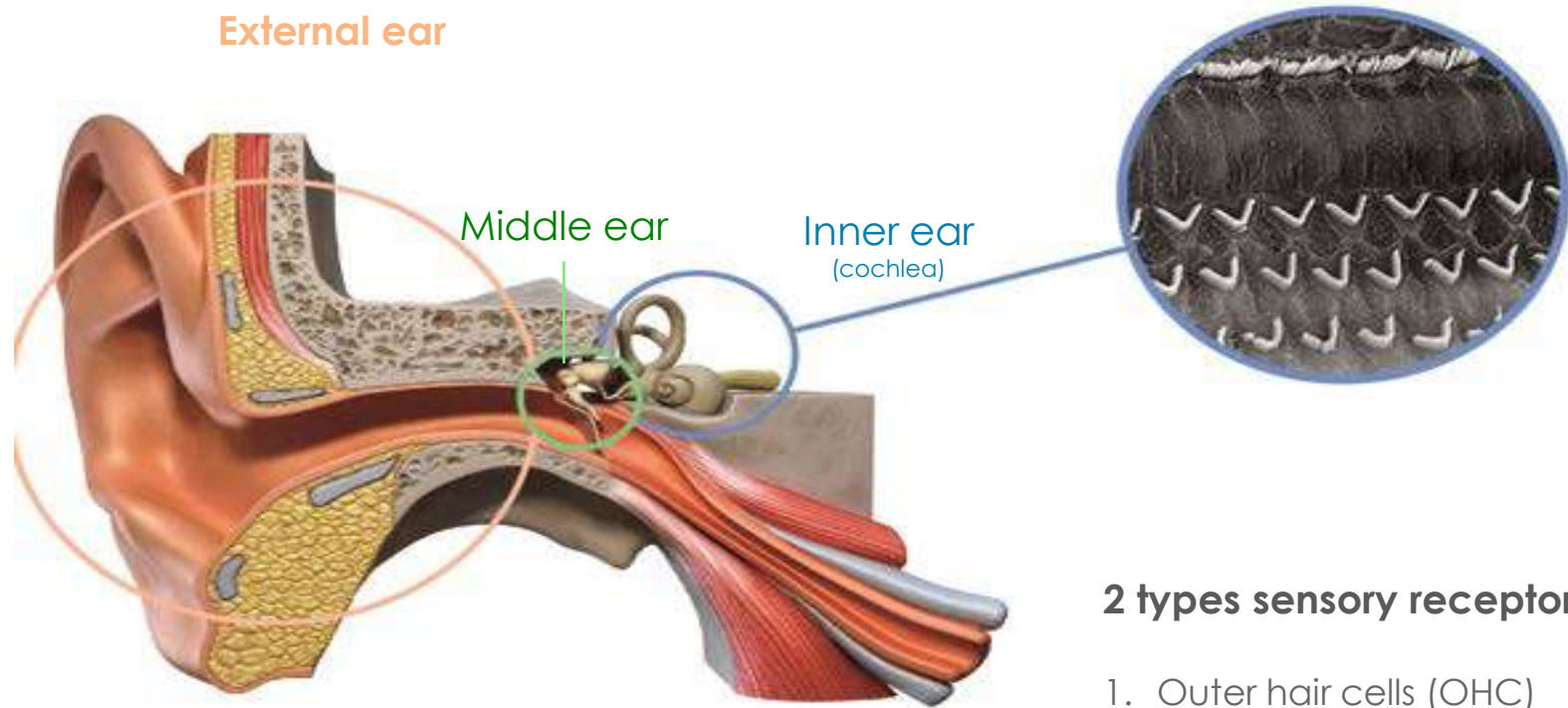
The increasing demands on communication in our society renders the *loss of hearing* as a serious handicap:

   -it limits appeal in the job market
   -reduces work participation
   -results in economic damage to the company
   -*social isolation* for the individual

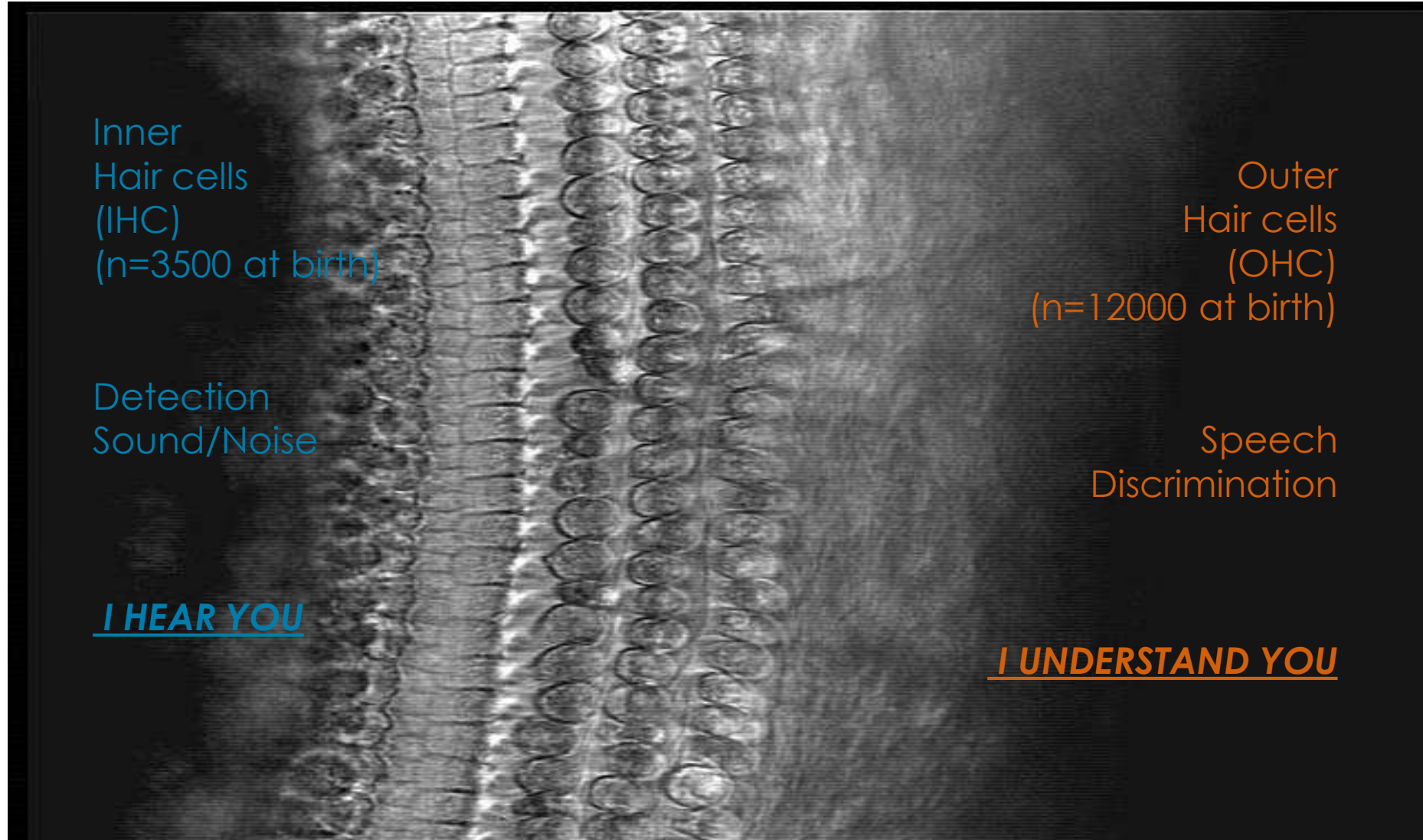*Appropriate focus*: **HEALTH, SAFETY & WELL BEING of each employee exposed to dangerous noise levels**
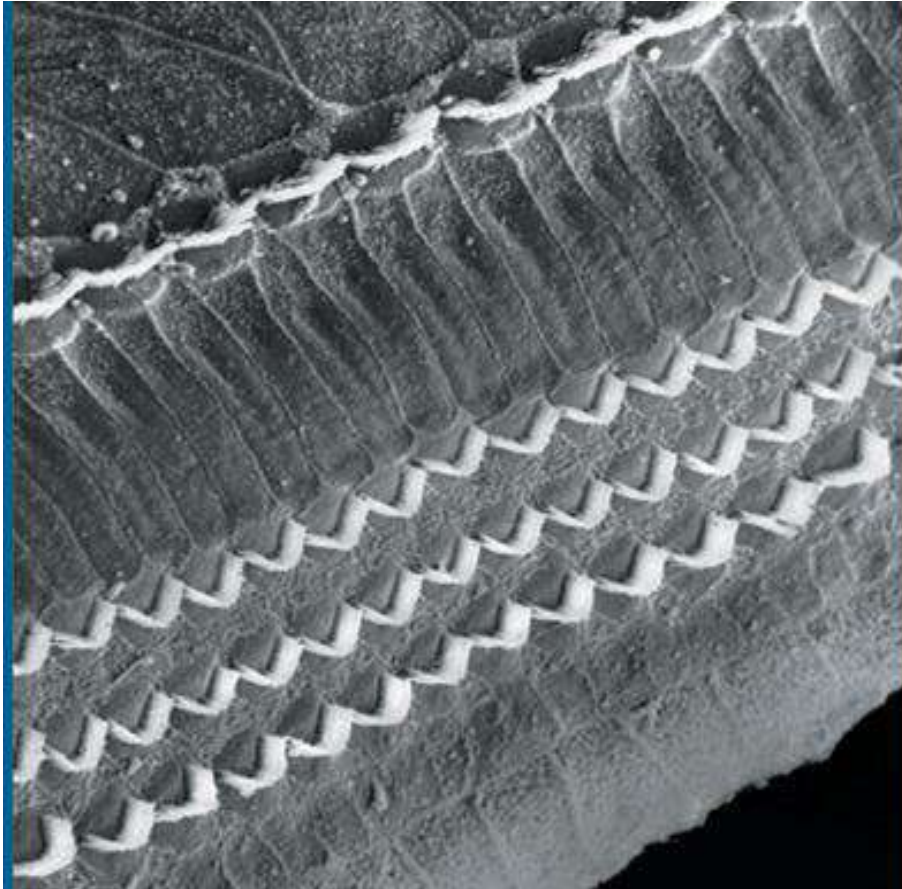

healthy hearing program

Exposure
Risk Profile

Protection
Verification & Training

Behaviour
Positive behavioural change

Hearing
Preventive OAE Scan

(Leading Indicator for Early Detection of communication loss)

Ear Anatomy

External ear

Middle ear

Inner ear
(cochlea)

2 types sensory receptors:

1. Outer hair cells (OHC)
2. Inner hair cells (IHC)

Function of Hair Cells

Inner
Hair cells
(IHC)
(n=3500 at birth)

Detection
Sound/Noise

I HEAR YOU

Outer
Hair cells
(OHC)
(n=12000 at birth)

Speech
Discrimination

I UNDERSTAND YOU

HARMONY

Intact hair cells   # Damaged hair cells
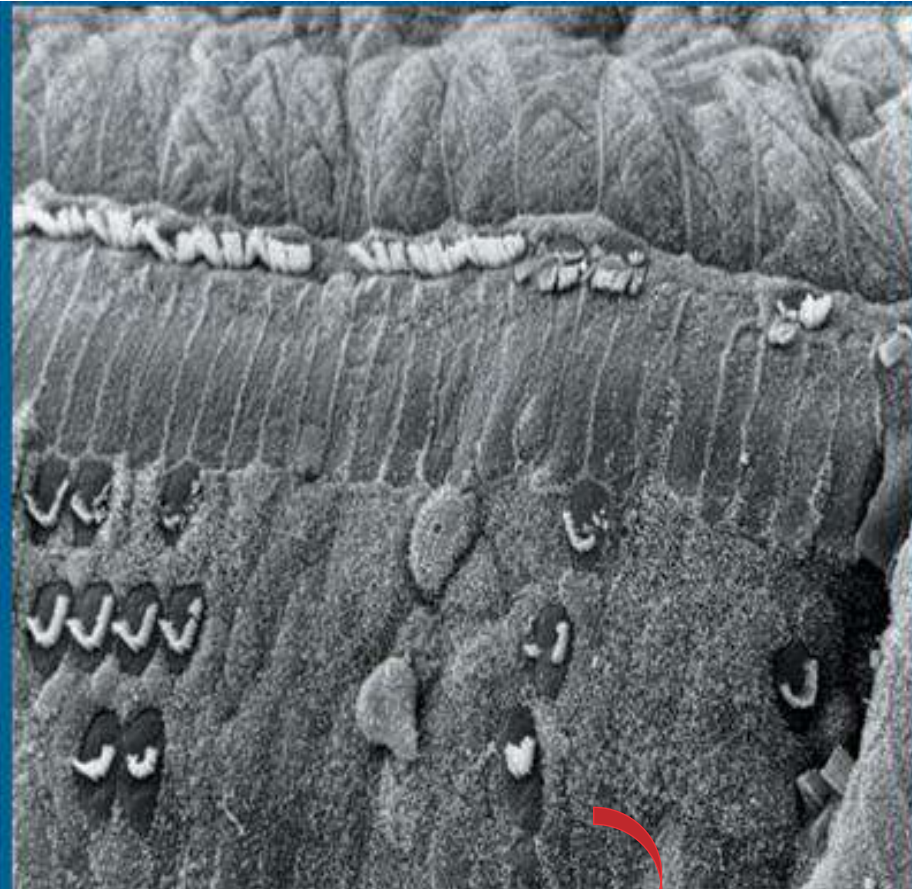
Causes:
-**Overstimulation by noise/sound**
-**Toxins (ototoxic drugs, chemicals etc.)**
-**Viral or bacterial infections**
-**Autoimmune diseases**

The OAE

Otoacoustic emissions (**OAE's**) are sounds that is generated from within the inner ear which can be **recorded by a microphone** fitted into the ear canal.

An otoacoustic emission (**OAE**) is a low-level sound emitted by the cochlea either spontaneously or evoked by an auditory stimulus.

Specifically, **OAEs** provide information related to the **function** of the _**outer hair cells**_ (OHC) (Stach, 2003).

OAE's were predicted by Austrian astrophysicist **Thomas Gold** in 1948 and its existence was first demonstrated experimentally by British physicist **David Kemp** in 1978

The OAE-technique

+ **Leading Indicator for Early Detection of communication loss**

+ <u>Sensitively</u> screens on the spot where <u>first</u> damage occurs

+ Objective and non-invasive technique (no malingering possible)

+ HC Software converts OAE results into <u>%damage</u> for easy interpretation and coaching purposes

+ High test-retest reproducibility

+ Fast (+/- 5 min/person)

+ No special infrastructure (soundproof booth)

+ Easy procedure to execute (probe fitting)

Questionnaire

Otoscopy

Tympanometry

Coaching on results & changing behavior!

OAE screening

Risk Profile (based on noise exposure & years of exposure)

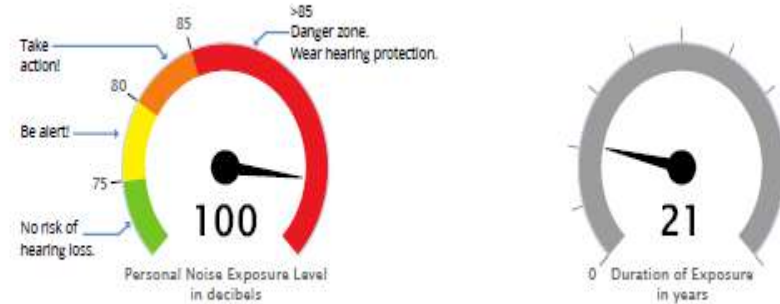
Lower dB exposure and shorter duration of exposure in years = lower risk

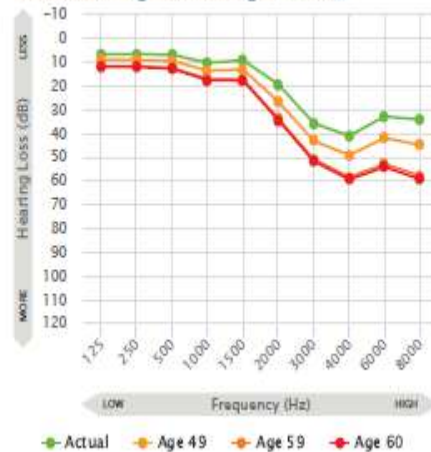# Risk Profile (based on noise exposure & years of exposure)

Higher dB exposure and longer duration of exposure in years = higher risk

OAE (OHC (Outer Hair Cell)) Damage Index Categories and Classification

Outer Hair Cell Damage Index %	Classification System
0%-20%	Damage within **normal** range
21%-40%	Damage progressing towards mild to moderate *communication loss*
50% -85%	Damage is great; therefore, employee might already have a serious *communication loss*
85% - 100%	Damage is serious; might present with poor communication abilities (possible *hearing loss* at certain frequencies)

OAE Report Example
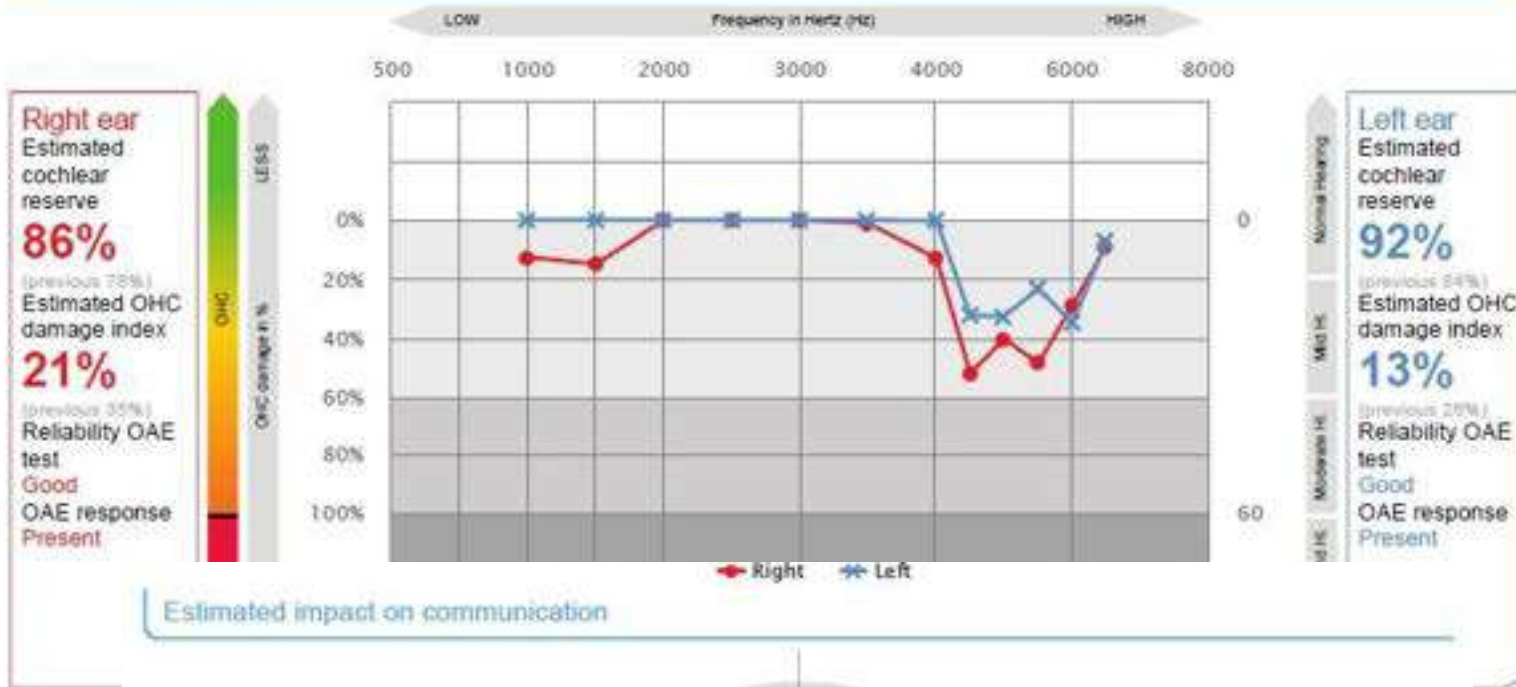
Audiogram vs OAE

Audiogram

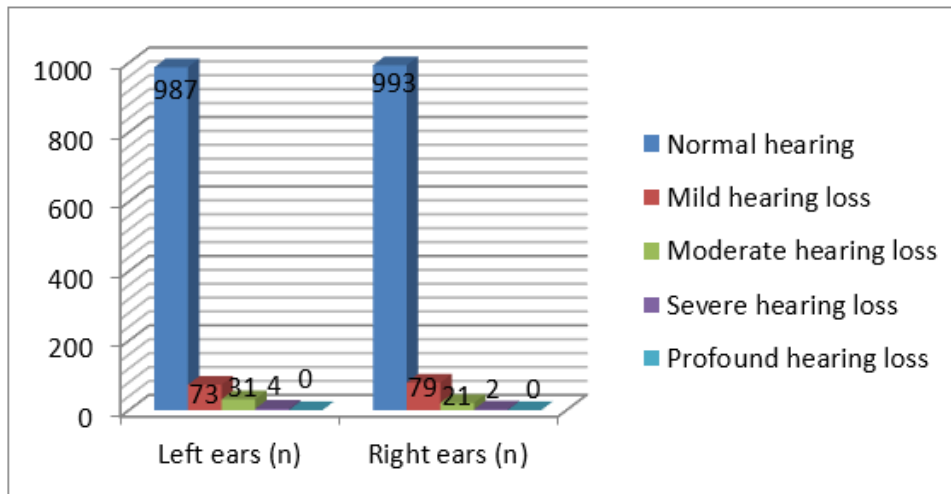Registration of hearing Loss (IHC)

OHC-Scan
(Oto Acoustic Emissions)

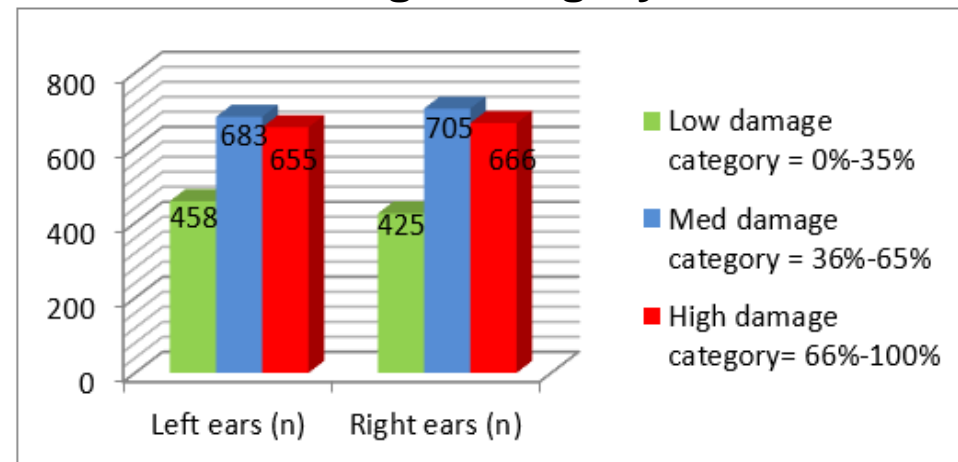Registration of integrity of OHC, communication loss

☐ Visualizes hearing damage in early stage well before visible on the audiogram and even before the person is concerned or aware of it or distressed.

Comparing Screening Audiogram and OAE results

Screening Audiograms:

OHC Damage Category:

Hair cell damage

Right ear
Estimated cochlear reserve
60%
(previous 45%)
Estimated OHC damage index
61%
(previous 78%)
Reliability OAE test
Good
OAE response Present

Left ear
Estimated cochlear reserve
70%
(previous 67%)
Estimated OHC damage index
48%
(previous 52%)
Reliability OAE test
Good
OAE response Present

Legend: Right, Left
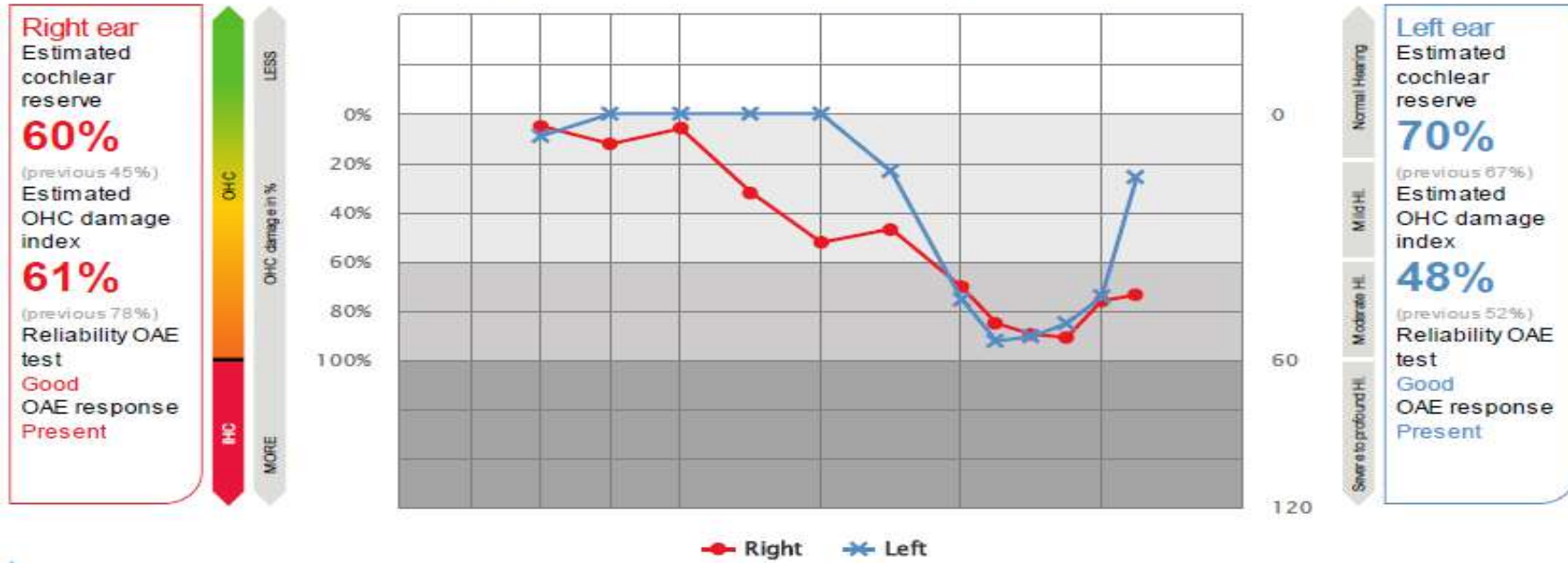
Your audiogram (dated 13-09-2023)

HARMONY

Hair cell damage
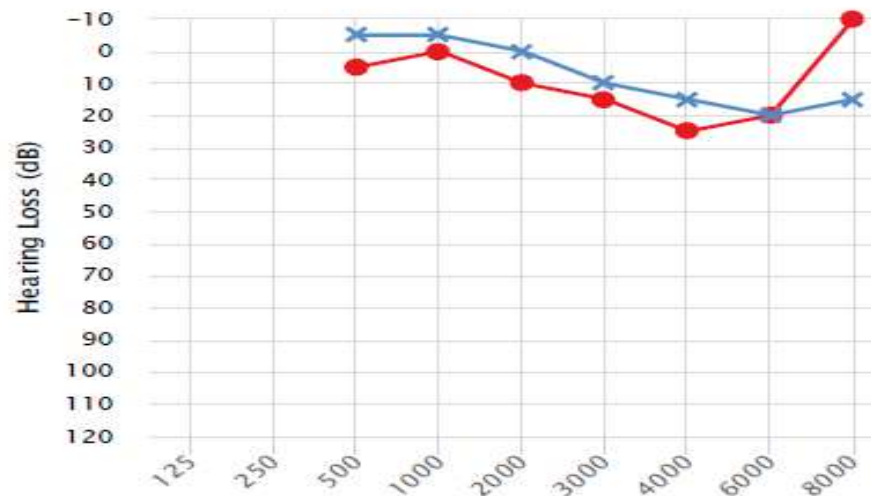
Right ear
Estimated cochlear reserve
50%
Estimated OHC damage index
73%
Reliability OAE test
Good
OAE response
Present

Left ear
Estimated cochlear reserve
54%
Estimated OHC damage index
67%
Reliability OAE test
Good
OAE response
Present

Right   Left

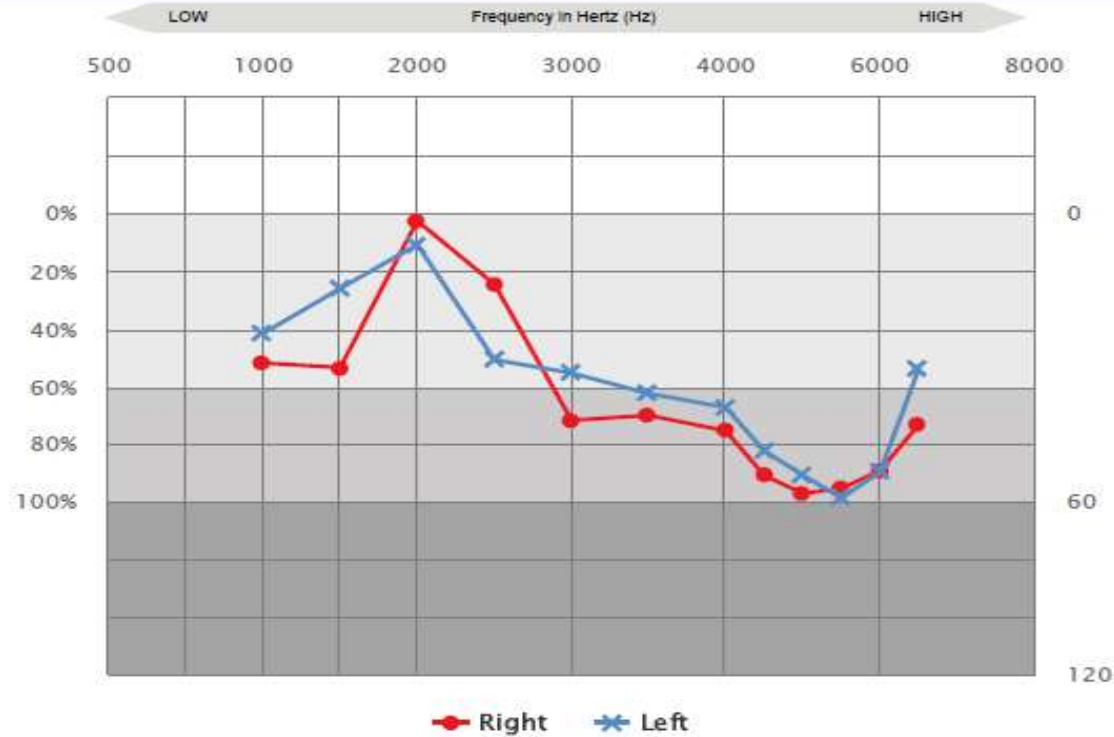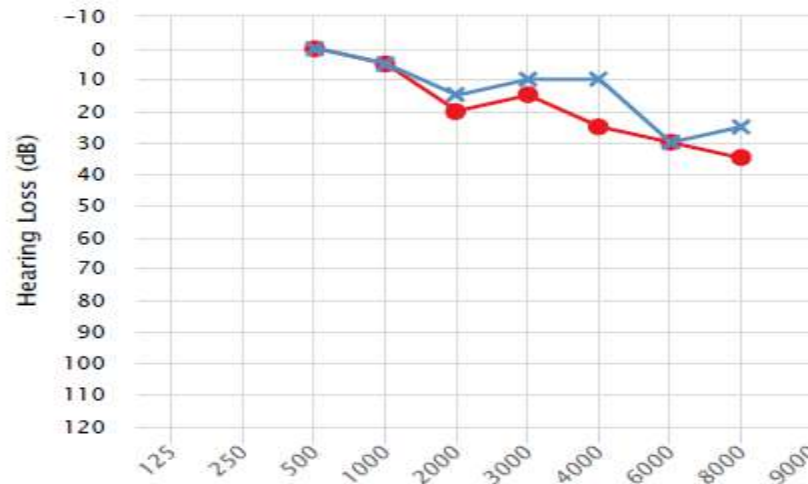# Your audiogram (dated 07-09-2022)

Implementation of *OAE's in Hearing Conservation Program* at HARMONY GOLD

Route Form

Managers & Occ Hygienist
(Pivot System)

OMP's
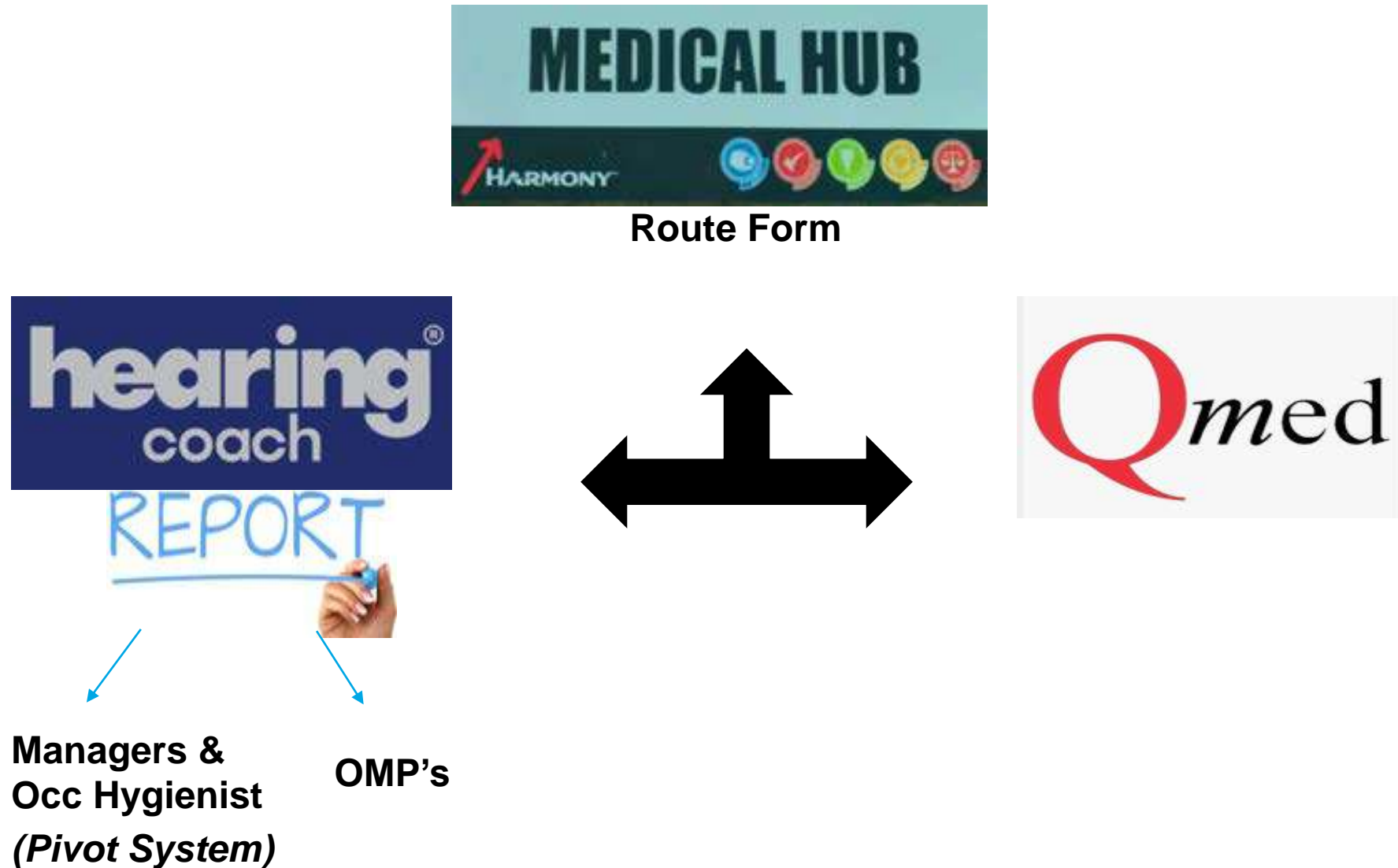
Bilateral % of Outer Hair Cell (OHC) Damage Average for group

Important to note: any shift of 10% or more in Outer Hair Cell damage is considered significant

Chart data points:
- 2013 (n=8977): 54%
- 2014 (n=22001): 55%
- 2015 (n=25560): 55%
- 2016 (n=22601): 54%
- 2017 (n=24526): 52%
- 2018 (n=22338): 52%
- 2019 (n=25720): 50%
- 2020 (n=27491): 53%
- 2021 (n=28514): 54%
- 2022 (n=30775): 54%
- 2023 (n=9517): 55%

— Bilateral % of Damage average
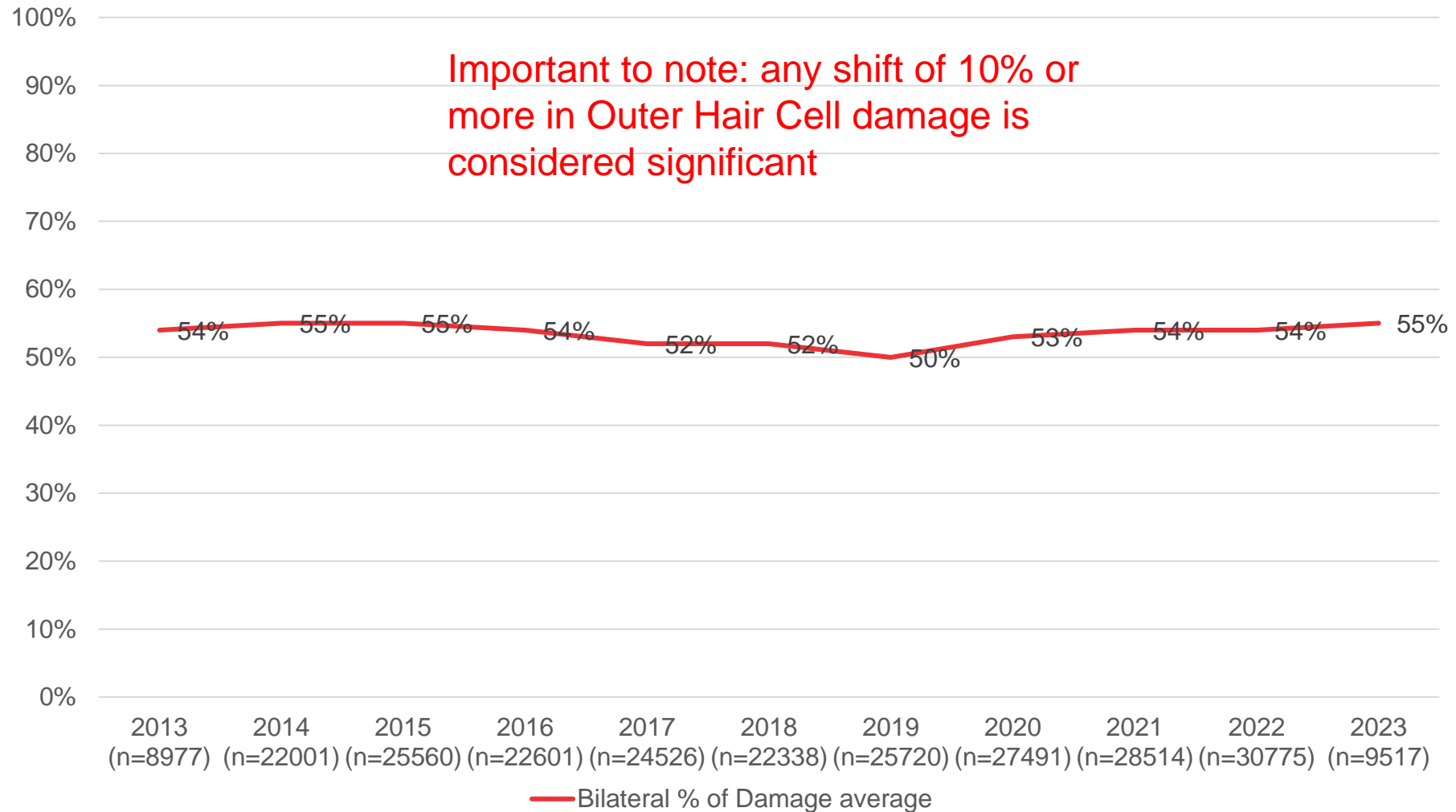
Top 10 Occupations with Highest OHC Damage Index
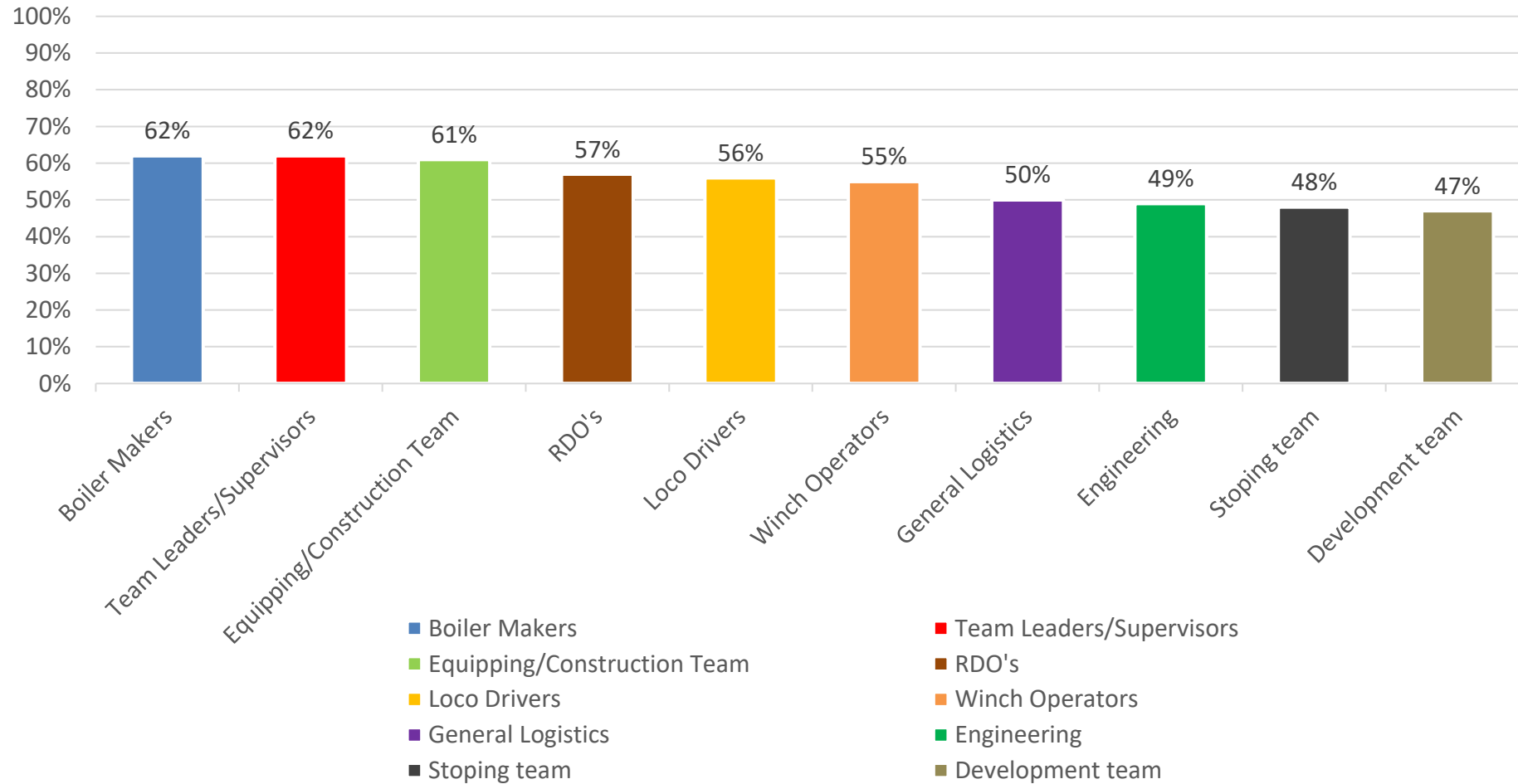
Shift in OAE Results per age group
Pre and Post Covid

Age group	Pre Covid (2014-2019) 6years			Post Covid (2020-2023) 3,5years		
	Shift in OHC Damage	Actual OHC Damage		*Shift* in OHC Damage	Actual OHC Damage	
		2014	2019		2020	2023
60-69yrs	2%	71%	73%	4%	74%	78%
50-59yrs	4%	61%	65%	3%	67%	70%
40-49yrs	6%	45%	51%	7%	52%	59%
30-39yrs	3%	35%	38%	6%	40%	46%
20-29yrs	1%	27%	28%	10%	30%	40%

History and Benefits for HARMONY GOLD from *Hearing Conservation Program*

❖ OAE monitoring duration: 15 years (2008)

❖ Implementation of HearingCoach program: 12 years (2011)

❖ Estimated employees screened annually: ± 22 000 to 30 000

❖ Total number of employees screened monthly: ± 2000 to 3000

✓ Individualized coaching on **early damage**

✓ Annual maintenance and seal checks on product, along with further coaching

✓ In NIHL compensation cases, readily available data on the history of HPD use and hearing damage

➢ Plan for future: moving from annual to **risk based** medical examinations

We thank you
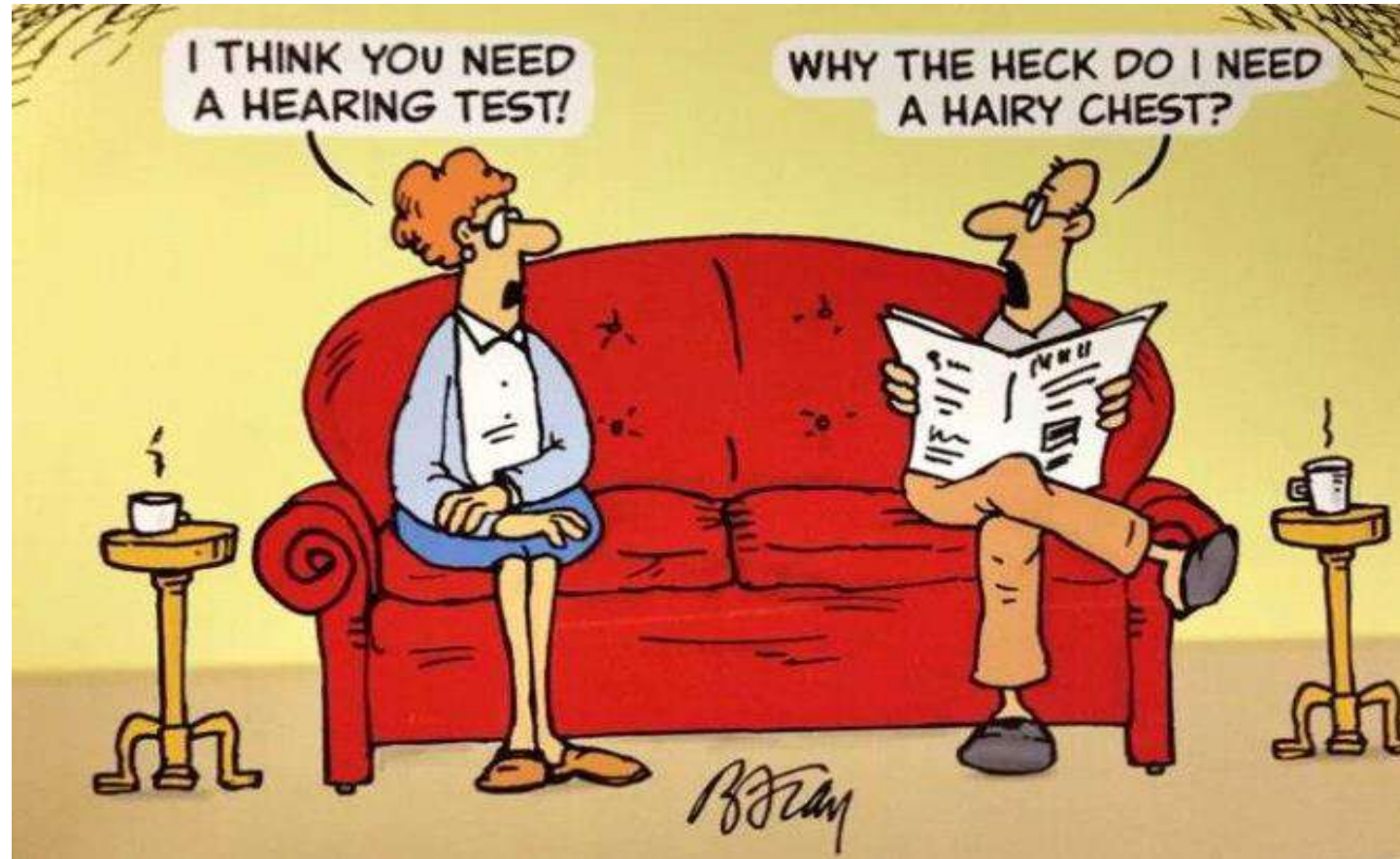
Minerals Council MOSH Noise Day of Learning
Hearing Protection Device Fit Testing
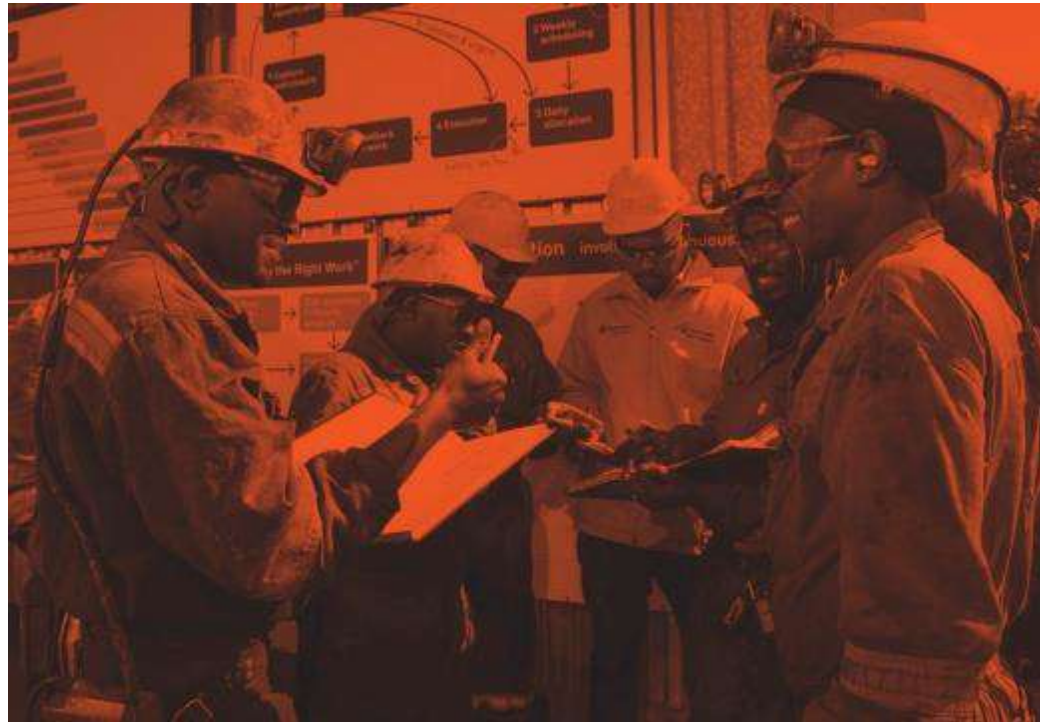
RELIANCE ON HEARING PROTECTION
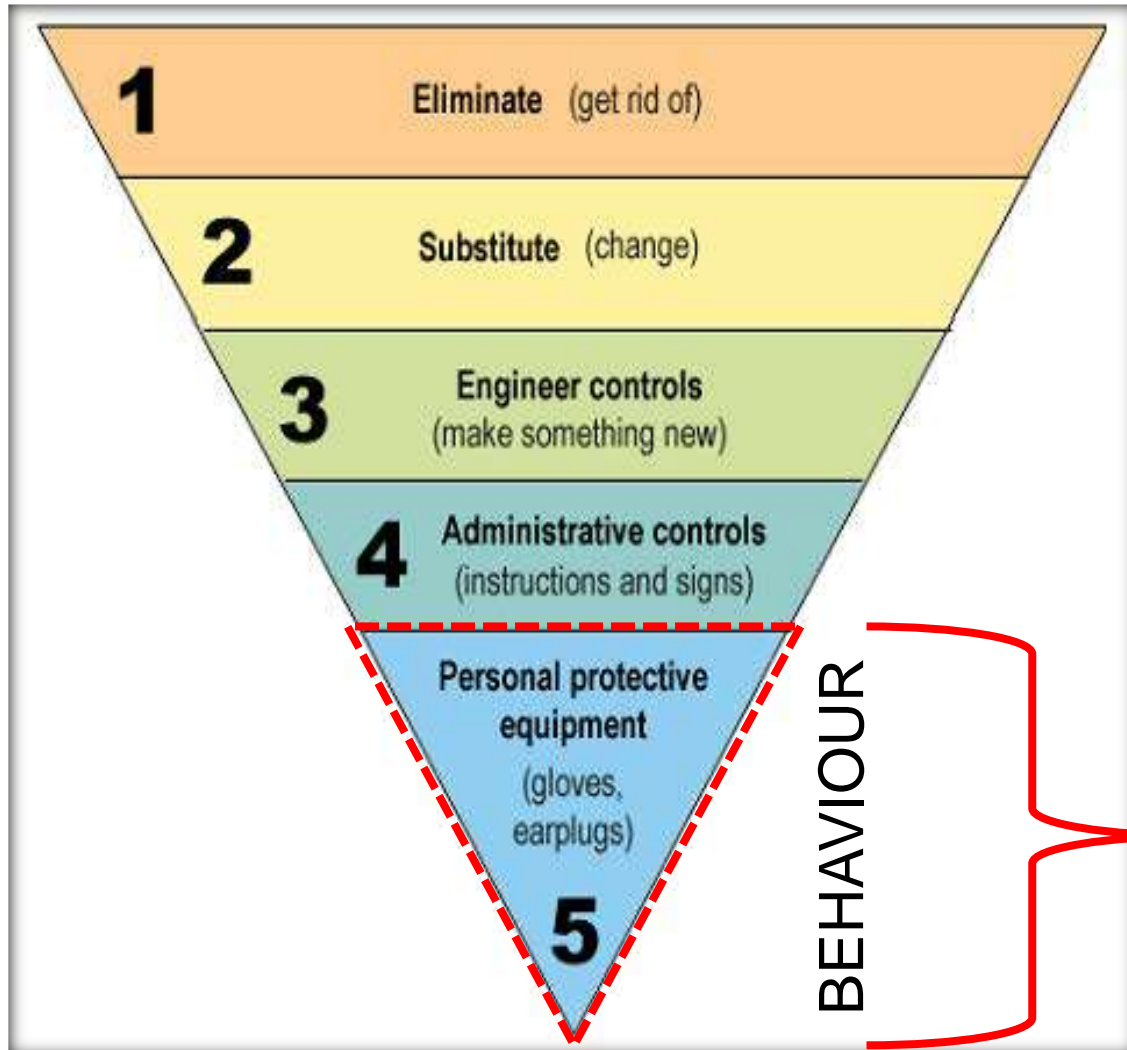
Higher order controls preferred – however…

Consider the extent of reliance on HPDs at your mine or site?

HOW WELL ARE WE MANAGING BEHAVIOUR?

❑ **User resistance**

❑ **Inappropriate selection**

❑ **Incorrect fitment**

SERITI

HEARING PROTECTION – KEY DEPENDENCIES

Noise Monitoring (Risk Assessment)

HPD Selection

Verify Control Effectiveness

How?

Plan
Do
Check
Act

Communicate Site Zoning & Rules

User Training (Fitment)

SERITI
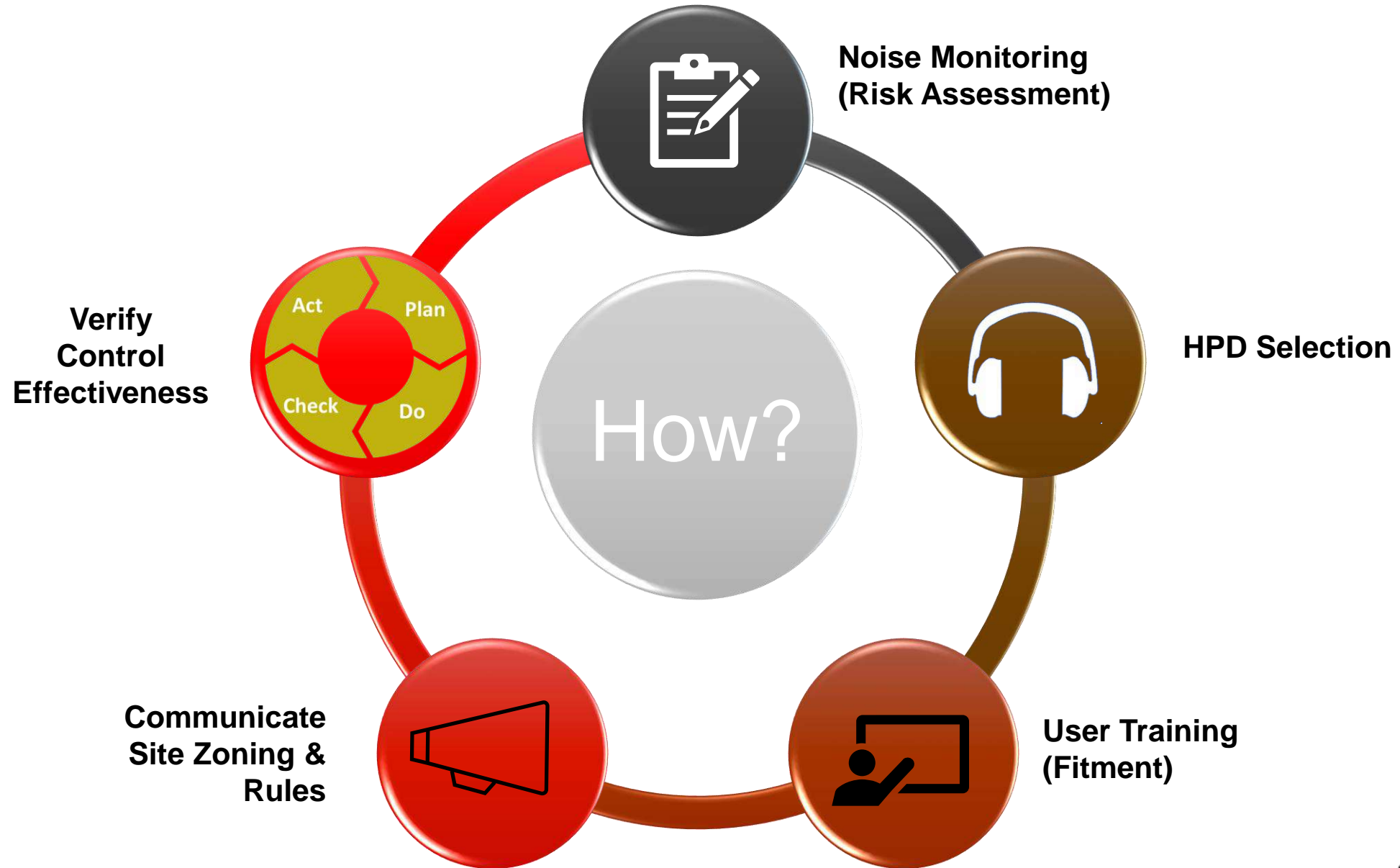
ENTER E-A-Rfit VALIDATION METHOD

1 Fit.
Have the employee insert their earplugs or put on their earmuffs.

2 Test.
Connect to microphones and begin speaker test sound.

3 Assess.
Use PAR to customize hearing protector selection.

ENTER E-A-Rfit TECHNICAL CONCEPT

- Quantitative method based on field microphone-in-real ear (F-MIRE) technology

- Dual-element microphones measure & compare the ambient sound level to the sound level inside the ear canal with hearing protection fitted

- Calculates a personal attenuation rating (PAR), inclusive of a safety factor for variance in user fitment

EXAMPLE REPORT – FAILED TEST

EXAMPLE REPORT – SUCCESSFUL TEST

PRACTICAL EXPERIENCE

1. **Baseline test takes around 10 minutes to complete, dependant on extent of coaching required**

2. **1st-time successful fitment rate without initial coaching during baseline phase typically below 60%, depending on HPD type**

3. **Up to 35% of employees require refresher training to obtain a successful fit test, depending on HPD type**

4. **Approx. 5-10% required change in device**

PRO's & CON's

ADVANTAGES	DISADVANTAGES
✓ One-on-one training opportunity	✘ Limited to one HPD manufacturer/brand
✓ Quantitative test	✘ Requires administrative resource
✓ Immediate & effective user feedback	
✓ Quick & user-friendly interface	
✓ Provides person-specific validation	

#1 VALUE ADD = EXCELLENT TRAINING & EDUCATION TOOL

SERITI

IMPLEMENTATION APPROACH & NEXT STEPS

1. **Management of change - Stakeholder engagement sessions with safety & employee representatives**

2. **Location and resourcing:**

   - **Site Clinic selected as most practical choice;**

   - **Clinic Medical Technician trained & dedicated station**

3. **Fit testing performed during medical surveillance visits – minimising operational disruption**

4. **Fit-test triggered by noise exposure captured on OREP (link with Occupational Hygiene measurements)**

Next Steps:
1. Gather statistics over longer period of time to improve understanding of training efficacy
2. Attempt to ascertain correlation of fit testing implementation with NIHL trend
3. Create more visibility on fit testing statistics & associated feedback to/from employee stakeholders

SERITI

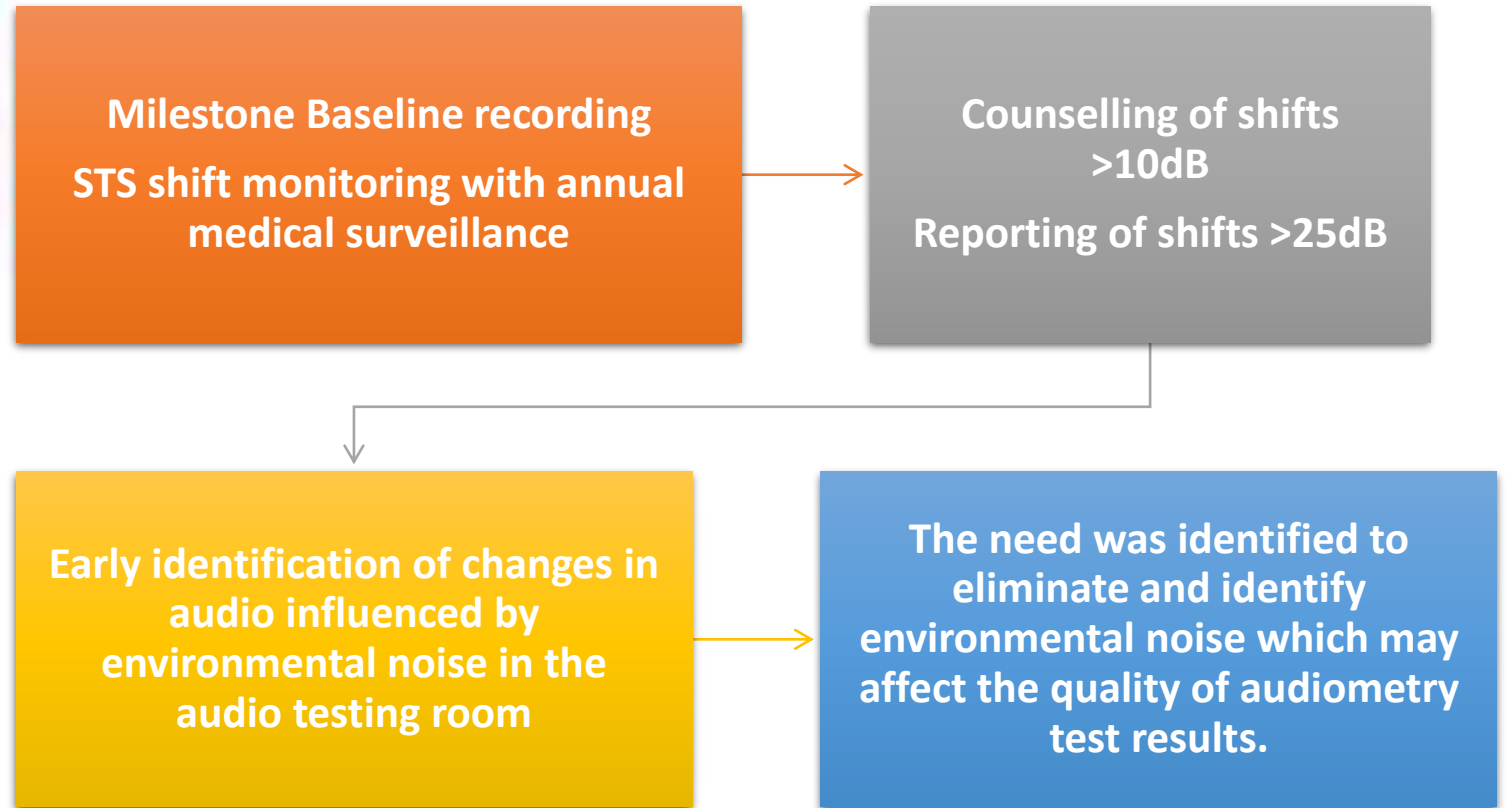# QUESTIONS?

SERITI

GLENCORE

- **Linda Prinsloo – Audiologist**

- **Glencore WCM OHC**

  - *B. Communication Pathology (UP)*

THE APPLICATION OF CONTINUOUS REAL-TIME MONITORING FOR QUALITY ASSURANCE: AUDIOMETRIC ASSESSMENTS

GLENCORE

Continues Noise Monitoring in Audio Room

SOUND EAR INSTALLED IN AUDIO ROOM

MONITORS ROOM ENVIRONMENTAL NOISE

PRE-SET TO LEVELS INDICATING WHEN NOISE REACHES UNDESIRED LEVELS (VISUAL)

CONNECTED TO AUDIO TESTING SOFTWARE

TEST WILL BE PAUSED IF NOISE LEVELS REACH UNDESIRED LEVELS.

GLENCORE

AUDIO TESTING SOFTWARE CONNECTED TO SOUNDEAR

TEST WILL BE PAUSED WHEN NOISE LIMIT IS EXCEEDED

GLENCORE

On – Site (Rietvly)
Visual Display and Sound Monitoring

On – Site
Visual Display and Sound Monitoring

- *Visual warning to encourage HPD use when noise limits >85dB*

- *Next phase:*
- *Continues noise measurements.*
- *Data to be analyzed.*
- *Email – notification sent / alarm settings.*

- *Device can be moved to different areas i.e workshops.*

GLENCORE

Soundear3 Technical information

IEC 61672-1 Class 1 compliant sound level meter.

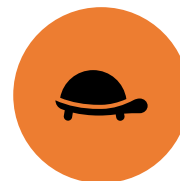Measuring range RMS: 30 to 120 dB.

Deviation +/- 0.5 dB.

Frequency range 20Hz – 20kHz.

A-weighted (RMS) and c-weighted (Peak).

Slow (1s) and Fast (125ms).
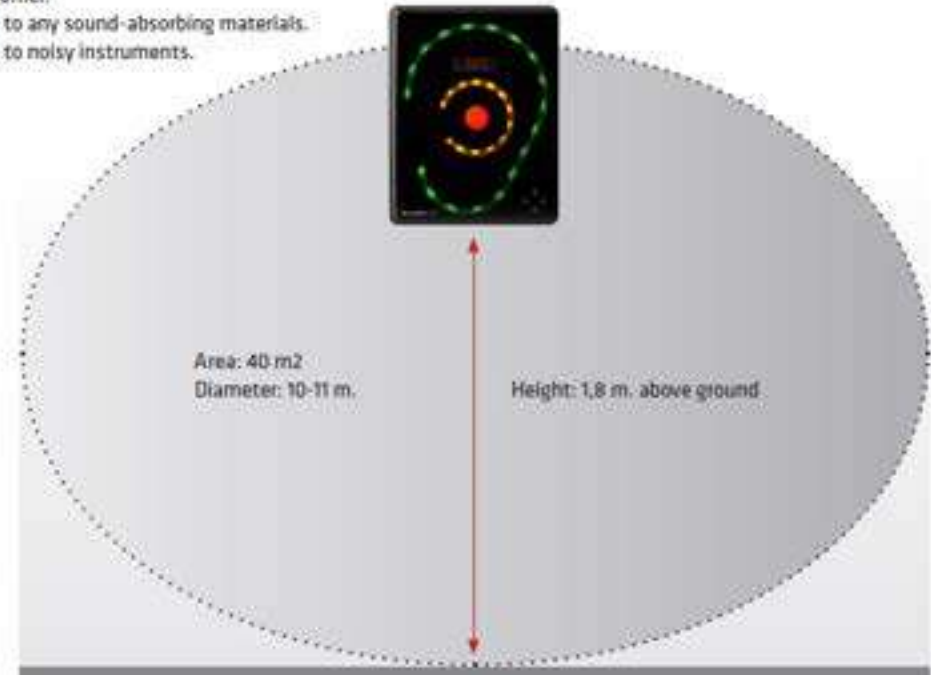
5VDC Micro USB

Current consumption, max 2.5W

GLENCORE

OUTDOOR MONITORING SYSTEM – DATA FLOW

Cloud/Local Broker

Cloud systems

Mounting

- On a visible spot on the wall.
- At 1.8 metres above floor level.
- On the opposite side of the room from the door.
- Not in a corner.
- Not close to any sound-absorbing materials.
- Not close to noisy instruments.

Area: 40 m2
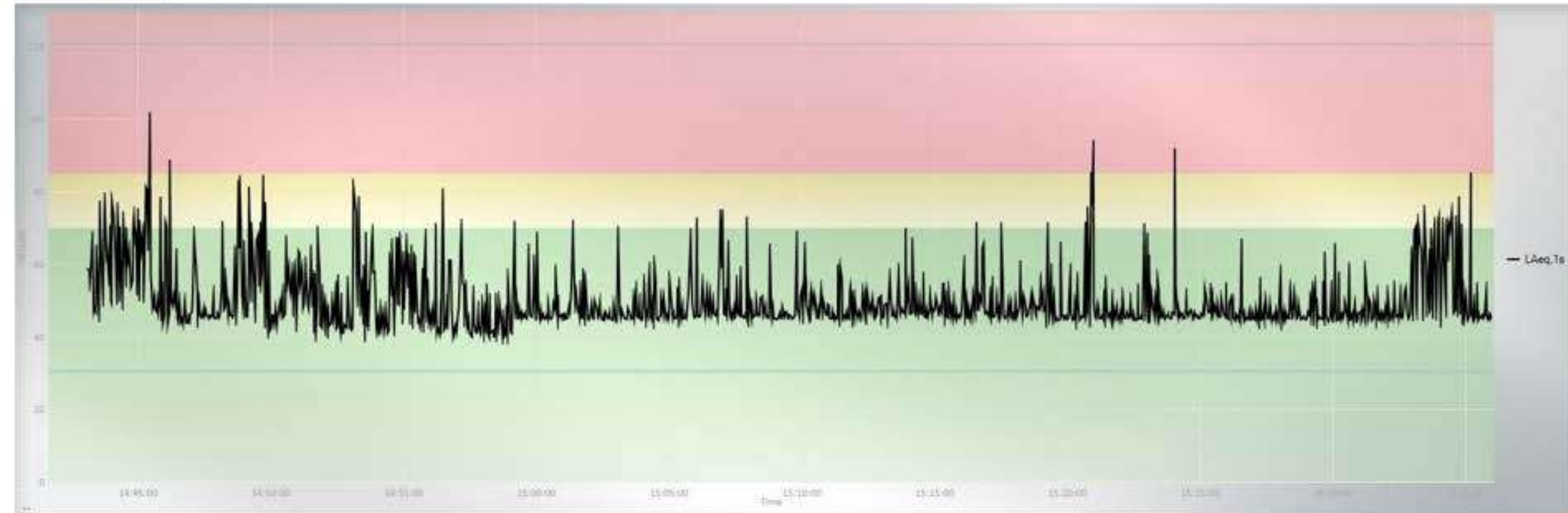Diameter: 10-11 m.

Height: 1,8 m. above ground

GLENCORE

Live Measurement / 2023/09/11

Amtronix Technical Workshop

Chart

Chart statistics ▲

Amtronix Technical Workshop

LAeq,1s,min 39.8 dB(A)
LAeq,1s,max 91.6 dB(A)
LAeq,1s,avg 63.0 dB(A)

From 2023/09/11
14:57:08
to 2023/09/11
15:35:57

Peak count:	>105	>110	>115	>120	max:
	11	7	4	1	124.5

Show in chart ▲

LAeq: ☑ 1 sec

LCpk max: ☐

LAF max: ☐

LAS max: ☐

GLENCORE

If your SoundEar®3 device is connected, you will be able to view what is being measured live. Move the cursor over the graph to view measurement and time.
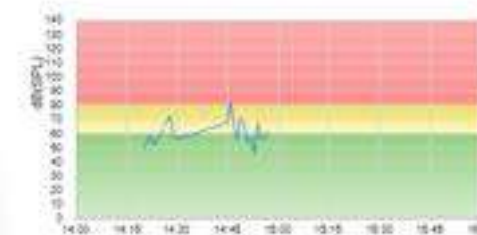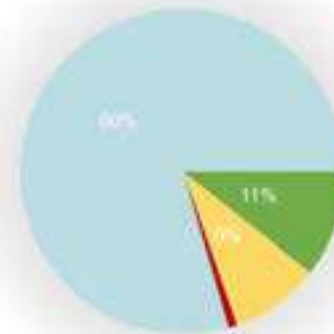
GLENCORE

Reports available

- Average noise per connected device.
- Breakdown of each device measurements of selected period
- Line charts of the measurements with colour-coded preset warning indicators.
- Hour chart.
- Daily charts.
- Lden of the selected period.

Device averages

Amtronix Technical Workshop

GLENCORE

Noise Report

Location:	Soundear report 2023/09/15 09:49:08
Report period:	00:00 Friday, 08 September 2023 - 23:59 Friday, 15 September 2023

Chart [LAeq,1min]

GLENCORE

Hours

Days

GLENCORE
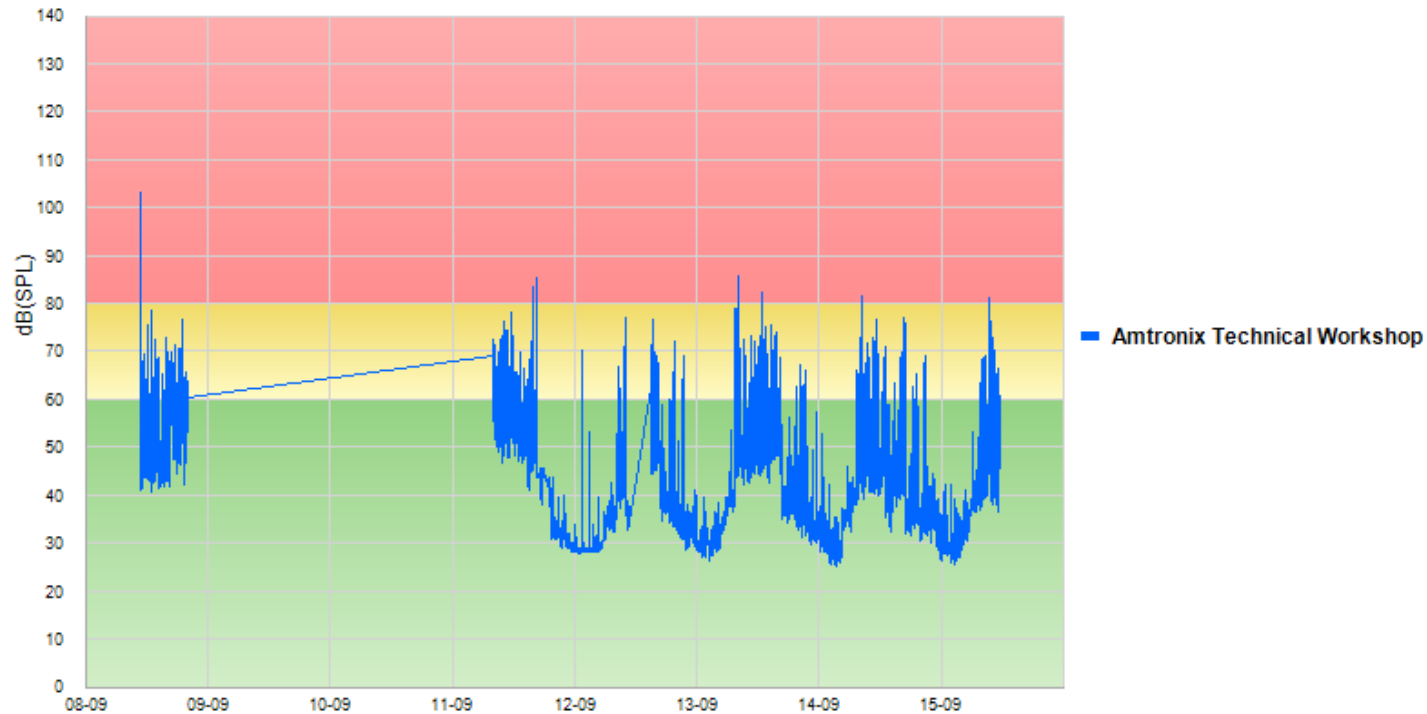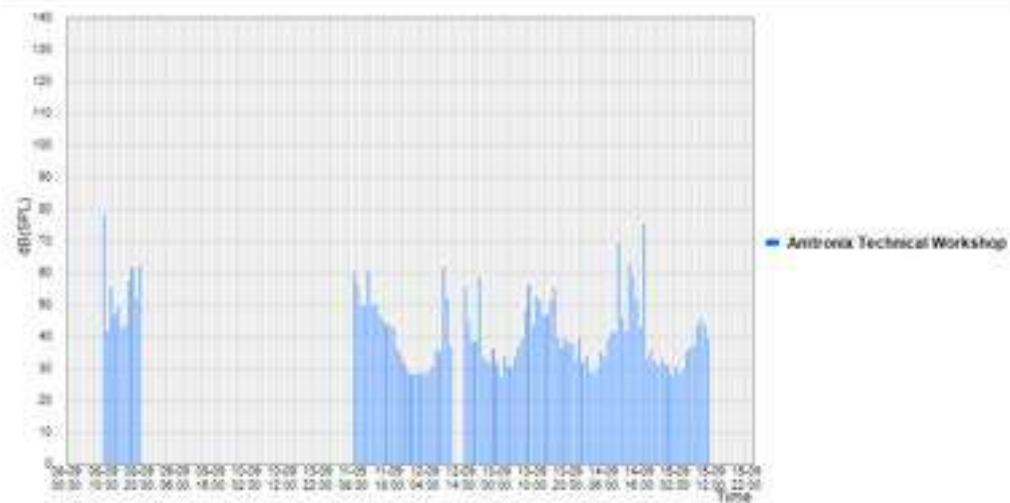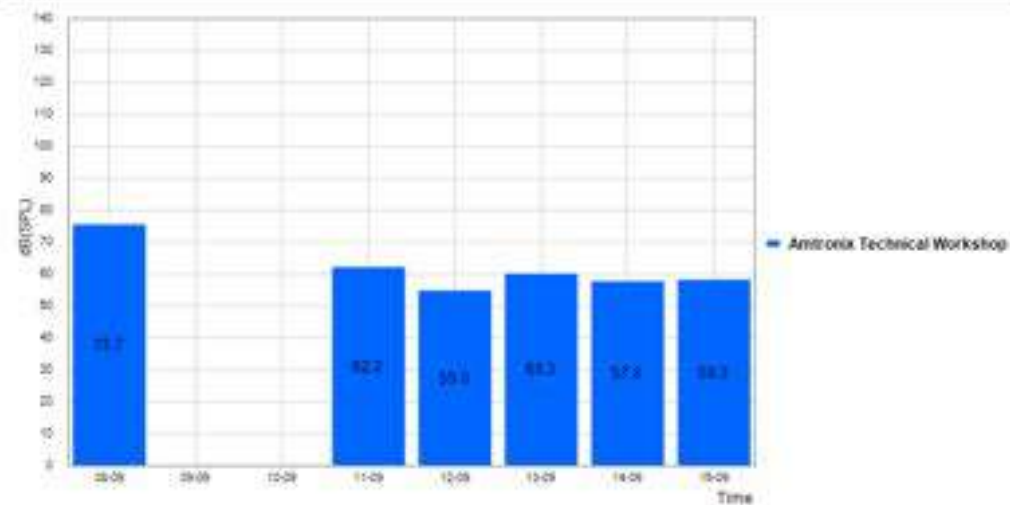
Amtronix Technical Workshop: Average from 2023/09/08 to 2023/09/15

GLENCORE
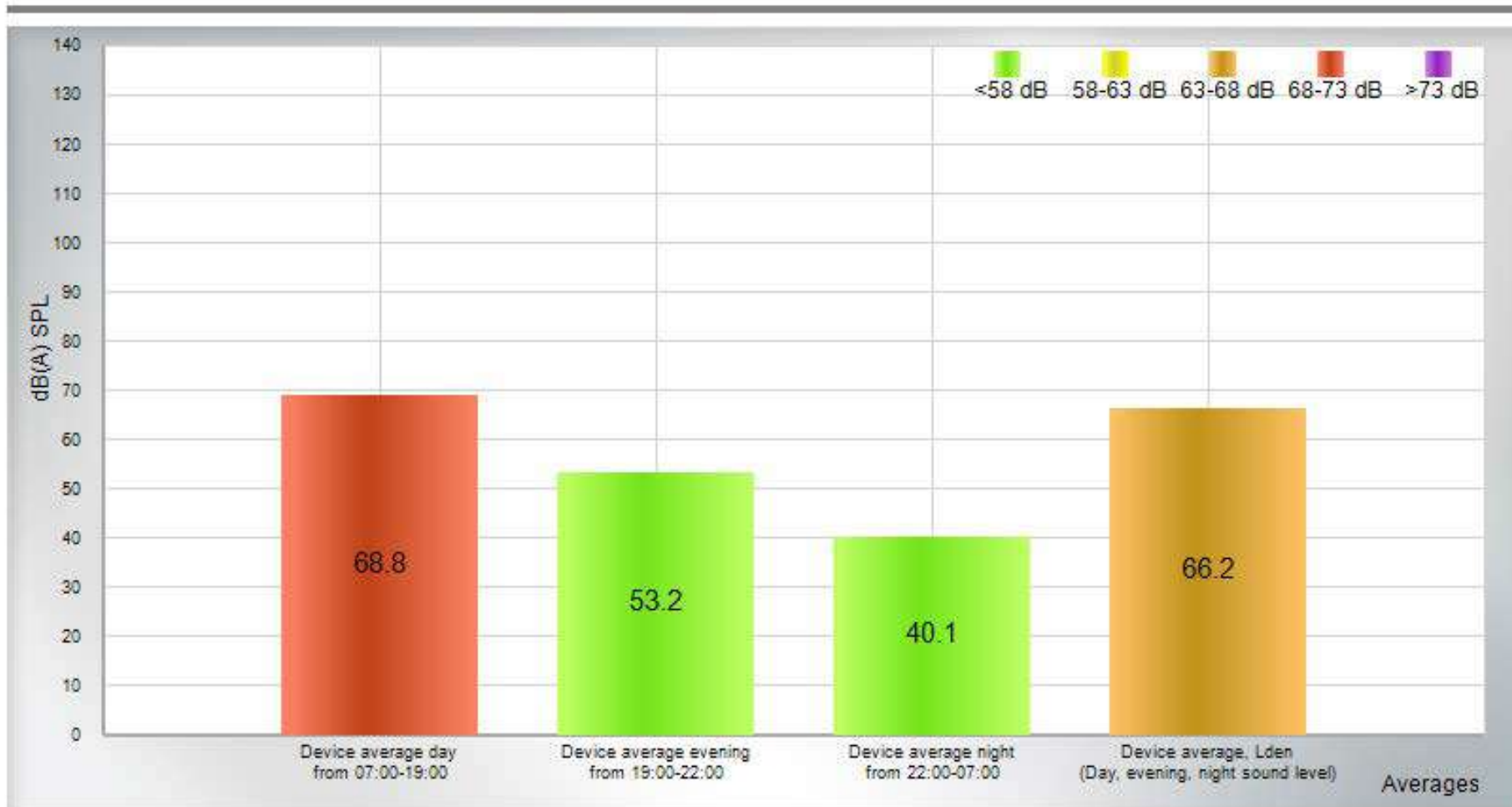
Why noise monitoring?

SoundEar®3 310XL

- Continuous monitoring of noise environments!
- Better audiometric testing!
- Better hearing conservation programs!
- More vibrant visual indicators!
- More in-depth reporting!
- **More Control, Less Hearing Loss!**

92.3

SoundEar®3XL

GLENCORE

THEME 4: RESEARCH AND DEVELOPMENT

MHSC RESEARCH ON NOISE

Industry Noise Show and Tell Day of Learning

Emperors Palace, Gauteng

21 September 2023

Presenter: Ms. Mathapelo Flo Magampa

PRESENTATION OUTLINE

- MHSC research on Noise over the years
- MHSC research topics submission process

GEN 420 'An Examination of methods whereby noise levels in current and new equipment may be reduced'
Agency: Bluhm Burton Engineering, 1997

Purpose of the study:

- To identify major equipment noise sources in Hardrock and coal mining

- To recommend noise control treatments for identified mining equipment

Findings:

Occupations most affected :

- **In Hardrock:** Rock Drill operators, diesel and electric locomotive crews

- **In Coal sector:** Continuous miner operators, LHD and utility vehicle drivers, shearer operators and shuttle car operators were most affected.

GEN 420 'An Examination of methods whereby noise levels in current and new equipment may be reduced'
Agency: Bluhm Burton Engineering, 1997

Recommendations:

- Application of standard noise control principles e.g Enclosure and absorption to LHD vehicles, personnel vehicles and railed vehicles to reduce operator noise levels.

- Use of remote controlling of vehicles to move the operator away from major noise sources

- For rockdrills; Fitting with exhaust mufflers was recommended

(However, reductions in drill performance is evident)

COL 714 "Quantification of noise sources in mechanical board and pillar coal"
Agency: EUP, 2001

Purpose of the study:

- To provide further research taking into account GEN420

- To identify and quantify specific noise levels on individual machines and machine components in Coal

- To provide information which would assist in reducing the incidence of noise induced hearing loss.

Findings:

- Noise levels on CMs were very high. In one case 115 dB(A) was recorded.

- The conveyor chain seems to be the major offender in terms of noise generation on continuous miners.

- Noise levels caused by LHDs were also high, however were lower than for CMs

COL 714 "Quantification of noise sources in mechanical board and pillar coal"
Agency: EUP, 2001

Recommendations:

To reduce continuous miner noise levels:

o   Focus to be placed on conveyor chain and scrubber development

(These redesign changes will compromise the performance and productivity of these systems.)

To Reduce noise levels caused by LHDs:

o   Engine noise must be attenuated.

General Recommendations:

•   Setting of firm targets and associated penalties for not attaining these targets

•   Procedures to test for conformance

25 years in Pursuit of Zero Harm

A Practical Guide to
NOISE AND VIBRATION CONTROL
in the
SOUTH AFRICAN MINING INDUSTRY

Authors: J L van Niekerk and J R Hassall
ISBN: 1-919833-16-2
First edition: May 2005
Date of publication: May 2005
© Mine Health and Safety Council
This publication has copyright under the Berne Convention. In terms of the Copyright Act, No. 98 of 1978, no part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording or by any information storage and retrieval systems, without permission from the Mine Health and Safety Council.
Address of publisher: MHSC, Private Bag X63, Braamfontein, 2017
Tel: +27 011 358 9180
Website: http://www.simrac.co.za
Design & Layout: Puro Media

SIM 050501 'Project Scope for Low-Noise Drilling'
Agency: CSIR, 2006

Purpose of the study:

- To examine the previous work done on sound emissions from high noise emitting equipment in industry

(specific interest to rock drills)

- To search the national international literature for alternative technologies that hold potential for development as hole-making devices.

Findings:

- Buying-on-price highlighted as a hinderance to the introduction of quieter drills to the

Marketplace

- Access to state R&D funding could prevent the symbiotic mine-manufacturer-R&D

 relationship.

- The general culture within the mining industry identified as a concern

2003 Industry Noise Milestones	
By 2008, the hearing conservation programmes implemented by industry must demonstrate a deterioration in hearing of not greater than ten per cent in occupationally exposed workers.	By 2013, the total noise emitted by all equipment installed in the workplace must not exceed a sound pressure level of 110 decibels (dB) at any location in the workplace.

25 years in Pursuit of Zero Harm

SIM 050501 'Project Scope for Low-Noise Drilling' Agency: CSIR, 2006

Key recommendations:

- Changes to the industry culture;

- The management of time-equivalent exposure to drill noise;

- The application of technologies to reduce noise; and

- The application of appropriate standards, both for the measurement of noise and the specification of equipment.

SIM 110501 'Improvement of noise-induced hearing loss awareness to target audiences in the SAMI'
Agency: CSIR, 2011

Purpose of the study:

- To review previous research outcomes relating to Noise-induced Hearing Loss (NIHL) awareness and Hearing Protection Device (HPD) practices and make recommendations to improve awareness material

Recommendations:

- Include NIHL awareness training as a unit standard in the MQA requirements

- Develop training materials for NIHL prevention that comply with best practice and theoretical concepts for adult education and health promotion.

- Develop skills of trainers for NIHL prevention awareness and HPD practices

- Evaluate success of awareness training and HPD practices

- Manage awareness training and Hearing Protection Device strategy through Hearing Conservation Programme co-ordinators

25 years in Pursuit of Zero Harm

SIM 120501 'Noise controls for mining equipment'
Agency: CSIR, 2014

Purpose of the study:

- Expand the work done in project SIM 050501

Findings:

- Using the silencers designed in SIM 05-05-01, and designing second generation silencers after testing the first generation, the sound power level reduced from 116.3 dBW (unsilenced) to 105.0 dBW (first generation silencers) to 101.7 dBW (second generation silencers).

- The sound power consequently reduced form 0.4W to 0.031W to 0.015W (for the unsilenced, first generation silencers and second generation silencers respectively).

(These developments were done to validate the acoustic methodology without full consideration of the environmental and other constraints of the real application)

MHSC
Mine Health and Safety Council

SIM 120501 'Noise controls for mining equipment'
Agency: CSIR, 2014

Recommendations:

- Use the developed methodology for noise reduction on mining equipment to reduce noise levels in mines.

- Encourage OEMs to make use of the technology developed to reduce noise levels of mining equipment.

- Use the prediction methodology to predict noise levels of mining equipment underground.

CoE 180701 'Review the current SAMI noise exposure limit and conduct a study on vibration OEL in relation to the SAMI'
Agency: EUP, 2021

Purpose of the study:

- Review: literature on mining noise and vibration exposure

- Determine the impact of current noise OELs on employees.

- Determine the impact of vibrations on employees.

- Review of relevance and applicability of current noise and vibration OELs.

- Develop proposed noise and vibration OELs with associated guidance notes.

Outcomes:

Guidance note on proposed OELs for both Noise and Vibration

MHSC
Mine Health and Safety Council

Submission of research topics, motivation example

sngobeni@mhsc.org.za;

| MHSC 2023/2024 ANNUAL RESEARCH PROGRAMME: EVIDENCE BASED RESEARCH MOTIVATION |
|---|
| **1. Research question to be addressed** |
| What biological hazards are prevalent in South African mines and how can they be effectively managed? |
| **2. Proposed Study Mines / Sites** |
| A representative sample of mines including major commodities: Gold, Platinum and Platinum Group Metals, Coal, Diamond and others. This should be inclusive of underground mines, surface mines and at least a refinery and a smelter. |
| **3. Background / motivation to the research question** |
| The Mine Health and Safety Act (29 0f 1996) requires the employer to ensure health and safety of employees at the mine, to identify and respond to hazards and risk and to further prepare and implement a code of practice on any matter affecting the health and safety of employees and other persons affected by activities at the mine. Like any other occupational hazards (chemical hazards (such as dusts, mists, vapours) physical hazards (such as noise and vibration) etc.), the employer is expected to identify and respond to these and their level of risk in order to protect the health of employees. With the start of the COVID-19 pandemic (caused by the virus SARS-CoV-2), A Guideline for a mandatory code of practice was developed to guide the industry in as far as |

STRIVING FOR ZERO HARM

EVERY MINE WORKER RETURNING FROM WORK UNHARMED EVERYDAY

Enterprises University of Pretoria Noise Reduction Projects:

A proposed framework to effect targeted noise reduction in the mining machinery

Dr Abrie Oberholster
Prof Stephan Heyns

Centre for Asset Integrity Management
Department of Mechanical and Aeronautical Engineering
University of Pretoria

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
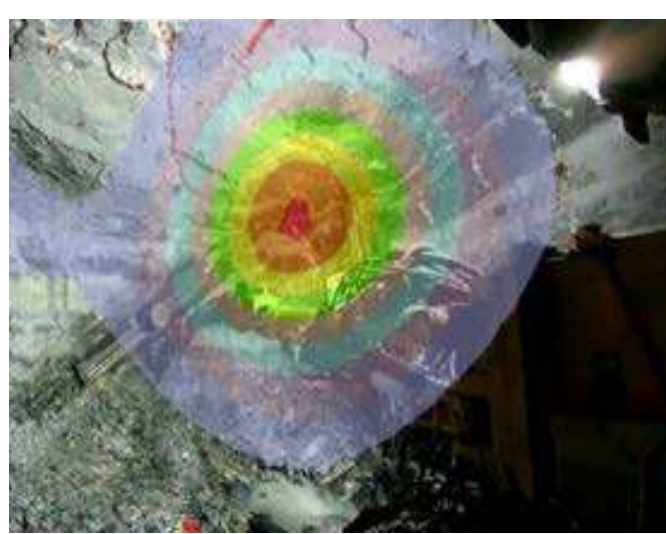
Mining industry related research at the University of Pretoria

- Virtual expert operator for underground exploration drilling
  - Online rock classification during drilling
  - Microphone as electronic ear

Traditional methods of sound source localization

- Careful measurement execution
  - ISO 3744 good starting point
  - Stationary machine operation

- Instruments:
  - Sound Level Meter
  - ICP microphones
  - Sound Intensity probes (SI)
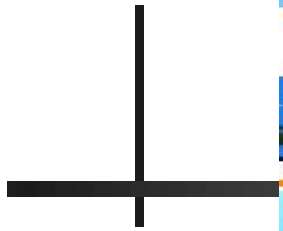
- Generate SI vector plot
- Noise contours
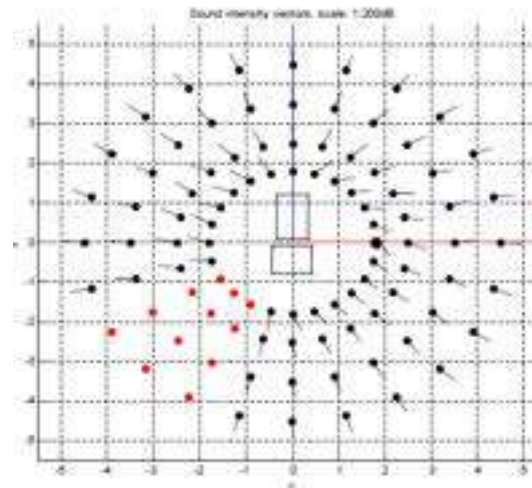
Acousting imaging

- Consists of array of microphones

- "Heat map" overlaid with camera image

- Capacitates noise source localization

- Targeted approach to addressing noise related issues
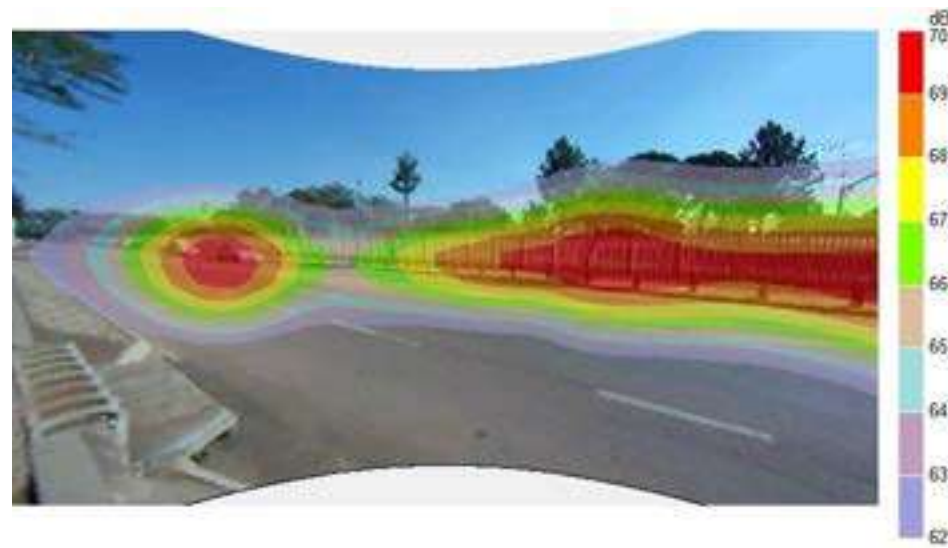
- Moving machinery & non-stationary conditions

*Siemens, 2018*

Moving vehicle noise

Acoustic imaging for targeted noise reduction in machinery

- Upgrading of University of Pretoria laboratory and field-testing facilities for sound source location (2020) Mine Health and Safety Council COE 150903
- 15 critical machines all commodities (MCSA)
- 4 additional machines tested

| Commodity	Machine
Coal	Continuous miner
	Shuttle car (not tested)
	Large dragline fan
Diamond	Drill rig
	Pneumatic pump
	Crusher
Gold	Underground drill rig
	Mechanical loader
	Scraper winch
Other	Impact tool
	Blower (not tested)
	Compressor
Platinum / chrome	Rock drill
	Diamond drill
	Drop-raise drill (not tested)
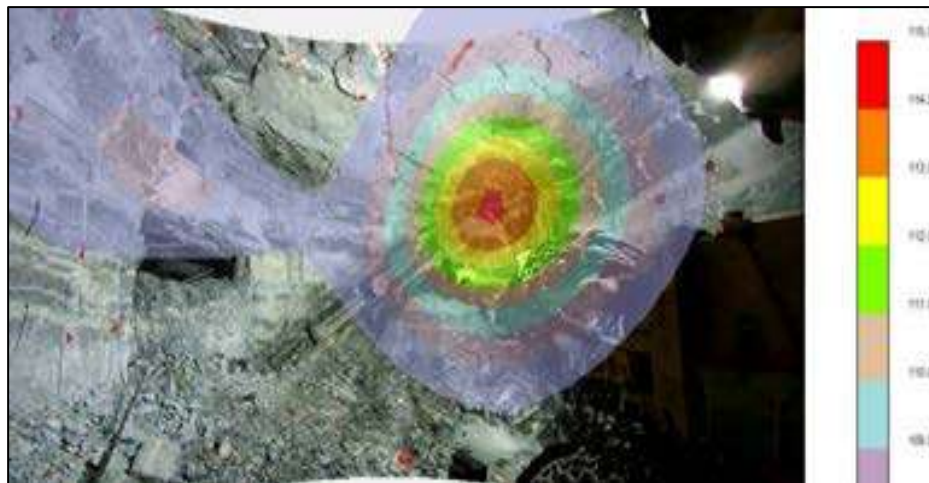
22 kW axial-flow fan
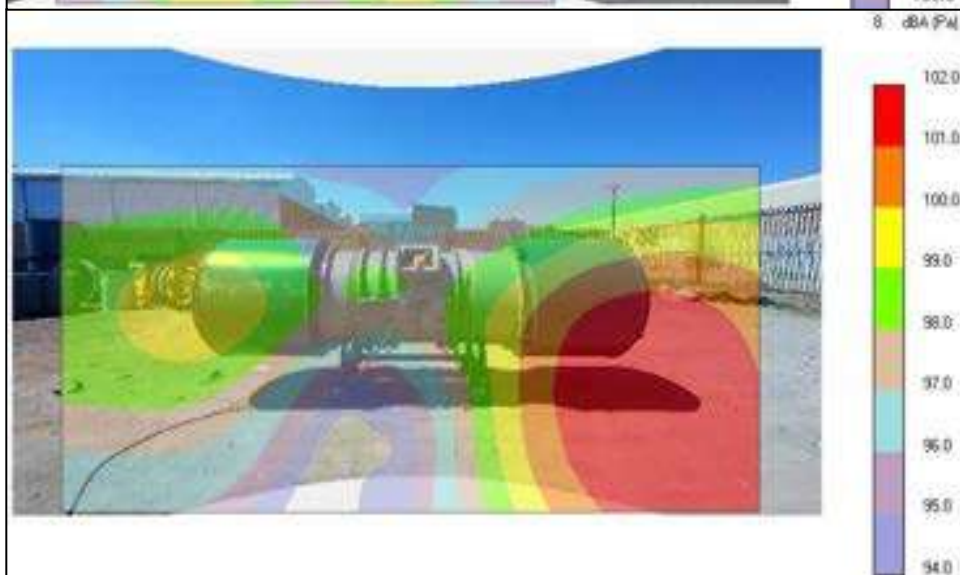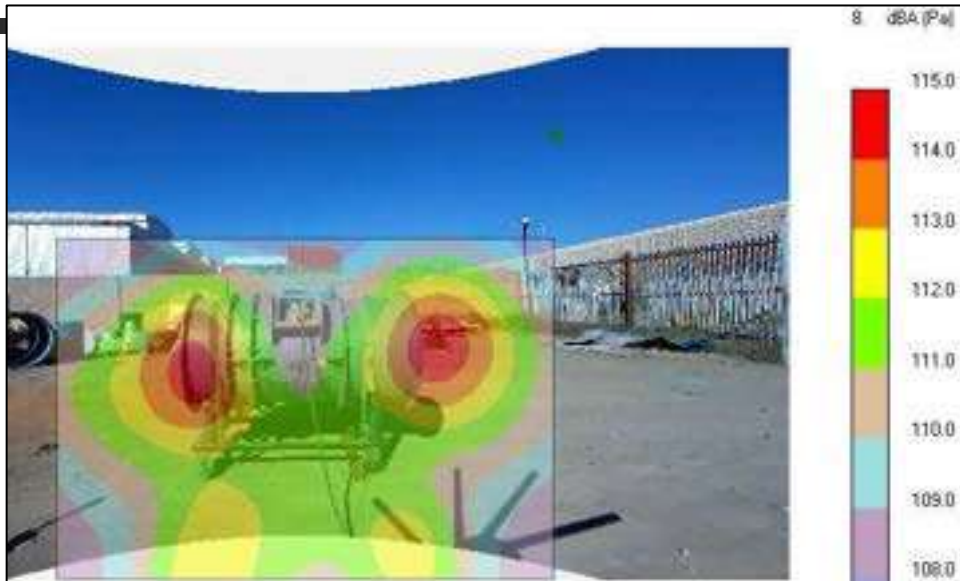
Pneumatic chainsaw

Pneumatic chainsaw
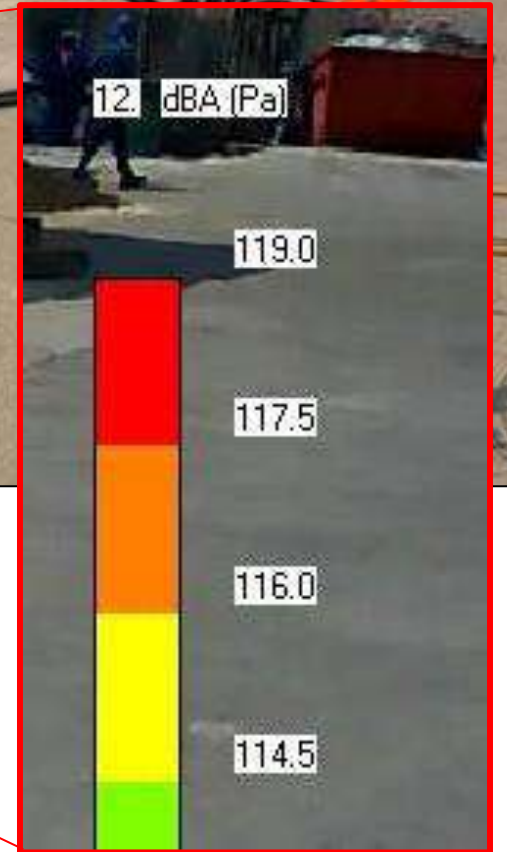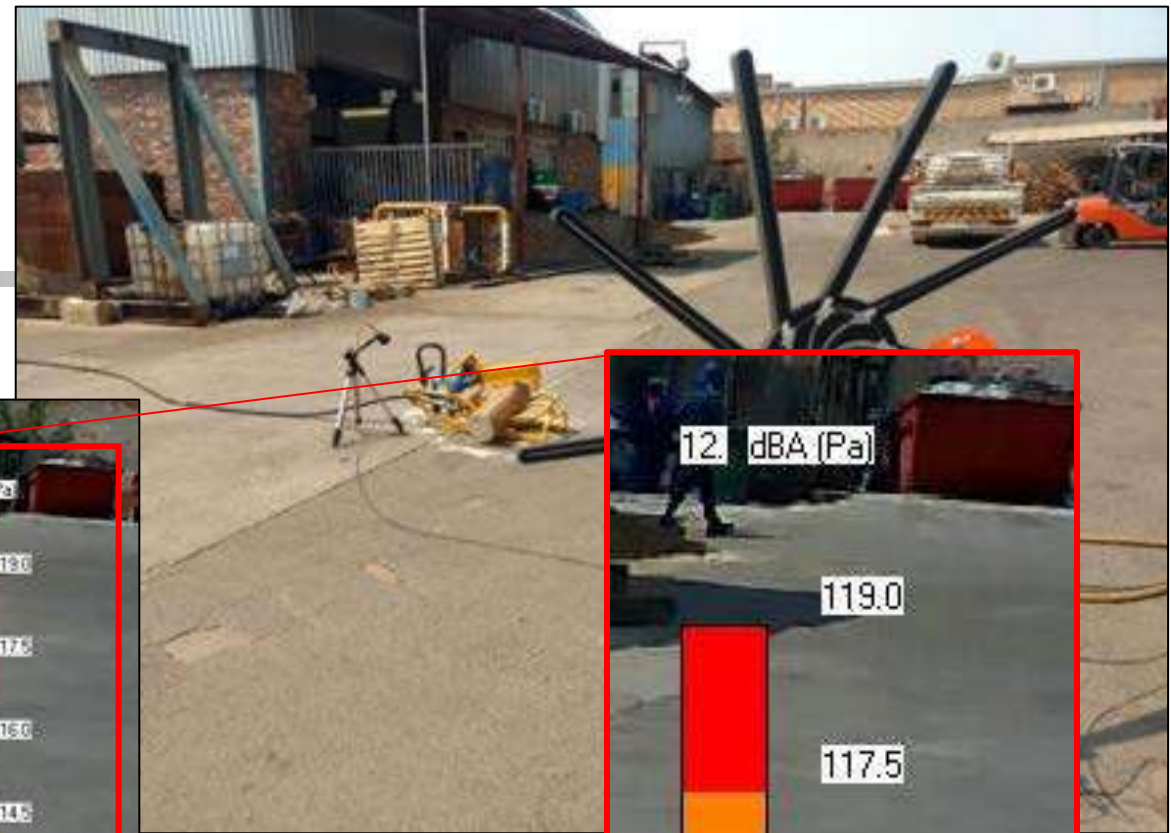
Equipment limitations

- Intrinsic safety
- Mobility
- Robustness

- Siemens acoustic camera is not suitable for measurements in underground mines
- Siemens acoustic camera is ideally suited for measurements in controlled environments
  - Targeted noise reduction

Proposed framework for industrial implementation: Mining House

- **Identify machine with unacceptable noise levels**
  - Sound pressure level meter

ATEX DECIBEL
METER SE-400
(explosion proof)

- **Verify noise source**
  - Eliminate loose air hose connections, etc.
  - Verify noise caused by machine
  - E.g., SoundCam

SoundCam 2.0 (IP54)
~ R350k

Proposed framework for industrial implementation: OEM

- OEM contracts EUP for controlled tests
  - Identification of problematic components or operating regimes, or possible acoustical design flaws
  - Provides OEM with targeted information
- OEM resolves problem
- EUP performs verification tests

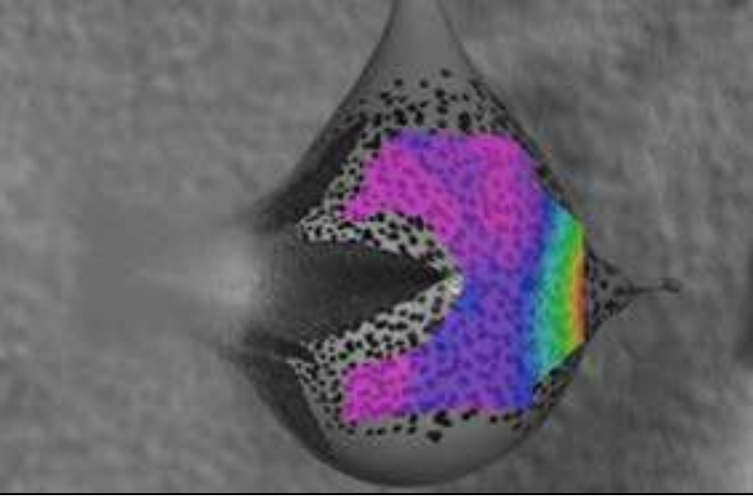Siemens HD Acoustic Camera

Current status
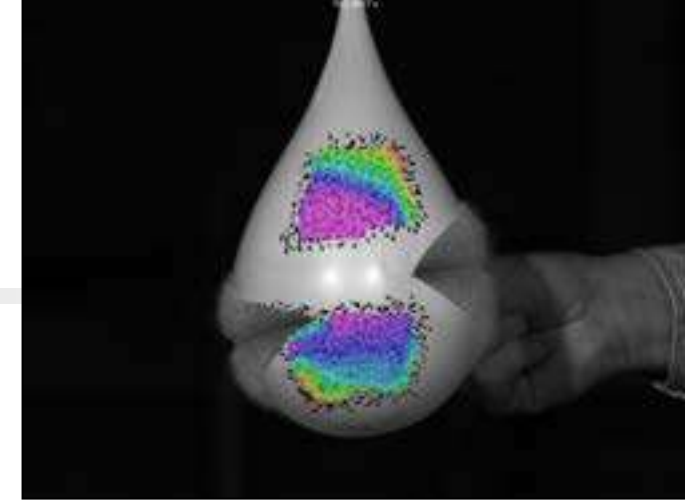
- UP granted full acoustic imaging software license for academic and research purposes

- Acoustic camera to be shipped overseas for troubleshooting and repairs

- Commercial software license requires update from 2019 version

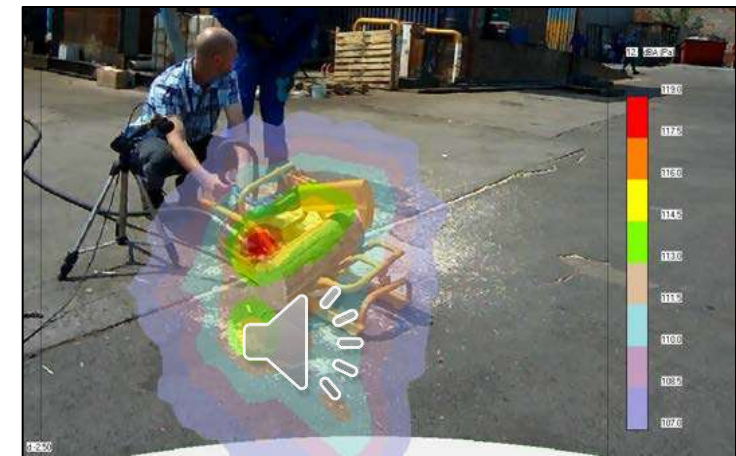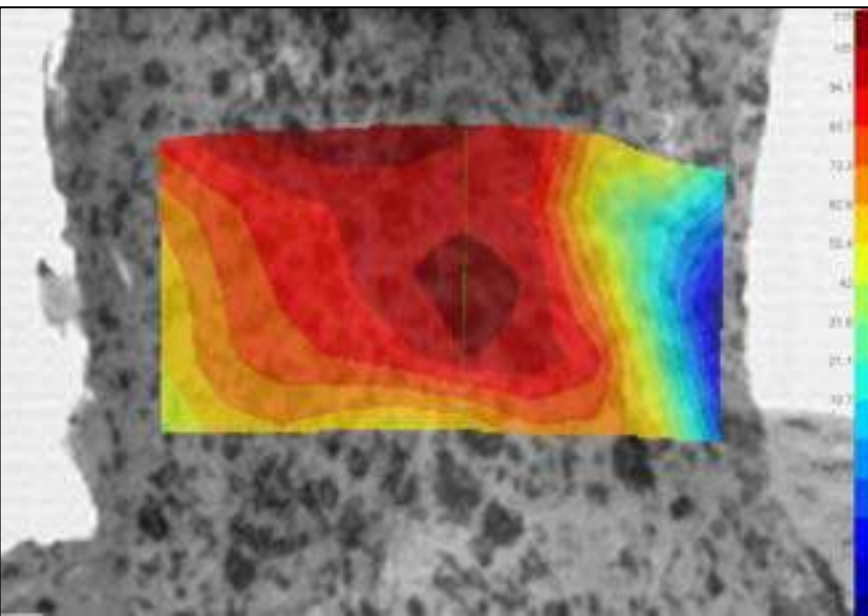- Industrial partnerships and/or funding

Thank you!

Abrie Oberholster

(e) abrie@up.ac.za

(c) 083 651 2804

(w) 012 420 3288

CSIR TMM Digital Twin: Problem Space – Background

MINERALS COUNCIL SOUTH AFRICA

"The Art of the Possible"

Mining Operators

Technology OEM & OTM

CSIR

"The Art of the Possible":
- ❑ Support Zero Harm
- ❑ Productivity
- ❑ Localization

Industry Milestones Requirements: Noise emitted by equipment should not exceed 107dB(A), by December 2024

Legislative Requirements: In accordance with regulation 9.2 (2) or section 12 of the MHSA, the employer is required to establish and maintain a system of occupational hygiene measurements in respect of occupational exposure to noise

Mine Health and Safety Act, 1996 (Act No. 29 of 1996) and Regulations

Regulations

Collisions between trackless mobile machines and pedestrians
8.10.
(1) The *employer* must take *reasonably practicable* measures to ensure that pedestrians are prevented from being injured as a result of collisions between trackless mobile machines and pedestrians. At any mine where there is a significant risk of such collisions, such measures must include at least the following:

CSIR TMM Digital Twin: Strategic Objective

To provide mining houses with a near real-time risk profiling and productivity tool that takes an objective approach to assessing risks based on the Mine Health and Safety regulations (Act no. 29 of 1996 – clause 8.10)

Digital Twin Model

Real-world Device/Machine

processing

Data

extraction

CSIR TMM Digital Twin: Simulation Core Capabilities

Data Insights around vehicle movement

Minimum distance between HV and any RV

02 Vehicle Technology Modelling

Geographical Modelling

Management Modelling

05 Statistical Machine Learning

Modelling Simulation As-a-Service

Digital Twin Technology

Sensor Technology Modelling

RISK MANAGEMENT Technologies
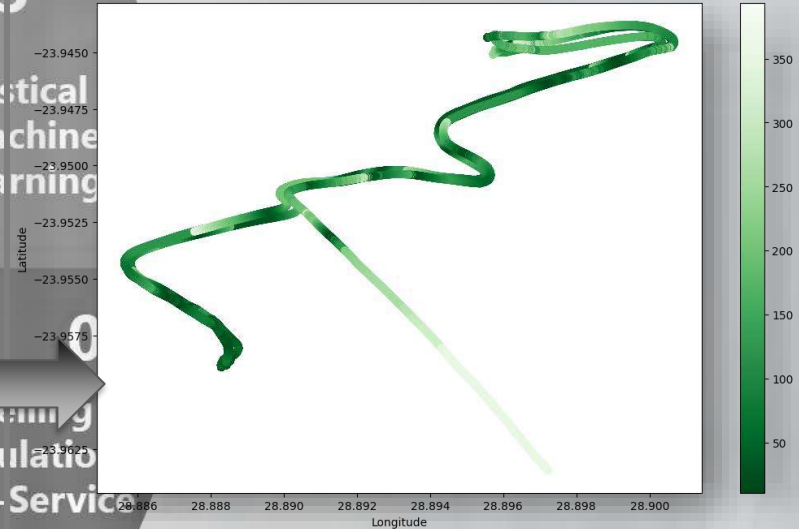
Critical Noise Zone
Warning Noise Zone
Safe Noise Zone

213

CSIR TMM Digital Twin: Ecosystem

Data Inputs

Equipment Noise Register

Maintenance Records, Noise Critical Controls

Historical Data & Knowledge

TMM Digital Twin Data Analytics

TMM Digital Twin Framework

TMM Digital Twin Simulation Frameworks

Data output and analysis

Non-conformance Events (noise limit)

Failed Critical Controls

Noise Zoning

214

CSIR TMM Digital Twin: Noise Heatmap (Example)

Higher Noise Activities → Lower Noise Activities
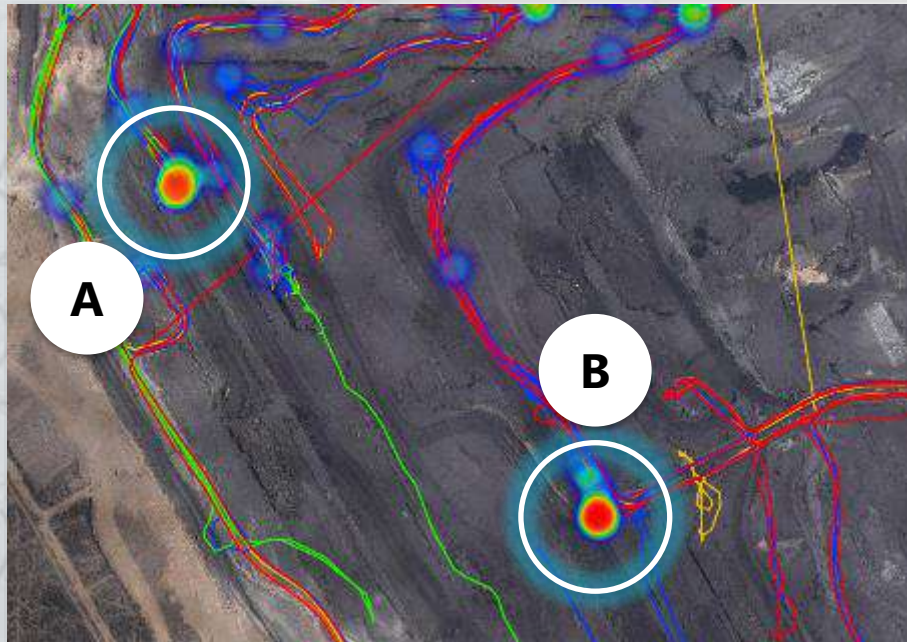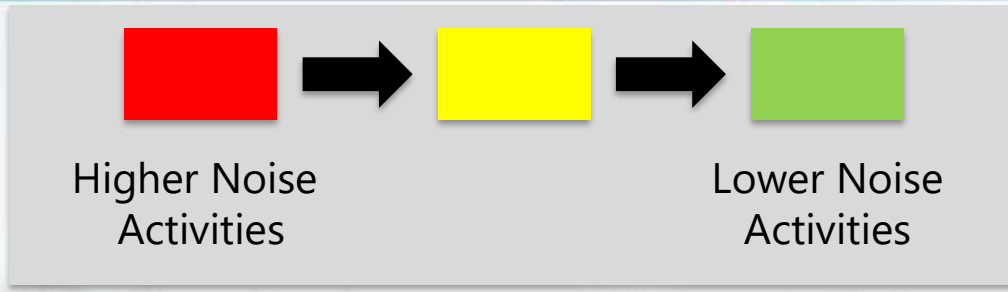
Simulated Heatmap (Noise Zone Radius **5m**)
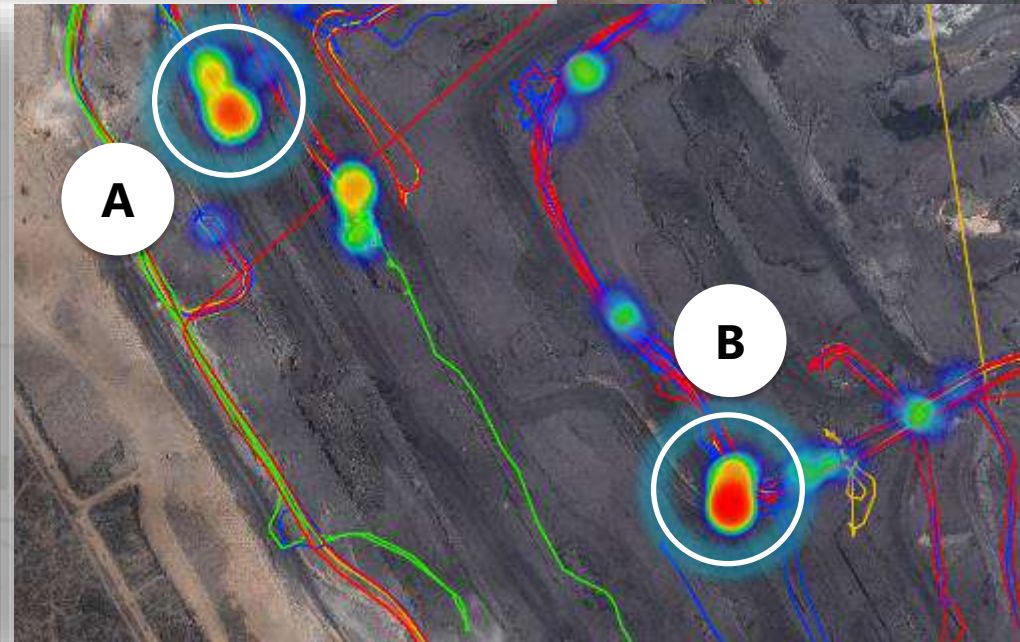
Simulated Heatmap (Noise Zone Radius **10m**)

Layout: GPS Data & Noise Datasets

Equipment Interaction

21 5

CSIR TMM Digital Twin: Typical Layout Grid for Analyses
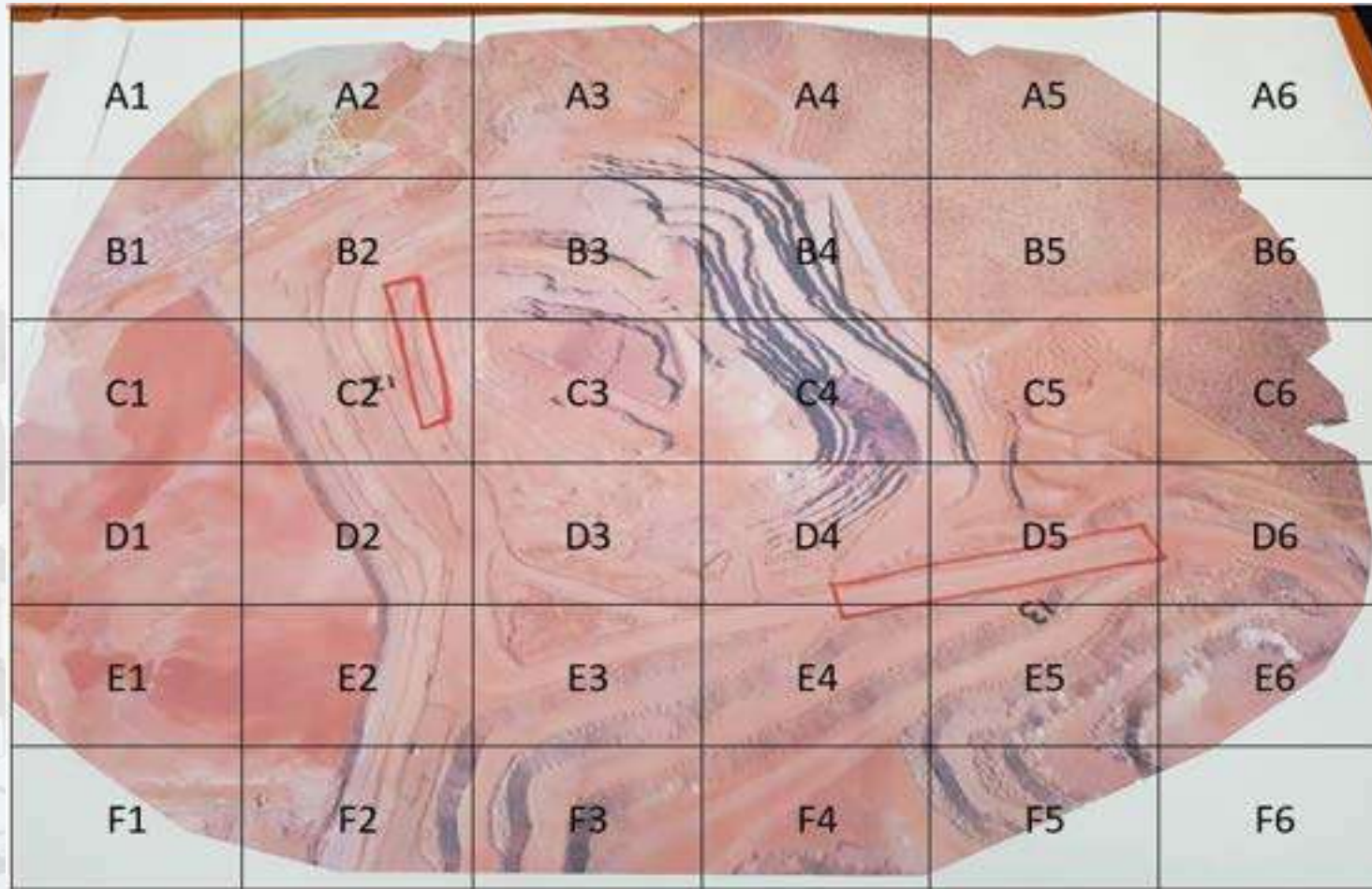
Mine layout described as a sector grid, A1 to F6

Important note: Actual operational data is not shared due to data privacy

CSIR TMM Digital Twin: Typical Noise Zoning
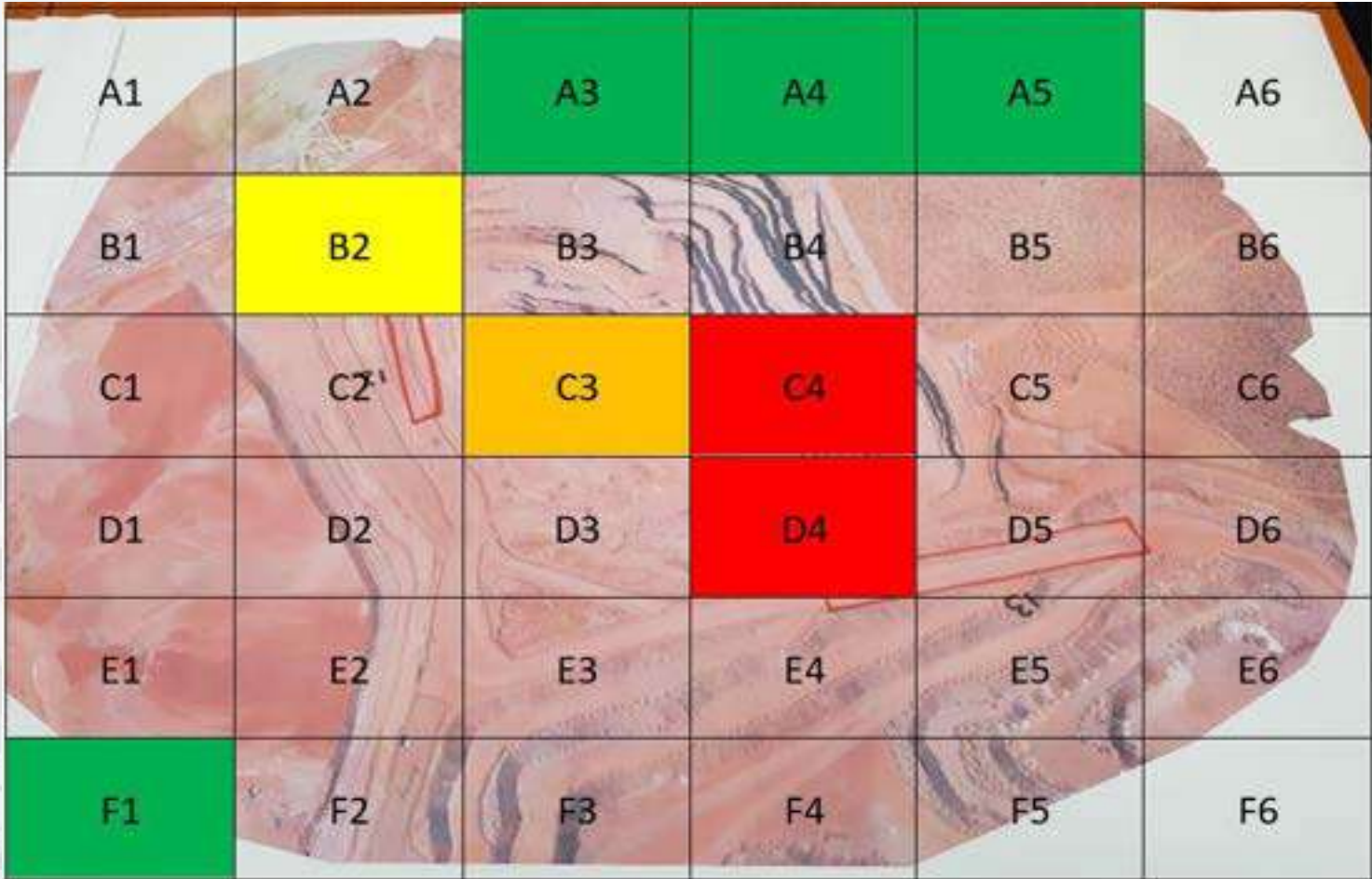
Infringement level	
Very High	🟥
High	🟧
Medium	🟨
Low	🟩

Violations displayed
- Noise Violations
- Critical Controls
- Maintenance Records

Important note: Actual operational data is not shared due to data privacy

CSIR TMM Digital Twin: Non-Conformance Events Summary

Non-conformance events

Pie chart showing three equal segments:
- Noise Limit Exceedance: 33%
- Maintenance Programme Violation: 33%
- Critical Controls: 33%

Legend: ■ Noise Limit Exceedance ■ Maintenance Programme Violation ■ Critical Controls

Non-conformance events per vehicle type

Bar chart with Y-axis "Number of events" ranging from 0 to 1,2. Categories: Haul Trucks, Light Vehicles, All other vehicles. Each category shows three bars each at value 1.

Legend: ■ Noise Limit Exceedance ■ Maintenance Programme Violation ■ Critical Controls

Important note: Actual operational data is not shared due to data privacy

CSIR TMM Digital Twin: Typical Non-Conformance Analysis – Noise Zoning

Important note: Actual operational data is not shared due to data privacy

CSIR TMM Digital Twin: Equipment behaviour analysis

65 Conformance

25 Revving Events

Equipment visibility

45 Maintenance Records

15 In-cab noise measurements

10 Equipment Interaction

Equipment Profile
- Machine health status
- Noise Risk Profile
- Critical Controls Efficiency

Equipment Score

72 (+2)

Score based on equipment profile and site performance

Site Performance

220
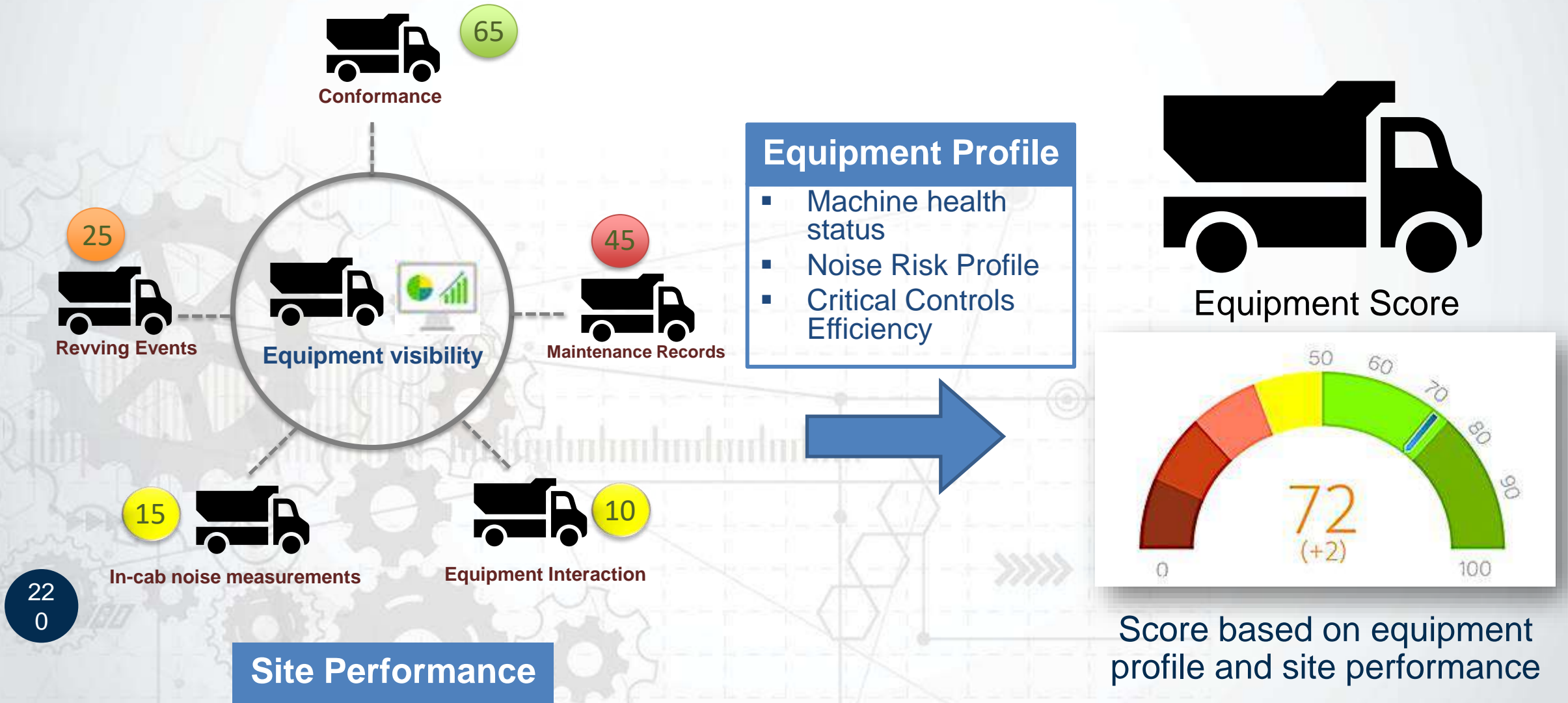
CSIR TMM Digital Twin: Dynamic Noise Risk Assessment

Qualitative Analysis

Likelihood of Occurrence (Probability of Occurrence)

Impact / Severity

3	4	5
2	3	4
1	2	3

Risk Assessment Table

Update **Likelihood of Occurrence**

Noise Risk Management (NRM) Update

Update **NRM** by means of the TMM Digital Twin Cloud Based Interface

Real-World Data: Noise Measurements Maintenance records Critical Controls

Quantitative Analysis

TMM Digital Twin Simulation Frameworks

Simulation of key events to determine the **likelihood of occurrence**

CSIR TMM Digital Twin: Way-Forward (Noise Perspective)

Operation Analysis	Development and Testing	Operational Piloting	Deployment
• Understand the requirements, scope and operation. • Systems and technology analysis • Type of datasets	• Use the TMM Collision Prevention Digital Twin framework to configure for Noise Monitoring Digital Twin • Ingest noise-related datasets • Verify, validate and refine accordingly	• Implement and commission the Digital Twin in a real-world mining operation. • Monitor the performance. • Refine based on findings and feedback from operation.	• Commercialise the Digital Twin. • Full-scale deployment of the Digital Twin in mining operation.

3 – 4 Months	6 Months	6 Months

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