MINING INDUSTRY
OCCUPATIONAL
SAFETY & HEALTH

MINERALS COUNCIL
SOUTH AFRICA

LEADING PRACTICE ADOPTION GUIDE

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Executive Overview

Noise-Induced Hearing Loss (NIHL) remains one of the most prevalent occupational diseases within the South African Mining Industry (SAMI), accounting for approximately 38% of all reported occupational diseases despite a broader 16.5% decline in total cases between 2022 and 2023. While long-term data indicates progress in reducing overall NIHL incidence since peak levels recorded in 2014–2015, annual cases have stabilised at approximately 700 per year, confirming that hazardous noise exposure persists particularly within engineering and maintenance environments.

Recent DMPR statistics highlight elevated NIHL cases among engineering-related occupations, including supervisors, rock drill operators, machine operators, and artisans. A key contributor to this risk is the use of pneumatic hand-held tools such as impact wrenches and pressure testing guns, which generate peak sound pressure levels exceeding 100 dB(A), with measurements reaching up to 121.5 dB(A) at simulated ear position, well above recommended occupational exposure limits. These impulsive and high-frequency noise sources present both immediate and cumulative hearing risk.

In response, Sishen Iron Ore Mine implemented an engineering control intervention through the retrofitting and integration of exhaust mufflers (silencers) on high-risk pneumatic tools. Implemented under the MOSH Leading Practice Adoption System, the intervention prioritised noise elimination at source rather than reliance on personal protective equipment alone.

Measured outcomes demonstrated significant reductions in noise exposure:

- **PT Gun:** Reduced from 105 dB(A) to 67.9 dB(A) during tyre pressure testing at 7 Bar.
- **Impact Wrench:** Reduced from 112.6 dB(A) to as low as 94.0 dB(A) depending on muffler configuration, achieving reductions exceeding 10 dB(A).

Importantly, productivity impacts were negligible. Time studies confirmed only a 30-second increase in PT gun bleeding time and no measurable effect on impact wrench operational efficiency.

Beyond exposure reduction, the intervention delivered measurable operational and financial benefits. Improvements to the PT Gun combination tool extended nitrogen sensor lifespan from approximately two weeks to four months, reducing annual replacement costs from R259,200 to R32,400 and yielding annual savings of R226,800. Additional safety benefits include reduced mobile plant downtime, lower dust generation, improved protection against projectile debris, reduced hand injury risk, and decreased likelihood of tyre pyrolysis events.

The practice was implemented through a structured risk-based framework aligned to recognised industry standards. Mufflers are formally classified as Critical Controls, supported by updated procedures, training programmes, pre-use inspections, Planned Task Observations (PTOs), Visible Felt Leadership (VFL), and defined maintenance requirements. Adoption followed a phased MOSH implementation process, including management endorsement, labour engagement, pilot testing, monitoring, and controlled roll-out.

Sustainability of the practice is dependent on continued leadership commitment, availability of approved mufflers, ongoing competency verification, OEM engagement, and integration into operational risk management systems.

This leading practice demonstrates that effective muffling of pneumatic hand-held tools is a practical, scalable, and cost-effective engineering control capable of materially reducing hazardous noise exposure. The intervention supports industry Zero Harm objectives and provides a replicable model for widespread adoption across the South African Mining Industry, reinforcing the strategic shift from compliance-based monitoring to proactive exposure elimination at source.

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1 Introduction and Background


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Noise-Induced Hearing Loss (NIHL) remains one of the most significant occupational diseases within the South African Mining Industry (SAMI). Although substantial progress has been made over the past two decades, the statistical data presented highlights both improvement trends and areas requiring intensified engineering intervention.

The ten-year analysis of NIHL cases from 2014 to 2024 demonstrates a clear reduction from peak values recorded in 2014 (1,424 cases) and 2015 (1,493 cases) to lower levels stabilising at approximately 700 cases in 2023 and 2024. The initial spike in 2014–2015 likely reflects the culmination of historical exposures combined with strengthened reporting mechanisms aligned to industry milestones. Following this peak, a general downward trajectory is evident, with notable decreases between 2016 and 2018. The decline observed in 2020 coincides with reduced operational activity during the COVID-19 pandemic; however, the modest rebound in 2022 suggests that backlog medical assessments and resumed operations contributed to temporary increases. The stabilisation around 700 cases per annum in recent years indicates progress but confirms that NIHL has not yet been eliminated. Importantly, the latency period associated with NIHL means that many current cases may reflect exposures incurred decades earlier (Refer to Figure 1.)

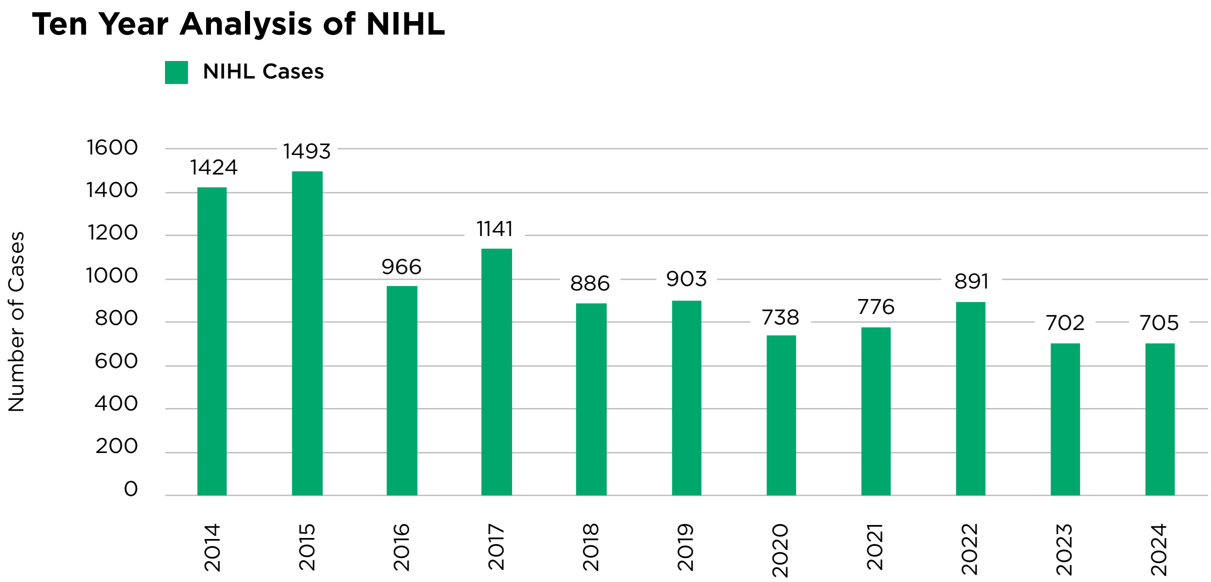

Figure 1: *Ten Year Analysis of NIHL*

The NIHL cases analysis by occupation between the reporting period of 2024/2025 according to the Department of Mineral and Petroleum Resources (DMPR) provides further insight into exposure risk profiles. Team Leaders/Supervisors (86 cases) and Rock Drill Operators (84 cases) represent the highest number of reported cases. Machine Operators (59 cases) and General Labourers (45 cases) also show significant burden. Notably, engineering-related roles, including Engineering Employees, Fitters, Boilermakers, and Artisan Aides collectively account for a meaningful proportion of cases, even if individual category numbers appear lower. Engineering personnel are often exposed to high-impact noise during maintenance activities, plant repairs, metal fabrication, grinding, welding, and equipment testing. These exposures are frequently intermittent but intense, and engineering workshops may present complex acoustic environments where reverberation amplifies overall noise dose. Furthermore, engineering employees often operate in close proximity to production areas, increasing cumulative exposure (Refer to Figure 2).

DMPR Report: NIHL Cases Analysis by Occupation (Apr-Mar 2024/25)

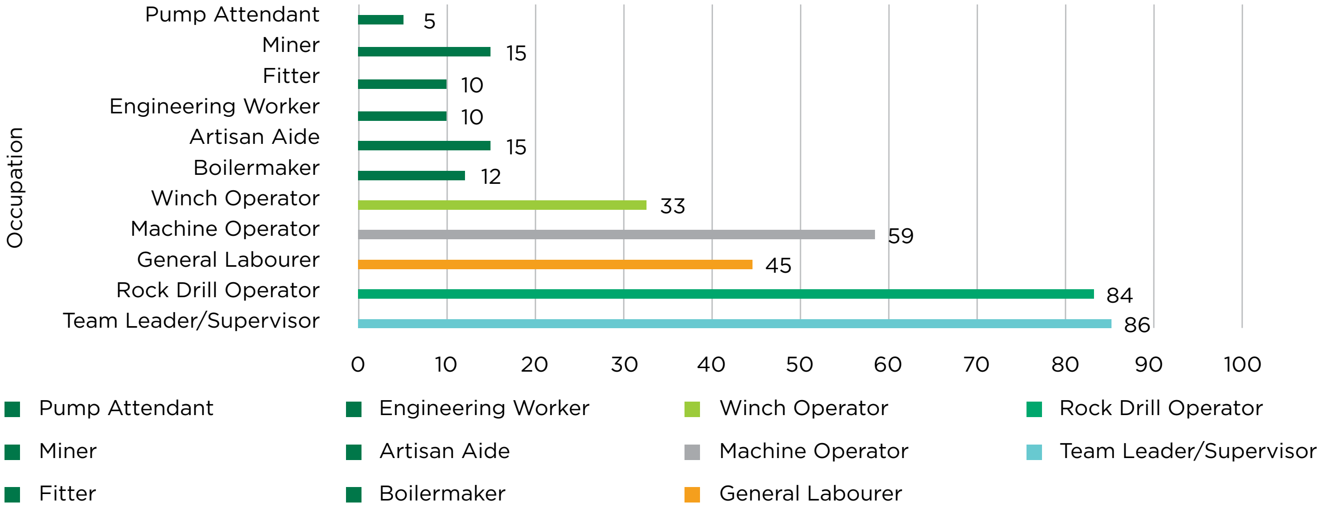

Figure 2: *NIHL Cases Analysis by Occupation*

The long-term dataset from Rand Mutual Assurance (RMA), comparing NIHL claims received versus workforce numbers (2003–2023) reveals a significant reduction in claims from 29,105 in 2003 to 893 in 2023. While workforce numbers fluctuated over this period, including a peak around 455,000 in 2012 and a stabilisation around 320,000–350,000 in recent years, the decline in claims has been disproportionately greater than the reduction in workforce. Declining claims do not necessarily equate to the elimination of hazardous noise exposure; rather, they may reflect improvements in monitoring, technological adaptation, and workforce restructuring (Figure 3).

Number of ONIHL Claims Received vs Lives by Year

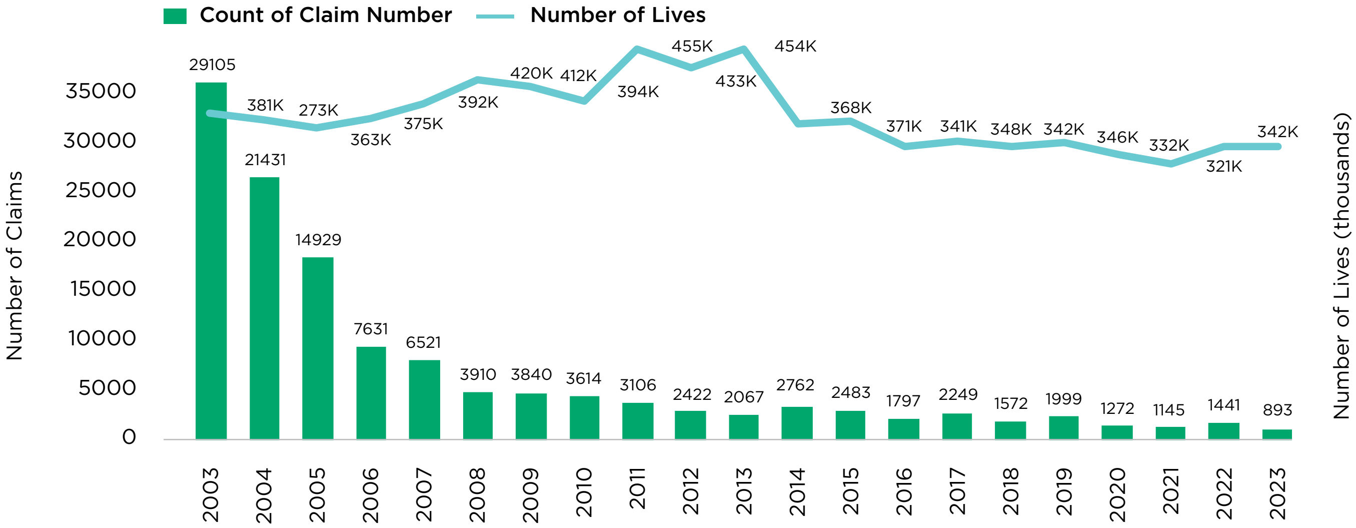

Figure 3: *Number of ONIHL Claims*

The inclusion of engineering employees among high-risk occupational groups in the NIHL statistics reinforces the importance of controlling noise associated with engineering activities, including impact wrenches and pressure and temperature testing. This leading practice aims to address the risk associated with those activities through the use of appropriately designed and fitted mufflers to reduce noise at the source.

2 Understanding Mufflers

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2.1 The Science Behind Noise Reduction

A muffler, commonly referred to as a silencer, is a crucial component designed to minimize the noise emitted by engines and other mechanical devices. These acoustic devices play an essential role in reducing the loudness of sound pressure created when compressed air is released, enhancing the overall experience for users and the surrounding environment. Mufflers work based on several physical principles: absorption, reflection, destructive interference, and expansion of sound waves. Most mufflers are designed to target specific frequency ranges, typically the low-frequency noise produced by engines or industrial equipment. According to research, there are three main types of mufflers; Absorptive mufflers, which use materials like fiberglass or mineral wool to absorb sound energy; Reactive mufflers, which use a series of chambers and tubes to reflect sound waves in a way that causes destructive interference; and Combination mufflers, which incorporate both absorptive and reactive elements for broader frequency attenuation.

Mufflers are ingeniously designed with a series of passages and chambers. These chambers, often resembling a maze, are strategically positioned to ensure that the exhaust gases undergo multiple interactions before exiting the muffler. The arrangement helps manage the pressure drop that occurs during the exhaust process, which can also influence engine performance.

A Reactive Silencing

This method uses the principles of sound wave interference. Mufflers are designed with resonating chambers that are harmonically tuned. When sound waves produced by the engine exit these chambers, they can interact in such a way that opposing sound waves cancel each other out, a phenomenon known as destructive interference. This process significantly diminishes the sound's intensity.

B Resistive Silencing

This approach involves creating a barrier to sound waves. The mufflers structure includes porous materials that resist the flow of sound, thereby absorbing some of the sound energy and converting it into heat. This method is particularly effective at reducing high-frequency noise.

C Absorptive Silencing

Similar to resistive silencing, this technique utilizes absorbent materials inside the muffler. These materials capture sound waves and dissipate their energy, effectively lowering the noise level before the exhaust gases exit the system.

D Shell Damping

This technique involves using the mufflers outer shell to dampen vibrations. By adding mass or using specific materials, the shell can absorb sound energy, further reducing noise levels.

2.2 Applications in Industry

In heavy industries and mining, mufflers are commonly used on diesel engines, compressors, and ventilation fans. Studies show that the application of properly designed mufflers can reduce noise levels by 15 to 35 dB(A) depending on the design and installation. For example, in underground mining, mufflers installed on load-haul-dump (LHD) vehicles significantly reduce operator exposure to engine noise. Research has also emphasized the importance of retrofitting older equipment with modern muffler systems to achieve regulatory compliance.

2.3 Muffling Design Considerations

Effective muffler performance depends on several factors:

Backpressure

Excessive backpressure from poorly designed mufflers can reduce engine performance.

Frequency targeting

Some mufflers are better at reducing high-frequency sounds, while others focus on low-frequency rumble.

Durability

Industrial environments require mufflers made from corrosion-resistant and high-temperature materials.

2.4 Recent Innovations

Recent innovations in muffling include:

Active noise control,

which uses microphones and speakers to cancel sound waves.

Smart materials,

like shape-memory alloys and tunable membranes, for adaptive noise control.

Modular muffler systems

that allow quick adjustments based on noise monitoring feedback.

2.5 Benefits of Using Mufflers

The benefits of employing mufflers extend beyond mere noise reduction. Key advantages include:

Improved Comfort

By minimizing noise pollution, mufflers enhance the comfort of operators and nearby employees.

Compliance with Regulations

Mufflers help ensure compliance with industry milestones, and in most cases reduce the HEG classification thereby avoiding excessive noise sampling in various operational areas.

Equipment Efficiency

A well-designed muffler can improve airflow and improve performance, striking a balance between noise reduction and power output.

2.6 Type of Mufflers

A **Sintered Bronze Mufflers**

Low-cost Sintered Bronze Mufflers are easy to install in new and existing exhaust ports of valves, cylinders and other air powered equipment. Each Sintered Bronze Muffler is capable of passing a certain volume of air with minimal back pressure restriction, so it doesn't interfere with the operation of the cylinder or valve. Available in different sizes, ranging from small to large to fit most pipelines.

B **Reclassifying Mufflers**

Silencing Mufflers help to reduce work area noise and oil mist produced by air exhausting from cylinders, valves and other air powered equipment. Each Reclassifying Muffler passes a certain volume of air with minimal back pressure restriction, so it doesn't interfere with the operation of the cylinder or valve. Available in a range of sizes.

C **Cold Mufflers**

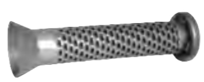
Mufflers for both the hot and cold air discharge. Normally, muffling is not required if the cold air is ducted. resulting in up to 20dB(A) noise drop without affecting the compressed air drop.

D **Hot Mufflers**

Heavy Duty Silencing Mufflers feature a corrosion-resistant aluminium outer shell with an internal stainless-steel screen that protects valves and cylinders from contamination that could enter through the exhaust ports. This also keeps contaminants such as rust from being ejected at high speed from the exhaust port. The typical noise reduction is up to 14 dB(A) up to 20dB(A) noise drop without affecting the compressed air drop.

E **Straight-Through Mufflers**

Mufflers feature a corrosion-resistant aluminium outer shell lined with sound-absorbing foam for better noise reduction. The typical noise reduction is up to 20 dB.



F **Baffle Muffler**

They utilize a series of internal chambers and baffles to absorb and cancel out noise. These chambers are strategically designed to create turbulence in the air flow, effectively reducing noise levels without sacrificing performance.

Mufflers could be applied to Air Guns, Air Nozzles & Jets, Air Knives, or any similar compressed air pipeline. Mufflers are sophisticated devices that employ a variety of sound reduction techniques to minimize noise from mechanical systems. By utilizing reactive, resistive, absorptive, and shell damping methods, mufflers contribute significantly to a quieter and more pleasant environment, while also supporting compliance with noise regulations and potentially enhancing productivity. Understanding these principles not only highlights the importance of mufflers but also sheds light on the engineering marvels that help maintain a balance between functionality and noise control.

3 CASE STUDY
Sishen Iron Ore Mine

Tshipi Borwa Mine.

3.1 Problem Statement

Sishen Iron Ore Mine, located near the town of Kathu in the Northern Cape, South Africa, is one of the largest open-pit mines in the world, stretching over 14 kilometres in length. It serves as the flagship operation of Anglo American's Kumba Iron Ore business and is globally recognised for its scale and high-quality production.

Sishen produces premium-grade lump and fine iron ore using opencast mining methods. Once extracted, the ore is transported to the mine's state-of-the-art beneficiation plant, where it undergoes a series of processes including crushing, screening, and separation to upgrade the iron content. Beneficiation is achieved primarily through dense media separation (DMS) and jig technology, ensuring efficient recovery of high-quality ore. Notably, the jig plant at Sishen is the largest of its kind in the world, reinforcing the mine's strategic importance in supplying consistent, high-grade iron ore to both domestic and international markets.

The use of handheld tools such as impact wrenches and pressure testing guns on mining vehicle tyres has emerged as a critical concern in the mine. These tools, commonly used for tightening and loosening lug nuts as well as testing and inflating high-pressure tyres, are known to produce peak sound pressure levels exceeding 100 dB(A). Such levels far exceed the recommended occupational exposure limits set and pose immediate and cumulative risks to hearing health if not effectively managed. The sudden release of air during pressure testing, and the repetitive metallic impulses from impact wrenches, generate high-frequency, impulsive noise, which is particularly damaging to the inner ear.

As a response to this risk, Sishen Iron Ore has implemented proactive measures to address this challenge. In collaboration with its business partners and the Hearing Conservation Committee, the mine continuously conducts detailed analyses of its noise risk profile. The main objective of these efforts is to identify, prioritise, and implement high-impact noise control measures within the framework of the mine's integrated Health and Safety Management System.

Among the most effective engineering controls adopted is the use of mufflers (silencers) on pneumatic hand-held equipment. These devices are specifically designed to reduce the sound emissions generated by machinery, engines, and ventilation systems, thereby significantly lowering noise exposure levels for employees operating in high-risk areas. This intervention reflects Sishen Mine's commitment to advancing hearing conservation, reducing occupational health risks, and aligning with industry-wide efforts to achieve Zero Harm.

Gold Fields - South Deep

3.2 Operational Application of Muffling

3.2.1 Pressure Testing Gun

During pressure testing process, noise primarily arises from several sources, including the release of air pressure, which can create hissing or popping sounds, and the operation of compressors that produce continuous noise from motor and exhaust venting. Structural vibrations within the testing setup may amplify low-frequency noise, while leakage points can emit a steady whistle if air escapes through small cracks. Additionally, burst events can cause sudden loud noises from rapid decompression, and friction from moving parts may add to the background noise.

Sishen Mine's tyre management contractor pioneered a transformative approach to earthmover (EM) tyre pressure control by introducing chamber air temperature measurement through inflation monitoring. This groundbreaking initiative marked a milestone in tyre technology, leading to the development of the first EM tyre air temperature measurement device. The innovation significantly advanced EM tyre pressure regulation, enabling more accurate and consistent pressure adjustments for tyres under operational ("hot") conditions. The initial device, a bi-metallic probe thermometer with a tapered rubber grommet designed for precise fit and durability, laid the foundation for subsequent advancements. This tool evolved into the Contractor Pressure-Temperature (PT) Gun, developed in partnership with Topy. This collaboration set the stage for modern Tyre Pressure Monitoring Systems (TPMS), optimized specifically for the demanding requirements of EM tyres.

Sishen Mine has enhanced the PT Gun by fitting it with a muffler, effectively reducing noise emissions during tyre testing and improving overall operating conditions, health, and safety for employees. This modification not only provides significant noise reduction but also enhances ergonomic conditions and safety by addressing loose cable issues, thereby creating a safer and more efficient work environment.

3.2.2 Impact Wrench

Impact wrenches are widely used in the mining industry for tasks that require the rapid tightening or loosening of bolts, nuts and fasteners, during maintenance of heavy machinery, trackless mobile equipment, and during tyre change operations. Sishen Iron Ore assessed its operations and identified this process as a high risk, with noise measurements ranging between 104dB(A) to 108dB(A). The noise reduction initiative introduced was done through the fitting of exhaust mufflers under the following operating conditions:

- Tests conducted while loosening and tightening nuts on Komatsu haul truck wheel assembly
- Two impact wrenches tested (old tool and new tool) – Chicago Pneumatic wrench model CP6060-P15R
- Impact wrenches have ¾ "drive shaft.
- Air pressure regulated at 5.8 Bar with maximum design specification of 6.3 Bar

The mufflers on the impact wrenches are installed using the following simple steps:

- Thread of both the 90° elbow reducer and the muffler are wrapped with PTFE thread tape (Plumber's tape) for airtight seal.
- Reducer elbow is screwed into the exhaust port of the Chicago Pneumatic impact wrench
- The muffler is screwed onto the reducer

Village Main Reef – Kopanang

3.3 Technical Aspects of the Practice

3.3.1 PT Gun Combination Tool

3.3.1.1 PT Gun Combination Tool Components

The PT Gun Combination Tool consists of the following components:

A Handheld Pressure Temperature Gauge

The Handheld Pressure Temperature Gauge is used to determine the chamber temperature reading. This is achieved by correlating the chamber temperature reading against the recommended cold inflation pressure as per the heat chart. The air is then slowly released until the thermometer reading stabilises by bleeding it for one minute or until the digital reading stops.

B Handheld Pressure Gauge

The Handheld Pressure Gauge is used to accurately establish tyre pressure. This is achieved by using an approved handheld pressure gauge. To achieve accuracy, the calibration of the Handheld Pressure Gauge is achieved by testing it against the master gauge and adjusted where required.

C Handheld Nitrogen Percentage Indicator

The Nitrogen Percentage Indicator is a hand-held instrument for indicating the Nitrogen percentage of the Nitrogen source. It is designed for use for the automotive industry. The unit is compact and ergonomic in design with easy-to-use, one button operation.

D Inline Water Trap

The Inline Water Trap is designed to remove water, oil, dirt and rust from the compressed air, protecting the pneumatic equipment from corrosion, seals damage and lubrication blow-out. The clean dry compressed air increases the pneumatic machinery efficiency and improves overall productivity.

E Air Exhaust Muffler

The Air Exhaust Muffler is installed to reduce the noise generated during the temperature pressure testing process.

F Combination Tool

The combination tool is used to join or merge the different parts into one unit, which is referred to as the PT Gun in this document.

3.3.2 Impact Wrench Muffling

3.3.2.1 Impact Wrench Muffling Components

	**A** **Chicago Pneumatic** The Chicago Pneumatic 6060-P15R ¾” drive is used to loosen and tighten nuts on wheel assemblies of HME and also as nut runners. Operates at maximum of 6 Bar / 90 Psi air pressure and speeds of up to 4000 rpm.
	**B** **Air Exhaust Muffler** The Air Exhaust Muffler is installed to reduce the noise generated from high pressure air release from the exhaust port of the impact wrench
	**C** **Elbow (90°) Reducer Attachment** The elbow is used to attach the muffler to the exhaust port of the impact wrench.


Kumba Iron Ore.

4 Generic Value Case

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The primary advantage of this practice is the reduction of noise exposure through effective muffling, however, there are additional benefits documented:

4.1 Health and Safety Benefits

Reduction in Mobile Plant Downtime Due to Faster Deflation

The practice contributes to reduced mobile plant downtime by enabling faster and more controlled tyre deflation. This improves maintenance efficiency, shortens task completion times, and supports quicker return of equipment to service, thereby enhancing overall operational productivity.

Reduced Dust Exposure

Effective muffling during deflation limits the release of compressed air and associated debris, resulting in lower airborne dust generation. This reduces inhalation risks for personnel and supports improved occupational hygiene conditions in the work area.

Enhanced Eye Protection against Projected Particles

The controlled deflation process minimizes the projection of particles and debris, thereby reducing the risk of eye injuries. This provides an additional layer of protection for workers, particularly during high-risk tyre maintenance activities.

Reduction in Hand Injuries and Accidental Release of Stored Energy

By controlling the release of stored pneumatic energy, the practice significantly lowers the likelihood of sudden pressure discharge. This reduces the risk of hand injuries and other musculoskeletal harm associated with uncontrolled deflation events.

Lower Risk of Tire Pyrolysis (Tire Bursts)

Controlled and efficient deflation reduces heat build-up and internal stress within the tyre. This lowers the risk of tyre pyrolysis and catastrophic tyre bursts, contributing to improved safety outcomes during tyre maintenance operations.

4.2 Initial Cost for the Installation of the Muffler

4.2.1 PT Gun Combination Tool

4.2.1.1 Noise Reduction

PT Gun	PT Gun Combination Tool
105 dB(A) from pressurized air release during temperature testing on tyre inflated to 7 Bar	67,9 dB(A) from pressurized air release during temperature testing on tyre inflated to 7 Bar

4.2.1.2 Time Study

PT Gun	PT Gun Combination Tool
One Minute Bleeding Time	One Minute and 30 Seconds Bleeding Time

Note: The Combination Tool takes 30sec longer to get to a recordable reading when compared to the PT gun.

4.2.1.3 Inline Water Trap

The incorporation of the Inline Water Trap on this Combination tool reduces the frequent replacement of the filter on the Nitrogen gauge.

4.2.1.4 Nitrogen Sensor

Historical Sensor Costs	Current Sensor Costs
Previously, each sensor had an average lifespan of approximately 2 weeks. • **Cost per sensor:** R1,350 • **Total nitrogen gauges at Sishen:** 8 • **Monthly replacement rate:** 16 sensors • **Monthly cost:** 16 sensors x R1,350 = R21,600 • **Annual cost:** R21,600 x 12 months = R259,200	With advancements, each sensor now has an expected lifespan of about 4 months. • **Annual replacement requirement:** 24 sensors • **Annual cost:** 24 sensors x R1,350 = R32,400

4.2.1.5 Financial Impact (Saving)

- **Annual savings:** R259,200 (previous) - R32,400 (current) = R226,800
- **Total reduction in cost per annum:** R226,800

This improvement represents significant cost savings and operational efficiency for Sishen by reducing sensor replacement frequency and associated expenses.

4.2.2 Impact Wrench

4.2.2.1 Noise Reduction

The table below summarises the noise reduction of muffling the impact wrenches under various operating conditions at Sishen Iron Ore.

Unit	Without Load	Under load	At Exhaust
CP 6060-P15R NO MUFFLER	112.6 db(A)	16.5 db(A)	121.5 db(A)
CP 6060-P15R WITH MUFFLER	104.3 db(A)	12.7 db(A)	111.9 db(A)
CP 772H-6 WITH MUFFLER	100.1 db(A)	97.9 db(A)	107.2 db(A)
NO MUFFLER	112.6 db(A)		
MUFFLER WITH FOAM/MESH INSERTS	104.3 db(A)		
INJECTION MOULDED PLASTIC BODY AND THREAD WITH SINTERED PLASTIC/METAL MEMBERANE	103.5 db(A)		
PIPE AND MUFFLER	98.1 db(A)		
MUFFLER ASSEMBLY	94.0 db(A)		
BACKGROUND NOISE LEVEL	58.3 db(A)		
VARIANCE	> 10 db(A)		

4.2.2.2 Time Study

The retro fitment of mufflers on the impact wrenches has no negative impact on the duration of the tool usage and productivity.

4.2.2.3 Initial Baseline Test

During the initial assessment, it was observed that the impact wrench in use did not have a muffler installed. Baseline noise measurements were therefore conducted under the following conditions:

Free Run	Nut Removal
• 1 m from source: 112.6 dB(A) • (Not attached to nut)	• 1 m from source: 106.5 dB(A) • (Nut removal from wheel assembly)

Considering the positioning of wheel nuts during operation, the impact wrench often has to be raised closer to the operator's ear. To simulate this scenario, noise measurements were taken at a distance of 30–40 cm from the exhaust port, representing the approximate position of the operator's ear: At exhaust (simulated ear position): 121.5 dB(A)

4.2.2.4 Comparative Tests with Mufflers

Further tests were conducted on the CP6060 P15R impact wrench under free-run conditions, using different muffler configurations. Free-run testing was selected as it provided consistent readings, which were generally higher than the intermittent noise levels observed when shifting the socket between nuts. The results from the tests are summarised below.

Noise Rating Levels on Impact wrenches with different types of exhaust air control

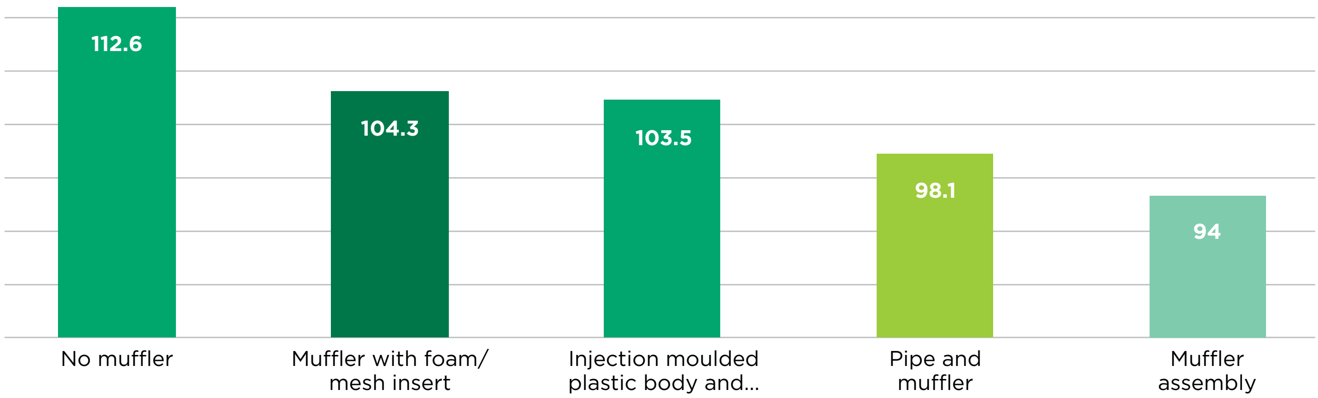

Figure 4: *Noise Levels on Impact wrenches with different muffler types*

4.2.2.5 Cost Analysis

Historical Costs	Current Sensor Costs
Previously, the impact wrench was custom fitted with OEM muffler. • **Cost Chicago Pneumatic:** R39,000 (excl VAT) • **Replacement rate:** 24 months dependant on use • **Annual cost:** R39,000 x 2 = R78,000.00 (excl VAT) (4 purchased every 2 years)	Cost inclusive of alteration/addition of muffler. • **Cost Chicago Pneumatic:** R39,000 (excl VAT) x 4 every 2 years • **Muffler cost per unit:** R 813 per muffler x 4 = R3252 • **Elbow/reducer attachment per unit:** R 200/elbow x 4 = R800

4.2.2.6 Financial Impact (Increase)

Annual increased expenditure only every 2 years:

- **Previous:** R156,000 (excl VAT)
- **Current:** R156,000 (excl VAT) + R3252 + R800 = R160,052 (increase of R4052)

The improvement introduces an additional cost due to the installation of aftermarket mufflers. However, it provides significant long-term benefits by reducing the risk of NIHL, which have an impact on the quality of life of affected employees and also reduces the risk of compensation costs.

5 Key Considerations

Kumba Iron Ore.

5.1 Risk Management

The risk management process was implemented through a structured and integrated set of tools designed to identify, assess, and control potential hazards in the workplace. The evaluation was conducted using the Downer EDI Mining Risk Assessment format and its associated risk rating system, ensuring alignment with recognised industry standards and consistent application across operations.

Risk assessments and Job Hazard Analyses (JHAs) formed a core component of the job preparation process, enabling teams to proactively identify hazards and implement appropriate control measures before work commences. Identified risks are further addressed through established training materials and operational systems, ensuring that employees are equipped with the knowledge and procedures required to work safely and effectively.

To support safe equipment operation, warning sheets are incorporated into the Handheld Tools Manuals, highlighting key safety considerations that must be observed during use. In addition, the Mine Pre-use Inspection Checklist plays a vital role in confirming safe working conditions prior to equipment operation, reinforcing compliance with safety standards and preventing potential incidents.

Collectively, these risk management tools strengthen hazard identification, promote proactive safety practices, and support continuous improvement in operational risk control.

5.2 Training

Current training methods applied at the source mine in achieving full implementation of the significant requirements of the practice. The practice has been fully documented, and all applicable documents have been integrated into the Tyre maintenance Contractor's training matrix. All applicable and relevant training materials were developed from a risk base approach, and the following documents have been developed in this regard:

- Tyre Management Risk Assessments
- Daily Tyre Management PTOs
- Tyre Management PTOs

All these developed materials are incorporated in the training program, Tyre Technicians and Line Supervisors, and is executed using the following training methodologies:

Formal Class Training

This training is provided by an internal Competent Training officer and Manager. The training entails a detailed theoretical session which highlights the critical aspects of the practice, including Hazard and Risk assessed and analysed, applicable controls applied and technical aspects of the practice.

On the Job Training

After being assessed and declared competent on the outcomes of the theoretical training program, tyre technicians in training are provided with a practical training at the work area and assessed in relation with the training requirement outcomes of the theoretical training programme.

5.3 Widespread Adoption of a MOSH Leading Practice

Adoption Process steps for Widespread adoption of a leading practice.

The following table provides guidance in terms of the process that each mine should follow in successfully adopting the Muffling for Pneumatic Handheld Tools leading practice. It is essential that each step is followed sequentially but recognise that the sub-tasks of a step could run parallel based on the resources available at the operation.

Main Step	Sub Tasks Required to Enable Successful Completion of Each Step
STEP 1 Secure Support for Adoption	**TASK 1** Facilitate / or confirm mine leading practice related risks and controls / verify whether the leading practice is applicable to the mine. (persuade / tool for mine of value case "site specific context") **TASK 2** Senior mine management / MANCO Session and orientation presentation **TASK 3** Engage organized labour (adopting mine Champion) **TASK 4** Issue mine wide communication **TASK 5** COPA / Interest Group sign up and attendance of Copa (full leading practice) and other Interest groups (simple leading practice) **TASK 6** Conduct adoption readiness review
STEP 2 Establish mine adoption Team	**TASK 1** Identify functional groups involved in the adoption process **TASK 2** Attend mosh "competence / Capability / awareness program"
STEP 3 Confirm mine Social Technical System (STS) elements to be addressed	**TASK 1** Review the Leading Practice Adoption Guide (LPAG) and generic adoption plan of source / demo mine to familiarise the operation with potential STS aspects **TASK 2** Confirm mine processes and documentation defining the operation's STS aspects (as listed in the Mine Adoption Readiness review)
STEP 4 Establish mine adoption plan	**TASK 1** Decide on pilot site / area **TASK 2** Update adoption plan **TASK 3** Develop leading practice monitoring plan
STEP 5 Review, update and monitor operational processes and documentation	**TASK 1** Develop and / or update existing COPs and procedures **TASK 2** Develop and / or update training material **TASK 3** Introduce monitoring mechanisms **TASK 4** Develop change communication plan and material/ update existing material, to communicate the impact and operational changes effectively
STEP 6 Execute leading practice adoption and implementation in pilot site / area	**TASK 1** Pilot site / area leading practice adoption **TASK 2** Monitoring of LP execution based on developed monitoring metrics (step 5 – task 3)
STEP 7 Roll out the lp to the rest of the organization / mine	**TASK 1** Facilitate effective roll-out and duplication of adoption process as undertaken / developed during pilot process **TASK 2** Provide ongoing feedback and reports on adoption to MOSH learning hub

5.4 Communication Strategy

5.4.1 Behavioural Communication Requirements

Change Communication in simple terms means the development of material to communicate the essence of the leading practice and the change it will introduce to existing operational processes. The communication is not intended to facilitate behavioural change. The communication material is key to communicating the new or revised controls, operational and risk management concepts embedded in the leading practice. People can only engage fully with the leading practice if there is a clear understanding of the benefit a "new way of working" (process) will hold for them, or how new or revised controls would provide additional barriers to risk. Adoption teams may opt to develop change communication in various formats for use in popularizing the leading practice but more so in communicating key aspects as part of the adoption guides that will be disseminated to adopters. It is advisable to develop visual material either in the form of flowcharts, schematics or video format. Currently, the mine is utilizing developed training materials and procedures to communicate to decision makers, affected employees and other stakeholders on facilitating full implementation of the EM Tool.

No	Stakeholders / Adopters (recipients)	Belief / issue addressed & Desired behaviour	Messages, Communication Content	Mode	Tools / means	When	Responsibility for delivery	Who to ensure	Evaluation / control measure
1	Technician	Desired behaviour: Fully understanding that Noise Reduction Through Muffling is classified as an Engineering Control to mitigate the development of NIHL amongst exposed employees and shall be utilised whenever identified pneumatic hand-held tools with air exhaust are used during their normal functions (e.g. impact wrench, blowers, pressure measuring tools. Belief, knowledge gap, lack of understanding, or misperception: The use of mufflers does not significantly reduce noise exposure and is not recognised as a critical control amongst users. Affixing mufflers to pneumatic tools reduces their efficiency.	Mufflers affixed to pneumatic tools and equipment significantly reduces noise levels, reducing the risk of adverse health effects. However, as a precaution, recommended HPDs should be worn during the use of muffled pneumatic tools and equipment.	Formal classroom training of competent pneumatic tools and equipment users, e.g. artisans,	Standard Operating Procedures (SOP), On the Job Training (practical demonstration) Audio visual tools	Annual or when there are changes in the practice	Trainer / First Line Supervisor	Line Manager	Competency testing, Planned Task Observations (PTO)
2	First Line Supervisor	Desired behaviour: Ensuring that all pneumatic tools or equipment used are affixed with approved mufflers, and that pre-use inspections are conducted at all times. Periodically conduct PTOs and positively reinforce desired behaviours from users. Belief, knowledge gap, lack of understanding, or misperception: The use of pneumatic tools and equipment without mufflers does not pose any significant risk exposure to users over a short period.	Mufflers affixed to pneumatic tools and equipment significantly reduces noise levels, reducing the risk of adverse health effects. However, as a precaution, recommended HPDs should be worn during the use of muffled pneumatic tools and equipment. Affixed mufflers are classified as Critical Controls and should have a maintenance plan	Training of First Line Supervisor on conducting effective PTOs and coaching and principles of critical control management	Standard Operating Procedures (SOP), where applicable, Critical Control Management (ICMM principles)	Annual or when there are changes in the practice	Trainer / Line Manager	Engineer	Competency testing, Planned Task Observations (PTO)

No	Stakeholders / Adopters (recipients)	Belief / issue addressed & Desired behaviour	Messages, Communication Content	Mode	Tools / means	When	Responsibility for delivery	Who to ensure	Evaluation / control measure
3	**Line Manager** **Engineer** **Engineering Manager**	Desired behaviour: Ensuring that there approved mufflers are always available on stock and all pneumatic tools or equipment used are affixed with approved mufflers. Line supervisors and users conduct pre-use inspections as required. Periodically conduct PTOs and VFLs and positively reinforce desired behaviours from users. Belief, knowledge gap, lack of understanding, or misperception: Retrofitting mufflers on pneumatic tools and equipment is costly and reduces efficiency, negatively impacting on maintenance turnaround time	Mufflers affixed to pneumatic tools and equipment significantly reduces noise levels, reducing the risk of adverse health effects. However, as a precaution, recommended HPDs should be worn during the use of muffled pneumatic tools and equipment. Affixed mufflers are classified as Critical Controls and should have a management plan. Continuous OEM engagements should be held to further reduce the noise levels of pneumatic tools and equipment	Training of the management team on conducting effective PTOs and VFLs, including coaching. Training on the principles of critical control management	Standard Operating Procedures (SOP), where applicable, Critical Control Management (ICMM principles)	Annual or when there are changes in the practice	Trainer /Engineer Manager	Engineering Manager	Competency testing, Planned Task Observations (PTO)
4	**Trainer**	Desired behaviour: Understand and incorporate the mine's noise risk management strategy in the training programme. Develop training material which are easy to understand and implement. Establish a competent declaration mechanism for continuous improvement purposes Belief, knowledge gap, lack of understanding, or misperception: There is no health impact associated with exposure to equipment noise.	Development of outcome-based training material which includes the technical and expected behaviours from all levels	Formal training of all levels on the requirements of the Leading Practice	Standard Operating Procedures (SOP), where applicable, Critical Control Management (ICMM principles)	Annual & On the job	Training or Engineering Manager	Engineering Manager	Audit Reports

5.4.2 Leadership Behaviour Requirements

5.4.2.1 Ideal behaviours

Ideal leadership behaviours have been captured and summarized under key elements of desired leadership behaviour document.

5.4.2.2 Planned Task Observation

Planned Task Observations are conducted as determined by the planning matrix. Any deviations observed during the planned task observations are recorded and followed by retraining and coaching.

5.4.2.3 Visible Felt Leadership

Unscheduled task observations are also conducted by the leadership team through Visible Felt Leadership (VFL's) engagements, similarly any deviations observed are recorded and further training and coaching provided to the observed tyre technician.

Details of relevant levels of leadership	**Antecedent** Things that are required to precede or prompt desired behaviour	**Behaviour** Desired key behaviours that are necessary for success	**Consequences** Actions following behaviour to increase, maintain or decrease behaviour
Technicia	1. Formal Training Programme 2. Understand that the muffler is used as a noise control apparatus 3. Pre-use Checklist 4. Incident reporting system 5. Planned Task Observations	1. A muffler is always affixed when using pneumatic tool 2. Pre-use inspections are always conducted 3. Incidents are promptly reported when there are any deviations observed, e.g. leaks on the connections, etc.	1. Planned Task Observations 2. Review of reported incidents 3. On-the job training
First Line Supervisor	1. Formal Training Programme 2. Muffler components availability 3. Pre-use Checklist 4. Incident reporting system 5. Planned Task Observations 6. Scheduled Maintenance system / Job Cards 7. Availability of Maintenance parts / consumables 8. Over inspection reporting system	1. Planned Task Observations conducted 2. Review of Pre-use Checklists & Incident reports 3. Performing of over inspections 4. Performing Scheduled Maintenance	1. Planned Task Observations 2. Review of reported incidents 3. On-the job training 4. Review of Job Cards 5. Review of over inspections

Details of relevant levels of leadership	Antecedent Things that are required to precede or prompt desired behaviour	Behaviour Desired key behaviours that are necessary for success	Consequences Actions following behaviour to increase, maintain or decrease behaviour
Second, Third & Fourth Level Supervisors	1. Formal Training Programme 2. OEM Engagement strategy 3. Pre-use Checklist 4. Incident reporting system 5. Planned Task Observations 6. Scheduled Maintenance System / Job Cards 7. Availability of Maintenance parts/consumables 8. Over inspection reporting system 9. Stock inventory system & Procurement system	1. Planned Task Observations conducted 2. Review of Pre-use Checklists & Incident reports 3. Performing of over inspections 4. Maintenance of adequate stock levels on replacement parts	1. Planned Task Observations 2. Review of reported incidents 3. On-the job training 4. Review of Job Cards 5. Review of over inspections 6. Review of replacement parts inventory
Trainer	1. Formal training programme 2. Audit programme & schedule	1. Formal training is provided to all employees involved in the task of Tyre Deflation on a periodic basis 2. On the job training is provided at scheduled intervals	1. Audits on Training programme

5.5 Maintenance and Availability of Equipment

5.5.1 Maintenance

PT Gun Combination Tool	Impact Wrench Muffling
• **Filter (water and sealant trap) replacement** required due to seal-a-wheel contamination – every year for each unit (3 on site) • **Thermostat** on PT gun every 2 years • **Nitrogen sensors** replacement – 16 per year • **Battery replacement** on nitrogen sensor every 24 months	• Muffler replaced if required but current practice is to remove from old impact and attach to new. • Daily lubrication required • No scheduled maintenance on impact wrenches – replaced when there are problems.

5.5.2 Availability

PT Gun Combination Tool	Impact Wrench Muffling
• **Nitrogen tester:** Contractor stock item at head office (supplier based in Canada) • **PT Gun:** no current replacement plan due to durability, imported from Canada (only used on Sishen mine) • **Filter, mufflers, fittings:** stock items locally available from hardware stores	• **Chicago pneumatic:** JHB based supplier but imported

6 Conclusion

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6.1 Key Lessons Learned

The following key lessons were recorded during the investigation and documenting phase of the Potential Leading Practice:

Adoption of a Multidisciplinary Approach:

Effective implementation requires the integration of expertise from various technical, operational, and health and safety disciplines to ensure a holistic understanding of the practice's impact and feasibility.

Original Equipment Manufacturer (OEM) Engagement:

Early and continuous involvement of OEMs is essential to align technical specifications, operational requirements, and lifecycle support for any introduced innovations.

Impact of Continuous Improvement on Documentation Timelines:

Continuous refinement of the practice, while valuable, can delay the finalization of documentation. A balance must be maintained between optimization and timely reporting.

Dedicated Project Management Structure:

Appointing a specialized project team with clearly defined roles and responsibilities enhances accountability and ensures alignment with milestones and deliverables.

Time Management and Prioritization:

Effective scheduling and resource allocation are vital to minimize delays, especially when operating in parallel with production activities.

Structured Project Planning and Monitoring:

The development and adherence to a comprehensive project plan, complemented by periodic progress reviews, is fundamental to maintaining momentum and ensuring consistent execution.

6.2 Practice Sustainability

The following aspects will determine the sustainability of the practice:

Risk-Based Adoption:

Full implementation must be informed by a risk-based approach, ensuring that the practice addresses key operational risks and delivers measurable improvements in performance or health and safety outcomes.

Leadership Commitment:

Endorsement and active participation from senior leadership are essential to drive cultural alignment, allocate resources, and reinforce accountability at all levels.

Behaviour Communication:

Sustaining behavioural change requires ongoing engagement, targeted messaging, and reinforcement mechanisms to embed the practice into the daily routines of employees.

6.3 Concluding Remarks

The development and documentation of this Leading Practice has highlighted both the strategic value and the operational requirements involved in introducing new approaches within the operation. The insights gained through this process underscore the importance of a structured, collaborative, and adaptive implementation framework. Moving forward, continuous stakeholder engagement, aligned leadership support, and integration into broader operational risk management frameworks will be essential in ensuring the practice is not only adopted but also sustained as a benchmark for industry improvement.

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