



WHITE PAPER

AI-Driven Predictive Maintenance for
Ball Mills



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Executive Summary

Ball mills are mission-critical assets in process industries such as cement, mines & metals, steel, fertilisers, and others, responsible for grinding ores, clinker, coal, and raw materials into fine powders essential for production. Failures can cause significant downtime, production losses, and safety incidents.

Ball mills face unique challenges including gear and pinion wear, lubrication failures, shell and liner

degradation, and misalignment under variable loads. Traditional inspection-based maintenance methods are reactive and often miss early signs of failure.

This paper explains the importance of ball mills, the challenges of monitoring them in real-world conditions, the role of advanced sensors, and how PlantOS, our Industrial AI platform, detects early-stage ball mill faults. We also present deployment results across 191 monitored ball mills, which demonstrated:

- >99% equipment availability
- 2,681 hours of downtime avoided
- 20% reduction in MTTR (Mean Time to Repair)
- 435 early faults detected and diagnosed

The Importance of ball mills in Industry:

1. **Cement:** Grinding clinker into cement powder.
2. **Mining & Metals:** Ore grinding for mineral liberation in concentrators.
3. **Fertilisers:** Processing phosphate and raw material feedstock.
4. **Power Plants:** Pulverising coal for boilers.

Ball mills are indispensable in process industries, and failures directly impact plant productivity and profitability.

Challenges in Monitoring

High load and variable speeds stressing drive train components.

Gear and pinion wear from heavy loads and misalignment.

Liner and shell degradation under abrasive conditions.

Lubrication failures leading to bearing seizures.

Harsh environments with dust, heat, and restricted access.

Why Sensor Selection Matters

- **Powered sensors (Electricity)** - Capture vibration, temperature, and acoustic signals from gears, pinions, and bearings.
- **Wireless sensors (Battery)** - Useful for auxiliary ball mills or remote sections.
- **Piezoelectric stainless-steel sensors** - Ensure durability and sensitivity in abrasive environments.
- **Torque/strain sensors** - Provide insight into load variations and grinding efficiency.

Selecting the right combination of sensors ensures balance between cost, data fidelity, and fault diagnostic accuracy.

How PlantOS Identifies Early-Stage Faults

PlantOS, the Industrial AI platform, ingests high-frequency sensor data and applies advanced analytics to detect faults at their earliest stages:

- **Data Capture:** High-frequency vibration, temperature, acoustic, and torque signals.
- **Feature Engineering:** Extracts 70+ engineered features from each dataset.
- **Adaptive AI Models:** Continuously Learn normal vs. abnormal mill behavior under varying loads.
- **Fault Classification:** Identifies failure modes such as Detects bearing clearance issues, misalignment, lubrication faults, gear/pinion defects, and shell/liner wear.
- **Prescriptive Insights:** Goes beyond detection, PlantOS recommends the most likely cause and the intervention required.

This **closed-loop AI system** reduces false alarms and builds trust with plant teams by aligning predictions with real-world outcomes.

Deployment and Results

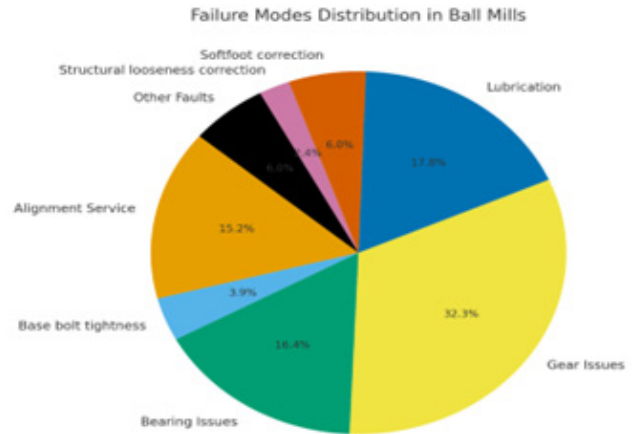
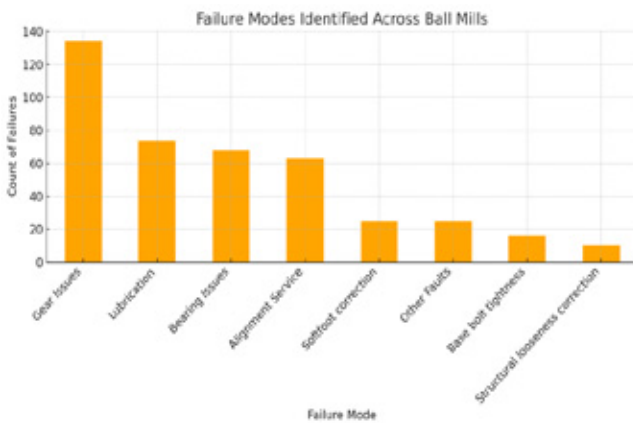
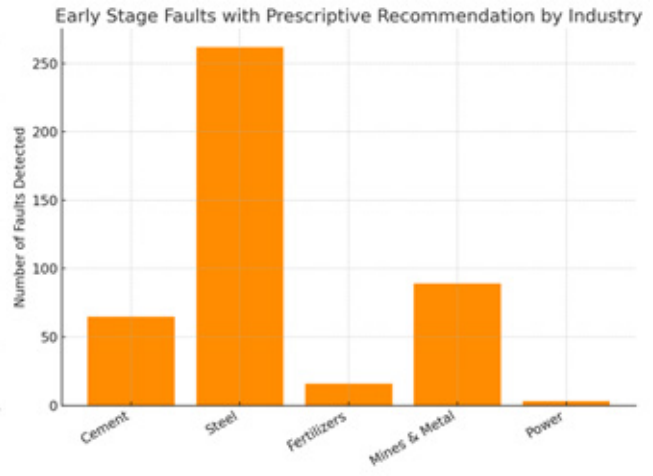
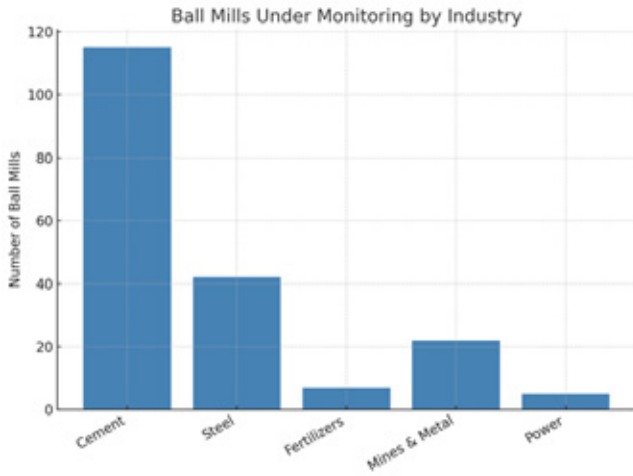
Scope of Deployment

- **Industries:** Cement, Metals, Mining, Fertilisers, Power
- **Ball Mills Monitored:** 191
- **Fault Reports Generated:** 435
- **Downtime Avoided:** 2,681 hours

Key Outcomes

- **Availability:** >99%
- **Maintenance Efficiency:** 20% MTTR reduced
- **Safety:** Reduced manual inspection in confined mill areas

Data Visualisations



Conclusion

Ball mills are high-maintenance, high-impact assets. Traditional inspection and schedule-based maintenance approaches are no longer sufficient under modern production demands.

The usage of piezoelectric sensors with stainless-steel (SS) bodies provides the accuracy, durability, and robustness required to withstand harsh industrial environments while capturing high-fidelity vibration and temperature data. When combined with the PlantOS Industrial AI platform, this ensures:

- **Early fault detection and prescriptive interventions**
- **Higher equipment availability**
- **Safer, more efficient operations across industries**

Please Note: The technical data presented in this document is based on an actual case or on as designed parameters and therefore should not be relied upon for any specific application and does not constitute a performance guarantee for any projects. Actual results are dependent on variable conditions. Accordingly, Movus does not make representations, warranties, or assurances as to the accuracy, currency or completeness of the content contained herein. If requested, we will provide specific technical data or specifications with respect to any customer's particular applications. Our company is constantly involved in engineering and development. For that reason, we reserve the right to modify, at any time, the technology and product specifications contained herein.