WHITE PAPER

Lubrication Strategies to Boost Overall Equipment Effectiveness in Steel Mills

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What is Overall Equipment Effectiveness?

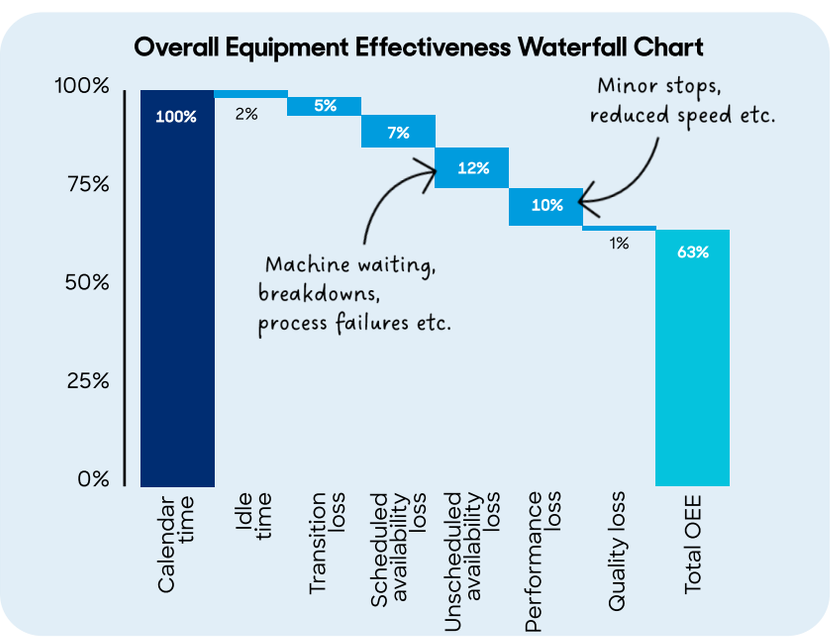
Overall Equipment Effectiveness (OEE) is one of the most widely used metrics for evaluating how effectively a manufacturing operation performs relative to its full potential. In heavy industry – particularly in steel production – it provides a practical framework for identifying inefficiencies, benchmarking performance, and guiding continuous improvement.

At its core, OEE brings together three key components of performance:

- Availability: how often equipment is running when it is scheduled to run
- Performance: whether equipment is operating at its intended speed
- Quality: how much of the product meets quality standards without rework or scrap

These combine into a single metric: OEE = Availability × Performance × Quality

An OEE score of 100% represents ideal conditions – no downtime, maximum speed, and zero defects. In reality, most operations run between 40% and 60%, with anything above 85% considered world-class. In practice, losses do not occur all at once – they build across availability, performance, and quality, as illustrated in the waterfall chart below.



Understanding where these losses occur is key to improving OEE. It is also worth noting that OEE is not just about productivity. Improvements often correlate with better safety and environmental performance. Reducing unplanned downtime limits exposure to high-risk environments such as hot metal zones and moving equipment, while early detection of issues like lubricant degradation or leakage helps prevent environmental incidents.

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The Role of Lubrication in OEE

Lubrication is often viewed as a routine maintenance activity, but its impact on OEE is significant. In a steel mill environment, lubrication sits at the center of equipment reliability and directly influences all three components of OEE.

In practice, when lubrication is well managed, equipment runs more reliably, more efficiently, and more consistently. When it is not, the impact is often felt quickly – and at significant cost.

Lubrication and Availability

From an availability perspective, lubrication is one of the most influential and controllable factors in preventing equipment failure.

Steel mill components such as work roll bearings, back-up bearings, and gear systems operate under extreme loads, high temperatures, and continuous exposure to contaminants like water and scale. Maintaining a consistent lubricant film is essential to protecting these components from premature wear and failure.

When lubrication is insufficient or degraded, failure modes can develop quickly. For example, under-greased work roll bearings can generate excessive heat due to heavily loaded metal-to-metal contact. If left unaddressed, this often leads to bearing damage requiring the mill to be stopped, the roll removed, and a replacement installed – typically resulting in 15 to 60 minutes of unplanned downtime.

Back-up bearings present an even higher availability risk. These components are significantly larger, even more heavily loaded, and replaced less frequently than work roll bearings. Their reliability depends on circulating oil systems that maintain film strength, remove heat, and control and remove water contamination. If lubrication conditions deteriorate and a back-up bearing fails, the impact can be severe, potentially forcing extended downtime and disrupting the entire production line.

Similarly, inadequate lubrication in gearboxes, pinion stands, and drive systems can lead to accelerated wear or catastrophic gear damage. Because these assets are essential to power transmission, any failure typically leads to a full halt in production

In practice, effective lubrication is not just about extending component life; it is a key control point for maintaining uptime.

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Lubrication and Performance

Performance losses occur when equipment is running, but not at its intended speed or efficiency. In many cases, lubrication-related issues do not immediately stop production, instead, increased resistance leads to heat generation and instability, gradually reducing throughput and increasing energy demand.

For instance, poorly lubricated gear systems can result in inconsistent torque transmission across mill drives. This instability often forces operators to compensate by reducing speed or applying additional power to maintain throughput. Over time, this leads to reduced efficiency and increased energy consumption. As wear increases, clearances expand and power transmission becomes less effective, further reducing performance and placing additional stress on the system.

In rolling applications, lubrication-related vibration may also trigger automatic slowdowns to protect equipment. While these safeguards prevent damage, they come at the expense of throughput.

Unlike availability losses, which tend to be visible and immediate, performance losses are often gradual. Yet over extended production periods, they can have a significant cumulative impact on overall throughput.

Lubrication and Quality

Lubrication has a direct impact on product quality, particularly in processes such as rolling where precision and stability are critical.

Grease applied to work roll bearings and table rollers plays a critical role in ensuring smooth and consistent strip movement. When lubrication is insufficient, the resulting metal-to-metal contact can generate vibration within the system. This vibration often manifests as surface defects on the strip. In cold rolling, it is commonly observed as chatter marks – typically associated with speed but frequently worsened by under-greasing.

Lubrication also affects strip tracking and alignment. Poorly lubricated bearings can disrupt steering, leading to edge damage and positioning issues – particularly in applications with tight dimensional tolerances.

In drive systems, lubrication influences the consistency of strip speed. Instability in gearboxes or pinion stands can introduce small fluctuations that lead to surface irregularities. Back-up bearings also play a critical role through their influence on gauge control. If lubrication deteriorates, rolling

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force becomes unstable, leading to thickness variation or, in more severe cases, strip damage and even tearing.

In many cases, quality issues appear before complete failure. Subtle changes in lubrication condition can introduce variability into the process, affecting surface finish, dimensional accuracy, and overall product consistency. For this reason, maintenance lubrication should be viewed not only as a reliability function, but as a key contributor to process stability and product quality.

Selecting the 'Right' Lubricant

Lubricant selection is the foundation of any strategy to improve OEE. Although important as a baseline, Original Equipment Manufacturer (OEM) specifications do not always reflect real operating conditions – i.e. the temperature, load, speed, and contaminants of the application.

Each lubricant selection decision links directly to OEE, for example:

- Incorrect viscosity increases wear and reduces availability
- Inadequate performance under load or temperature reduces efficiency
- Poor contamination resistance can introduce instability and affect quality.

The harsh environments of the steel mill amplify these challenges. Roughing mill gear systems may require high-viscosity oils for load, but contamination or temperature conditions may demand enhanced or synthetic formulations. Similarly, lubricants used in circulating systems must not only maintain film thickness but also manage water ingress and assist in heat removal.

Compatibility is also critical. Mismatches between lubricants, seals, or process fluids can lead to contamination, leakage, or degradation, increasing maintenance requirements and reducing reliability.

In practice, OEM specification should be viewed as the starting point. Optimizing lubricant selection based on real conditions will deliver improvements in equipment life, stability, and overall performance.

Maintenance Methodologies and Techniques

Lubrication practices are closely linked to maintenance strategy. Whether corrective, preventive,

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or predictive, the chosen approach directly impacts OEE. Corrective maintenance – addressing issues after failure – leads to unplanned downtime and reduced availability. Preventive maintenance improves this through scheduled activities but may still miss changes in operating conditions, leading to over- or under-lubrication. Predictive maintenance provides the strongest alignment with OEE improvement. By monitoring equipment condition in real time, it allows issues to be addressed before failure, improving uptime, maintaining performance, and reducing quality variability.

The table below outlines several key condition monitoring techniques. Each provides a different type of insight – no single method gives a complete picture – but together they enable a shift from time-based to condition-based maintenance, ensuring lubrication supports reliability rather than just maintaining minimum operating conditions.

Inventory, Storage and Handling

Technique	What It Detects	Strengths	Limitations	Typical Early Warning	Relative Effectiveness	Role in Lubrication Strategy
Vibration Analysis	Mechanical faults in rotating equipment (bearings, gears, imbalance)	- Highest overall detection capability - Detects lubrication issues early via vibration changes - Covers a wide range of failure modes	- Less direct insight into lubricant condition	~3 months before failure	~93%	Primary monitoring tool; identifies early-stage lubrication-related problems and supports predictive maintenance
Oil Analysis	Lubricant condition, contamination, and wear particles	- Direct insight into lubricant health - Detects contamination, oxidation, and wear metals - Identifies root cause of degradation	- Lower detection coverage for mechanical faults - Dependent on sampling quality and frequency	Weeks to months (trend-based)	~45%	Complements vibration; confirms lubricant condition and identifies wear mechanisms
Ultrasound	Early friction changes, lubrication condition, and bearing defects	- Highly sensitive to early-stage lubrication issues - Detects problems before vibration in some cases	- Requires consistent measurement routes - More operator-dependent	Earlier than vibration (very early-stage)	High (early-stage detection)	Enhances both vibration and oil analysis; useful for fine-tuning lubrication practices
Thermal Imaging	Heat build-up, friction, and late-stage failure conditions	- Fast and visual - Easy to apply across many assets - Confirms problems quickly	- Typically identifies issues later in failure cycle	~3 weeks before failure	Moderate (late-stage indicator)	Validation tool; highlights abnormal operating conditions and supports maintenance prioritization

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Lubrication performance begins well before the lubricant is applied. Poor storage and handling are a common source of variability that can undermine OEE.

Contaminated lubricants increase wear and failure risk, reducing availability. Reduced film strength affects performance, while contamination can introduce vibration or defects, impacting quality.

Best practices include:

- Maintaining clean, temperature-controlled storage
- Using sealed, clearly labeled containers
- Segregating lubricants to prevent cross-contamination

Handling is equally important. Contamination is often introduced during transfer, making controlled dispensing systems and filtration critical.

Inventory management also plays a role. Excess stock risks degradation, while insufficient stock can lead to incorrect substitution. Aligning inventory with usage patterns and using telemetry systems helps maintain consistency.

In practice, controlling storage and handling reduces variability at the source and supports all three components of OEE.

Collecting and Using Data

Collesting data is essential for linking lubrication practices to measurable OEE improvements. Without it, understanding performance losses – or improvements – becomes difficult.

In steel mills, data typically comes from a mix of manual records and automated systems. Maintenance teams log lubrication work, downtime, and failures in CMMS or EAM systems, helping build a baseline – especially where recurring issues can be linked to lubrication practices.

At the same time, sensors on critical assets capture real-time data such as vibration, temperature, pressure, and flow. This provides visibility into equipment condition and helps identify lubrication-related issues before failure occurs.

Oil analysis adds further insight into lubricant condition. For example, a drop in viscosity can indicate contamination from water, process fluids, or product mixing, which may require further laboratory analysis to confirm. However, the real value lies in trending results over time. Patterns make it easier to identify developing issues and act early.

More advanced operations integrate these data streams, linking equipment condition with

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production performance. This makes it possible to see how lubrication affects throughput and quality. Finally, tracking lubricant consumption also helps identify problems such as leakage, over-lubrication, or contamination. Combined with downtime data, it often highlights recurring issues.

Ultimately, the value is not just in collecting data – but in using it. When applied consistently, it supports more proactive and informed decision-making.

Conclusion

In steel mill operations, lubrication is far more than a routine task. It is a key factor in equipment reliability and a direct contributor to OEE.

Its influence spans availability, performance, and quality – often in ways that are not immediately visible but highly impactful. When managed effectively, lubrication supports more stable operations, more predictable maintenance, and reduced operational risk.

For organizations looking to improve OEE, lubrication is one of the most practical and cost-effective places to start. In most cases, improvement doesn't require major investment – just better control, consistency, and awareness of what's happening on the line.

About the Author

Greg Savernik is a senior reliability engineer with over 30 years of experience across heavy industrial sectors, including manufacturing, automotive, environmental, chemical, petroleum, and lubricants industries.

Throughout his career, Greg has built deep expertise in lubrication, asset reliability, and condition monitoring, working with Fortune Global 500 companies to improve equipment performance and reduce operational risk.

His experience spans a wide range of disciplines, including mechanical forensics, non-destructive testing (NDT), reliability-centered maintenance (RCM), and IIoT-based monitoring solutions. Greg is known for his practical, hands-on approach – combining technical analysis with real-world application to help maintenance and operations teams solve complex reliability challenges.

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Practical Checklist: How Steel Mills Can Improve Lubrication Performance

1 Get the baseline right

Confirm the current lubricant meets OEM requirements and is appropriate for the application. Specification is the starting point – not the end goal.

2 Look beyond the datasheet – understand real conditions

Identify what the equipment and lubricant really experience:

- Temperature extremes
- Load variations
- Speeds
- Water or process fluid contamination

More often than not, lubrication doesn't fail on specification – it fails due to the real operating conditions.

3 Fix the system before changing the lubricant

Check for:

- Poor sealing
- Contamination sources
- Inadequate filtration

A better product won't compensate for an uncontrolled environment.

4 Control how lubrication is applied

Avoid variability by defining:

- Correct quantities
- Relubrication intervals
- Application methods

Over- and under-lubrication are both common and both reduce reliability.

5 Add basic condition monitoring where needed

Use practical tools such as:

- Vibration monitoring
- Oil analysis
- Temperature tracking

Even simple feedback improves visibility and helps prevent failures.

6 Make sure data leads to action

Many sites already collect data, but don't act on it.

- Track trends, not snapshots
- Link failures back to lubrication
- Trigger maintenance based on actual condition

7 Keep lubricants clean from storage to application

Contamination often enters before the lubricant reaches the equipment.

Focus on:

- Clean storage areas
- Sealed containers and transfer tools
- Clear labeling and segregation

8 Prioritize based on equipment criticality

Not all assets need the same level of control.

- Low-impact assets → simple approach
- High-impact assets → tighter monitoring and better products

Focus effort where failure affects production.

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