



KLB INDUSTRIAL CORP.
MECHANICAL SYSTEMS & MAINTENANCE CONSULTING

STRATEGIC ASSET RELIABILITY REVIEW

Equipment Reliability & Operating Envelope Optimization

Woodmizer MR6000 Dual Arbor Gang Saw

Reference: KLB-MR6000-REL-001

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1. Executive Brief

This document presents the findings, advanced tribological analytics, and strategic correctives derived from a Tier 1 reliability engineering audit conducted on a high-criticality dual arbor gang saw system. The asset, operating via twin 200 HP electric motors and relying on 222-series spherical roller bearings, exhibited severe operational vulnerabilities linked strictly to sub-optimal tribological selection and inadequate precision maintenance procedures.

The core objective of this engagement was to fundamentally analyze the root cause of historical bearing distress, quantify the impacts of current lubrication regimes on asset lifecycle, and re-engineer the maintenance envelope. The resulting correctives encompass advanced temperature control mechanisms, precision internal clearance reduction enforcement, and stringent contamination defense protocols.

STRATEGIC VALUE PROPOSITION

The primary lever for eliminating premature failure is correcting a severe mismatch in lubricant specification. By transitioning from the currently employed ultra-high viscosity grease (ISO VG 1500) to an engineered, speed-optimized EP specification (ISO VG 220), thermal runaway induced by churning friction is effectively neutralized. This single parameter shift, when paired with the attached precision Standard Operating Procedure (SOP), is modeled to increase the bearing L_{10} fatigue life by a factor of 4x to 6x.

2. Asset Operating Envelope

Precision maintenance and tribology require an exact understanding of dynamic kinematics. The following table delineates the engineering envelope of the Woodmizer MR6000 arbor shafts.

PARAMETER	TECHNICAL VALUE
Arbor Speed Envelope	1,800 – 2,200 RPM (Sub-3000 RPM maximum capability)
Shaft Diameter	~3.0 in (76 mm)
Bearing Topology	222-series spherical roller bearings (tapered bore on adapter sleeve)
DN Speed Factor	~167,200
Drive Architecture	Belt-driven (5VX profile) imparting cyclic radial loads

3. In-Depth Tribological Assessment

3.1 Current State Root Cause: Viscosity Mismatch

The audit identified the bearing system utilizing an ISO VG 1500 synthetic base oil grease. Greases in the ISO VG 1500 class are chemically formulated for *extremely slow-speed, heavy-load, boundary-lubrication regimes*—typical applications include cement kiln rollers or severe steel mill roll presses operating at single-digit RPMs.

Applying this viscosity to a ~2000 RPM arbor shaft constitutes a severe application mismatch. High operational speeds dictate that the bearing must "plow" through the highly viscous base oil, resulting in massive internal fluid friction.

3.2 Churning Friction & Thermal Runaway

The relationship between excessive base oil viscosity and operating temperature in rolling element bearings is not linear; it is exponential. Excessive viscosity dramatically elevates churning losses. This mechanical energy is immediately converted to thermal energy (heat). As the bulk grease temperature rises, it accelerates oxidation, forces excessive base oil bleed, and eventually leads to a "thermal runaway" scenario where the lubricant actively destroys itself.

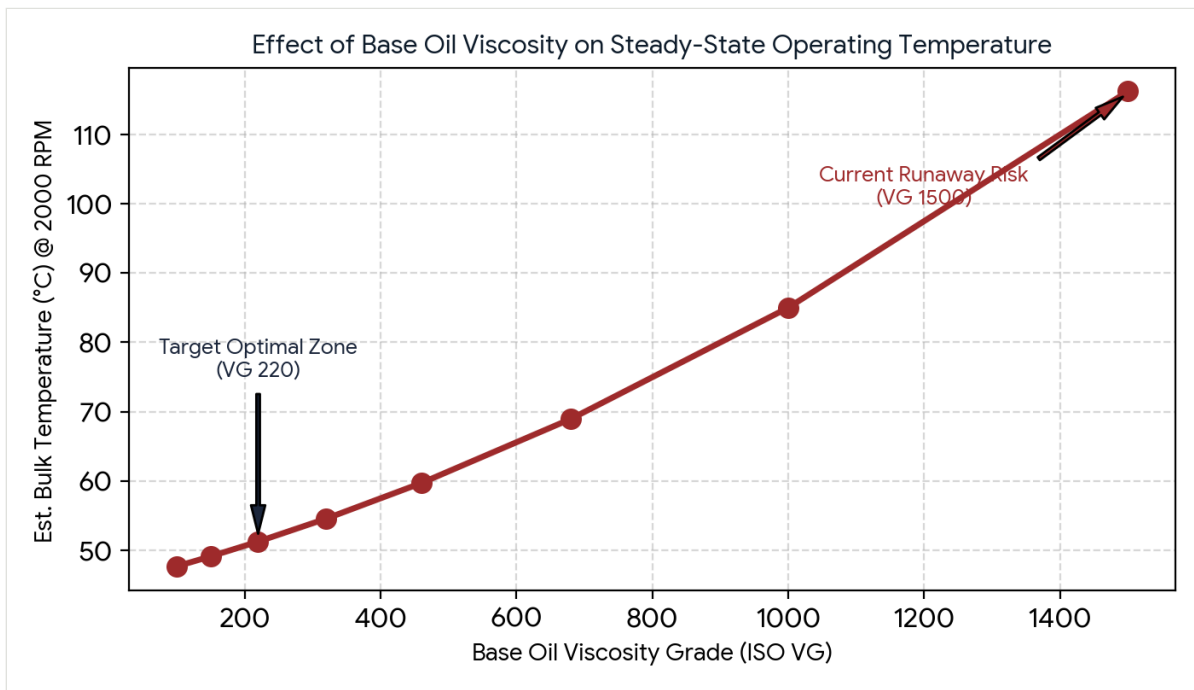


Figure 1: Projected steady-state operating temperatures driven purely by churning friction at 2000 RPM. Note the massive thermal penalty of VG 1500.

3.3 Elasto-Hydrodynamic Lubrication (EHL) & Kappa Value (κ)

Optimal bearing life is achieved when the lubricant film is just thick enough to separate the rolling elements from the raceway (Elasto-Hydrodynamic Lubrication), avoiding metal-to-metal contact without introducing drag. This is measured by the Kappa value ($\kappa = \nu / \nu_1$), which is the ratio of actual operating viscosity (ν) to the minimum required viscosity (ν_1).

For a DN factor of $\sim 167,200$, an ISO VG 220 base oil provides a highly optimized κ value (typically targeting 1.5 to 3.0 at operating temperatures). This guarantees full hydrodynamic separation of asperities while practically eliminating the thermal penalty of churning.

3.4 Thermal Effects on Fatigue Life (L_{10})

Bearing fatigue life, denoted as L_{10} , is extraordinarily sensitive to temperature. The Arrhenius rate rule broadly dictates that lubricant life halves for every 10–15°C rise above nominal baseline (~70°C). As the lubricant oxidizes and base oil evaporates due to the high heat generated by the VG 1500 grease, the actual protective film collapses, leading to premature spalling and ultimate catastrophic failure.

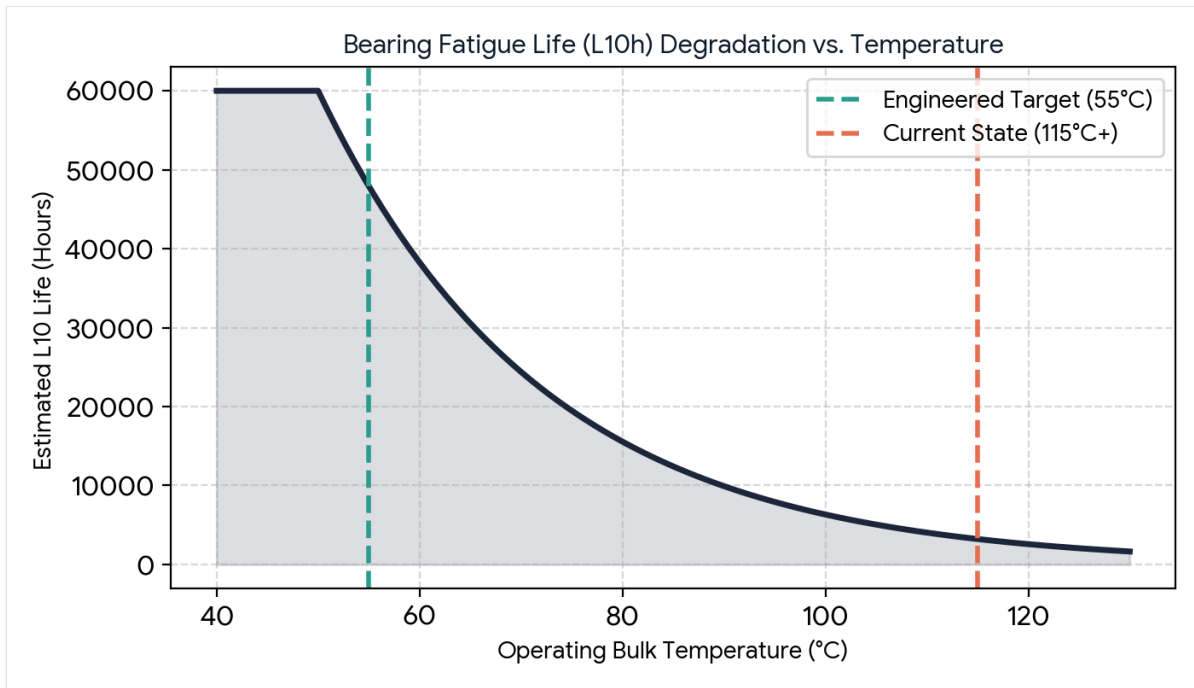


Figure 2: The exponential decay of bearing L_{10} fatigue life as a direct result of elevated operating temperatures.

3.5 Approved Lubricant Specification (Tier 1 Standard)

Based on the kinematic and thermodynamic analysis above, the facility must transition to the following standard immediately:

PARAMETER	ENGINEERED REQUIREMENT
Thickener Type	Lithium complex (EP/AW) - selected for high mechanical stability.
NLGI Consistency	NLGI 2
Base Oil Viscosity	ISO VG 220 (Target). <i>ISO VG 100–150 permitted conditionally based on advanced speed/temperature profiling.</i>
Additive Package	Extreme Pressure (EP), Anti-Wear (AW), Advanced Oxidation Inhibitors.
Fill Volume Control	Housing free volume strictly maintained at 25–35%. Do not pack housing solid.

4. Precision Maintenance Methodology

Correcting tribology is insufficient without flawless execution. This protocol governs the installation of 222-Series Spherical Roller Bearings (SRB) on tapered adapter sleeves. It guarantees strict control over cleanliness, fit, internal clearance reduction, and cycle repeatability.

PHASE 1: PREPARATION & CLEANLINESS

1.1 Safety & Work Controls MANDATORY

Establish full LOTO protocols. Utilize only clean, dedicated bearing installation tools (spanners, precision feeler gauges). *Under no circumstances is a hammer-and-drift permitted on locknuts (extreme risk of micro-spalling and structural damage).*

1.2 Environmental Cleanliness MANDATORY

Bearings must remain sealed in factory packaging until the exact moment of installation. The operational radius must be sterilized: no grinding or air-hose blowdowns permitted. Ensure seal land scoring is machined or sleeved prior to assembly.

1.3 Pre-Installation Inspection REQUIRED

Verify bearing internal clearance class (e.g., C2/C3). Inspect shaft seating for burrs or taper damage. Ensure all housing purge/relief paths are fully unobstructed to prevent overpressure.

PHASE 2: PRECISION MOUNTING & CLEARANCE CONTROL

2.1 Lubrication Priming REQUIRED

Manually pack the bearing with the approved ISO VG 220 grease prior to mounting. *Do not rely on grease fitting injection post-assembly; this creates immediate dry zones upon startup resulting in instant damage.*

2.2 Adapter Sleeve Positioning REQUIRED

Position the adapter sleeve aligned to the engineered bearing centerline. A light oil film on the sleeve OD may facilitate sliding, but absolutely avoid oiling the taper seat surfaces, which compromises strict friction control.

2.3 Baseline True Clearance REQUIRED

Measure radial internal clearance using precision feeler gauges between the outer ring and the most unloaded roller. Utilize the multi-point method: Measure at 3 o'clock (b), 9 o'clock (a), and 12 o'clock (c). Calculate baseline: $0.5(a + b + c)$.

2.4 Drive-Up & Clearance Reduction CRITICAL CONTROL

Tighten the locknut incrementally using a spanner wrench. Remeasure clearance reduction continuously. **Target mounted reduction: 0.003–0.004 in.** Maintain equal clearance across both roller rows.

PHASE 3: FINALIZATION & VALIDATION

3.1 Critical Prohibitions MANDATORY

Never set clearances with belt tension applied. Never hammer the locknut while the bearing is loaded (induces rapid brinelling). Never forcibly rotate the bearing over a pinched feeler gauge blade.

3.2 Final Locking & Commissioning Data REQUIRED

Seat the inner tab of the locking washer. Bend the nearest tang into the locknut slot (tighten forward to align; never loosen). Document all QA data: baseline clearance, final mounted reduction, and stabilized startup temperatures.

5. Engineering & Industry References

The methodologies and tribological physics outlined in this audit align strictly with global precision maintenance standards and bearing OEM engineering guidelines:

- **SKF Bearing Maintenance Handbook:** Standards for mounting and measuring radial internal clearance with feeler gauges, specifically validating the multi-point true clearance methodology.
- **NSK Handling Instructions for Bearings:** Directives for mounting bearings with tapered bores, clearance reduction tables, and continuous measurement during mechanical drive-up.
- **ExxonMobil (Mobilith SHC 1500 Data):** Manufacturer product performance data confirming ISO VG 1500 operational intent strictly for ultra-slow speed, high-temperature, heavy-load boundary environments (e.g., kiln rollers).
- **ISO 281 / EHL Theory:** Baseline calculations defining the relationship between base oil kinematic viscosity, operating temperature, and required film thickness (κ) for optimal rolling element life.

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