MORG'OIL BEARINGS
AND FLAT MILL PRODUCTS
THE DOMINANT WORLDWIDE LEADER
IN LOAD-CARRYING BEARINGS
HISTORY

NO BEARING TECHNOLOGY HAS IMPACTED THE METALS INDUSTRY LIKE THE INNOVATIVE MORGOIL BEARING

The MORGOIL® Bearing has been the premier oil film bearing utilized in rolling mills for the metals industry since the early 1930’s. In the 1970’s and 1980’s, Morgan Construction, a predecessor company of Primetals Technologies, developed KL® sleeve technology to improve bearing performance in rolling precision products and DF® sealing technology to eliminate oil leakage. In the extremely competitive 1990’s, the company invested in the world’s only backup roll oil film bearing test facility. Through the use of this facility and the design data generated, MORGOIL engineers have developed the KLX® sleeve to increase bearing capacity and provide a more cost-effective option.

The KLX is the latest evolution of the MORGOIL Bearing. It improves on all areas of the previous KL Bearing. The KLX offers higher load capacity for the same size bearing, and lower part counts to simplify maintenance and reduce both initial and operational costs. Intellectual property development and protection is a key focus as demonstrated by the extensive patent portfolio maintained by Primetals Technologies.

Primetals Technologies focuses on customer needs and can provide custom engineered solutions for all requests. The company also manufactures and reconditions other flat mill equipment, including automatic gauge control cylinders, shifting blocks, bending blocks, coiler mandrels and high capacity universal drives.

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**APPLICATIONS**
- New mills
- Rebuilt mills requiring higher load capacity

**DESIGN FEATURES**
- Thin wall sleeve technology with less than 2.5 micron wall thickness variation
- New sealing technology
- Removable hydraulic mount (standard)
- Integral key for roll, sleeve and sleeve ring
- Housingless thrust bearing

**MAIN BENEFITS**
- Higher capacity
- Smaller size
- Reduced cost
- Reduced operational cost

The central feature of the MORGOIL® KLX® Bearing is the thin walled sleeve, which better distributes rolling load and the resulting hydrodynamic pressure field, enabling an increase in capacity for the same size bearing. Figure 1 depicts the difference between a traditional KL® sleeve and a KLX sleeve. The body of the KLX sleeve is thinner, and the internal flange on the end of the sleeve has been removed.

Extensive testing of the KL and KLX designs have shown that all rolling mill bearings develop a wider than expected loading area due to small elastic deformations of the components. The KLX sleeve has been optimized to distribute rolling load more effectively, increasing the width of the load zone by up to 15%, while minimizing any increase in stress in the bearing.

Instrumented bearings and stress analysis have confirmed the improved performance of the KLX design. Figure 2 is a comparison of strain gauge results for the two sleeve configurations under typical operating conditions where Ø1 is the start of the load zone, and Ø2 is the end.

The elastic deflection, or flattening of the sleeve in the load zone, is what gives MORGOIL® Bearings their ability to carry very high loads. By encouraging this flattening in a controlled manner with the KLX® sleeve design, the load capacity of the bearing is increased. The thin-walled KLX design produces a performance benefit without sacrificing the accuracy of the bearing or the service life of the sleeve.

The KLX sleeve design results in a bearing of unprecedented range and capacity. Figure 3 shows a typical operating map of a KLX Bearing (note that actual operating ranges will vary depending on bearing size, features, and oil viscosity).

KLX Bearings operate most efficiently in the area marked “Continuous Hydrodynamic Operating Range,” and all KLX Bearings can be operated up to their “Standard Hydrodynamic Capacity” within that range (green shaded area). The “Standard Hydrodynamic Capacity” is the normal maximum design load of the bearing. KLX Bearings can also operate at very low speed and stop under full load up to their “Standard Hydrodynamic Capacity” with the use of a hydrostatic system (pink area + green area).

KLX Bearings can operate intermittently in the area marked “Intermittent Operating Range.” Primetals Technologies experts should be consulted regarding operation in this area.

Bearing capacity is affected by mill type, operating conditions, and other factors; always consult MORGOIL specialists for specific applications.
MORGOIL® Bearings have set the technological benchmark for others to follow since 1930. In order to continue this leadership position, we have invested heavily in development. A completely instrumented test stand, the MORGOIL mill simulator, was built to verify the performance of the KLX® Bearing. This facility, which is the only one of its kind in the world, enables MORGOIL to provide higher levels of performance at lower cost and continue its leadership position in the field of rolling mill bearing technology.

The MORGOIL mill simulator was designed specifically for development of the KLX Bearing. This facility allows testing of a full size 28”-76 KLX Bearing under conditions similar to those experienced in all types of mills. The mill simulator design uses a cantilevered shaft allowing an actual mill size and style chock/bearing assembly to be mounted and tested. The mill simulator utilizes a full size HAGC Cylinder for loading and contains over 120 channels of precision instrumentation. It also has a complete, highly controllable lubrication system including hydrostatic pumps so that all types of mills, under all conditions, can be simulated.

Extensive testing of the KLX prototypes under a variety of conditions has led to an unprecedented understanding of the physics behind oil film bearings under actual mill conditions. This in turn has led to a KLX oil film bearing optimized for harsh operating environments, with options designed for specific mill types, and for an initial investment cost less than previous keyless designs.

### DEVELOPMENT

**MORGOIL KLX BEARING**

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### APPLICATIONS

- Mills with higher capacity bearings such as the KLX®
- Mills with impact loading such as plate mills

### MAIN BENEFITS

- Allows higher loads for the same size bearing
- High compressive strength and low creep for extreme applications

With the continuing effort to reduce the size of mills while increasing their output, the specific load capacity of bearings has increased as well. To meet this need, MORGOIL® products include a new High Strength Babbitt (HSB) white metal bearing material. This proprietary babbitt results in significantly higher bearing capacity.

The major benefit of this material over both traditional babbitt and cadmium based babbits is the significant improvement in compression strength and reduction of creep, while keeping the traditional high babbitt “imbedability,” bond strength, and fatigue strength. Since cadmium babbits are no longer available, MORGOIL HSB is an alternative to cadmium that can be used in many applications such as older MESTA mills, which initially required the higher strength properties of cadmium-based babbit.
When selecting bearings for a mill, the designer should, at a minimum, know the following:

- Type of mill and material to be rolled
- Number of mill stands
- Number of rolls per stand
- Maximum rolling force for each stand
- Maximum and minimum strip speed or RPM at each stand
- Maximum and minimum roll diameters and roll lengths
- Whether the mill stops under load

For assistance in selecting the proper bearing, fill out the mill inquiry form on page 14 and send it to Primetals Technologies.

**SELECTION**

Calculate the force on each bearing from the stand separating force (Bearing Force = \( \frac{1}{2} \times \) Total Separating Force, where Total Separating Force is equal to the maximum rolling load plus any additional load introduced by roll bending).

In the Standard Capacity Rating section of the MORGOIL® KLX® rating chart, find the smallest bearing that can accommodate the calculated bearing load.

- Start with the 76 series bearings, as they are a good balance of performance and cost effectiveness.
- Bearings in the 86 series can accommodate higher loads in the same mill housing and can be more cost effective, but use a longer roll.
- Bearings in the -86 series can accommodate higher loads in the same mill housing size and can be cost effective but use a longer roll and have higher roll neck stresses.

Once a size is determined, check that the minimum acceptable roll diameter (\( E_{\text{min}} \)) is equal to or below the minimum backup roll diameter for the mill. If not, choose the next-largest size bearing.

The maximum tapered neck diameter (\( Z \)) should be at least 55% of the maximum roll diameter; this is for neck stress considerations. If \( Z \) is less than 55% of the maximum backup roll diameter, then choose a larger size bearing.

**LUBRICANT**

Almost as important as bearing size selection is lubricant selection, which is the responsibility of the bearing supplier. The following information is provided for background:

- High speed mills use lighter viscosity oil. A fast tandem cold mill may use ISO 220 cSt oil, a slower TCM may use 320 cSt oil.
- A slow, highly loaded hot strip mill may use ISO 680 cSt oil, where a hot mill that runs faster uses 460 cSt.
- A heavy reversing plate mill would generally use ISO 680 cSt oil, or ISO 460 cSt oil in a very cold climate.

When selecting an oil viscosity, low speed and high speed characteristics of the bearing must be checked. At high speed, the bearing could run too high a temperature, requiring a lighter oil. At low speed, the oil film may be too thin and heavier oil may be needed. If very slow speed continuous operation, or extended stopping under load is required, hydrostatic assist may be the solution. With more than 10,000 mill stands built on MORGOIL oil film bearings, our engineers will assist the mill builder in examining the trade-offs between hydrostatic assist and oil selection to develop the most cost-effective bearing selection.

**STRATEGIES**

There are two major strategies in mill bearing selection: lowest initial cost or maximum parts commonality. Generally, the first few stands of a tandem mill have the highest rolling loads. To minimize the initial cost, the stands with higher load can use a larger bearing, where the more lightly loaded stands can use smaller bearings. This does introduce added spare parts and constraints on which stands particular bearings can be used. The other strategy is to select a bearing for the greatest load and use that throughout the mill. This can somewhat increase the initial cost, but it improves commonality between stands and reduces spare part requirements.

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<tr>
<th>ROLL</th>
<th>CHOCK</th>
<th>DRAINS</th>
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<tr>
<td>A Roll barrel to bearing centerline</td>
<td>0 Roll end of chock to chock centerline</td>
<td>Xmin Minimum vertical distance from chock centerline to drain centerline</td>
</tr>
<tr>
<td>C Bearing centerline to outboard end of roll</td>
<td>D Chock centerline to outboard end of chock</td>
<td>Jmin Minimum horizontal drain centerline distance</td>
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<tr>
<td>K Diameter where fillet taper would hit roll barrel</td>
<td>Fock Centerline of chock to bottom of chock when using rocker plate</td>
<td></td>
</tr>
<tr>
<td>Emin Minimum allowable roll diameter for bearing size</td>
<td>FCyl Centerline of chock to top of chock when using hydraulic cylinder</td>
<td></td>
</tr>
<tr>
<td>M Roll barrel to sleeve taper length</td>
<td>L Chock bore diameter</td>
<td></td>
</tr>
<tr>
<td>Z Max taper diameter</td>
<td>E/2 Minimum distance from chock centerline to top or bottom of chock</td>
<td></td>
</tr>
<tr>
<td>Gmin Minimum chock width</td>
<td>Bmin Minimum rocker width</td>
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SLEEVES

If a maximum mill separating force increase is needed along with improved strip quality, then an upgrade to the MOROGIL® KLX® bearing is needed, Figure 4. The KLX bearing uses the latest technology thin sleeve design allowing for larger roll necks and higher unit loading. This conversion requires new rolls and bushings, but the increase in capacity can be up to 45% over a T type bearing (under certain conditions and including other improvements). New rolls are needed to cope with neck stress because of the large rating increase; however, the KLX bearing fits within the existing chocks.

If an upgrade is needed, but not the full capacity of the KLX, the original MOROGIL long key T type bearing can be converted to a KT, or short key design sleeve, Figure 4. This common conversion effectively eliminates keyway effect along with allowing an 18% increase in load rating of the bearing. This conversion can use the existing rolls with new keyways while filling the old keyways.

These conversions are particularly attractive for older mills, where the mill operators want to bring a mill’s capabilities up to that of a new mill, but don’t want the cost of a new mill. In some upgrade scenarios, it is possible to increase the width of the mill without moving the housings. In most cases, KLX upgrades can increase roll neck size.

BUSHINGS

This conversion also helps bearing rating increase through the use of High Strength Babbitt (HSB) bushings, Figure 5. High Strength Babbitt can also be used as a viable substitute for cadmium bushings. Through the use of a short key conversion of the sleeve, combined with High Strength Babbitt bushings, ratings can be significantly increased. Upgrading old T bearings to special short key sleeves and HSB bushings can increase the rating by up to 33%.

MILL UPGRADES
LOCKING AND SEALING

LOCKING

Some of the conversions require new rolls or bolt-on roll ends. If existing rolls are being used, the HM or LD™ lock can be used as an alternative, although without the full convenience of the hydraulic-type locks. See the catalog lock sections for further details.

SEALING

As with the other major areas of the bearing, the sealing system has also seen several changes over the years. This conversion uses the latest developments in sealing, the HD Sealing System, Figure 6: It consists of the HD seal and ceramic coated seal end plate. The seal end plate also includes the latest drainback and venting features. The system also includes a coolant guard.

If the current bearing has a DF® seal, the upgrade to HD sealing should be evaluated on an individual basis as to whether it would be cost-effective.

CONCLUSION

Upgrades, strategically planned between the mill operator and equipment supplier, can extend the life of a mill far into the future. MOROGIL® Bearing engineers work with customers to bring decades-old mills up to modern standards in an economical and operationally friendly manner. Conversions such as these help older mills compete with the quality of new mills and remain highly cost-effective. In many of these cases, mills have paid for the upgrade within a year through increased productivity and more efficient utilization of mill equipment.

With appropriate backup roll bearing upgrades, mills can increase capacity, allowing them to roll products that were not even considered before. Older oil film bearings and roller bearings have been successfully upgraded while reusing existing chocks, and in many cases rolls.
1. Bearing rating is per side of mill stand. Total Stand Force (TSF) is 2 x listed rating.
2. F dimension for plain carbon steel chocks, consult MORGOIL® engineering specialists for other materials.
3. Dimensions are for removable mount.

NA. Consult bearing supplier

Bearing ratings are for optimum operating conditions and may be less depending on the application. Consult Primetals Technologies for specific applications.
APPLICATIONS
• Mills that start and stop under high loads
• Mills with sustained operation under high load

MAIN BENEFITS
• Operation under high loads and low speeds
• Compensation of sleeve to bushing misalignment

Hydrostatics are used in oil film bearings when sustained operation under high load and low speed is required, or when the mill is required to start under load after long stops.

A high pressure pump feeds lubricant from the MORGOL® lubrication system into the load zone of the bearing, assuring full film operation of the bearing under all rolling conditions, Figure 7.

ADVANTAGES
• Constant oil flow under high pressure secures lowest friction coefficient (0.001 to 0.003) in the bearing under all operating conditions
• Reduced motor current peak during start after a long stand still and/or emergency stops
• Reduced maintenance cost, allowing fewer preventive maintenance bearing inspections per year
• Compensation of roll neck/sleeve to chock/bushing misalignment

COMPENSATION OF SLEEVE-BUSHING MISALIGNMENT
Under mill conditions where the alignment of the sleeve inside the bushing is disturbed, hydrostatic assist acts to correct the misalignment. Under misaligned conditions, as shown in Figure 8, flow out of the right hand pad tends to increase because of increased clearance due to sleeve tilting within bushing.

Increased flow through the right hand pad results in a higher pressure drop across the restrictors which are installed in all MORGOL® hydrostatic bushings. Since the restrictors inlet pressures are equal, different pressure drops across the restrictors result in different restrictor outlet pressures. The higher pressure in the left hand pad compensates the misalignment of sleeve and bushing by exerting a righting movement in the bearing.
BEARING OPTIONS: SE Sealing TECHNOLOGY
HD (HYDRODYNAMIC) NECK SEAL SYSTEM

APPLICATIONS
- All MORGOIL®, MESTA and MESTOIL bearings

MAIN BENEFITS
- No leakage in or out of the bearing
- Ease of mounting and dismounting
- Cost effective

EFFECTIVE SEALING IS CRITICAL IN BEARING DESIGN
Sealing encompasses more than the elastomer sealing element. It is important that all components function together as a sealing system to address the total leakage issue. MORGOIL engineers have spent thousands of hours testing and evaluating various seals, seal end plate designs and features, and other components to offer several systems based on a specific mill’s needs. Whether a mill is wet or dry, MORGOIL has an effective sealing solution.

The HD (Hydrodynamic) neck seal system is the most technologically sound sealing solution available. It builds on the years of sealing expertise MORGOIL has developed and pushes the design to new levels of performance. The seal has been designed to maintain proper hydrodynamic seal angles through the range of its travel. Extensive computer modeling as well as full-size testing has been undertaken to ensure the seal performs as expected. The seal remains effective under the difficult conditions encountered in all types of mills.

When used in conjunction with the new HD seal end plate, the HD sealing system provides an unmatched combination of several seal styles and material choices that can be used for different applications. There are also both wet and dry mill configurations.

The HD neck seal combines proven sealing technology with the latest sealing developments. The seal has been made much more rigid and remains in its proper position on the roll neck under the most severe conditions. Additionally, compliance ridges have been added to help the seal avoid the frictional force of the sleeve when mounting. The stainless steel band holds the seal at the proper diameter for years of sealing expertise MORGOIL has developed and pushes the design to new levels of performance. The seal has been designed to maintain proper hydrodynamic seal angles through the range of its travel. Extensive computer modeling as well as full-size testing has been undertaken to ensure the seal performs as expected. The seal remains effective under the difficult conditions encountered in all types of mills.

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The water side leg has a light contact with the seal end plate to reduce frictional forces. The oil side leg has been totally redesigned to function as a true hydrodynamic seal. The foot has been thickened at the contact point have been refined through computer simulation and testing to provide optimum sealing geometry.

This is the latest evolution of the MORGOIL® high performance sealing system. Multiple lines of defense have been included to ensure there is no leakage from this advanced design.

MAJOR HD SEALING SYSTEM COMPONENTS
- HD seal end plate
- HD neck seal
- Seal inner ring
- Coolant guard

The heart of the system is the HD seal. The HD neck seal has evolved to be a model of economic sealing efficiency. In one piece, it seals the neck, sleeve, oil and water sides of the seal end plate and is a flinger. It is specially designed for the harsh mill operating conditions encountered by MORGOIL Bearings. This seal has been designed to be used in conjunction with the HD seal end plate.

Oil must follow a complicated path with many hindrances and traps to escape the sealing system. Oil must first evade the oil side HD seal leg (1). This lip has been optimized to provide a hydrodynamic seal under all operating conditions. If oil gets by this leg, the rotation of the seal drags the oil, circumferentially distributing it around the HD seal end plate. As the oil runs down the vertical sealing surface of the seal end plate, it is captured by the drainback wells (2) which are undercut areas next to the dam that collect the oil. The oil is then directed back into the chock through passages (3). Oil that eludes the drainbacks must then get over the dam (4). Oil that escapes the dam must next move past the water side (outer) seal leg (5), the second active sealing element. This seal leg also acts as a flinger, throwing the oil to the seal end plate surface on the outer side of the seal end plate. Oil that accumulates between the outer leg and dam travels to the inner collection well (6), which is located at the bottom of the seal end plate next to the dam. The inner collection well empties into an auxiliary drain (10) that is plumbed away from the rolled product. If oil gets by the outer seal leg, it collects on the seal end plate dam (7) and is flung to the outer collection well (9). This well also empties into the auxiliary drain. The inner and outer collection wells and the auxiliary drain are optional features used only on dry mills. Next there is a coolant guard (8) that contributes to the labyrinth and is also the third active sealing element. This piece prevents coolant from entering the bearing.

In addition to these features, there is a venting system to equalize pressure in the chock and sealing area to improve drainage. There is a chock side vent (11) and a seal side vent (12) that meet in an equalization chamber (13).
**APPLICATIONS**
- Dry mills with tapered neck bearings

**MAIN BENEFITS**
- No leakage in or out of the bearing
- Ease of mounting and dismounting
- Cost effective

MORGOIL® uses a slightly different system for the special requirements of dry mill sealing. The outer leg of the neck seal receives no lubrication, neither coolant nor oil. Therefore this leg cannot come in contact with a stationary surface. If it does, the heat generated by un lubricated friction could cause the seal lip to experience unacceptably high temperatures.

Essentially, the oil side seal system operation is the same, but the differences are on the outboard side of the dam. As with the wet seal, the oil must first evade the oil side HD seal leg (6). This lip has been optimized to provide a hydrodynamic seal under all operating conditions. If oil gets by this leg, the drainbacks, as explained in the wet sealing section, capture the oil. Oil that eludes the drainbacks must then move past the dam (7). Oil that escapes the dam is then thrown outward by the outer side seal leg (8) acting as a flinger to the sloped surface (10) on the outer side of the seal end plate. From the horizontal centerline to the bottom of the seal end plate, the sloped surface guides oil to the inner collection well (11), which is located at the bottom of the seal end plate next to the dam. The sloped surface also has a hooked lip (9) at the outer edge that keeps oil from flowing over. Additionally, in the upper half of the seal end plate, the hooked lip will hold and direct oil downward by surface tension until the oil follows the drainage path through the inner collection well.

The inner collection well empties into an auxiliary drain (15) that is plumbed away from the rolled product. If oil gets by the hooked lip, it collects on the seal inner ring (12) and is flung to the outer collection well (13). This well also empties into the auxiliary drain. There is also a seal outer ring (14) that contributes to the labyrinth and outer collection well. A coolant guard can be used in place of the seal outer ring in the case of combination wet and dry rolling.

In addition to these features, dry mill sealing offers the same venting system used in the wet sealing system.

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**APPLICATIONS**
- All mills

**MAIN BENEFITS**
- Easy operation and accurate mounting
- Consistent mounting force for improved strip quality
- Safe and quick mounting and dismounting
- No crane or external tools needed
- Mechanical locking feature
- Improved mill productivity

The MORGOIL® Hydraulic Bayonet mount is our premier mounting and locking device. The Hydraulic Bayonet mount provides extremely easy and accurate mounting combined with chock removal, and has decades of field experience on hundreds of mill stands around the world. The mount is operated by an external hydraulic power pack.

The complete Hydraulic Mount assembly stays with the chock when the roll is dismounted for grinding. When mounting, it locks onto the roll through a bayonet end. To mount the bearing, the mounting port is pressurized and the lock ring tightened. The hydraulic pressure is removed and a locking segment inserted.

Removal is accomplished by reversing the procedure. The locking segment is removed, the mounting port is pressurized and the lock ring is loosened. The dismount port is then pressurized and the lock and bearing as a unit are pushed off the roll. The dismount pressure is removed, the lock rotated one quarter turn to disengage the bayonet, and then the chock is removed from the roll.

This is an excellent lock to use when grinding rolls in chocks since it consistently holds the bearing in its proper position.
BEARING OPTIONS: LOCKING

REMOVABLE MOUNT (RM)

APPLICATIONS
- Multi-stand mills

MAIN BENEFITS
- Easy, accurate mounting
- Mounting and dismounting
- Lower cost

The Removable Mount is the most cost-effective way of achieving hydraulic mounting and dismounting on multi-stand mills. This system separates the hydraulic mounting components from the mechanical locking components so that only one set of hydraulic cylinders is needed. The hydraulic mounting unit, which provides both the mounting and dismounting function in the same tool, is moved from chock to chock as bearings are mounted or dismounted. The Removable Mount tool attaches to the roll through an internal bayonet and locks to the threaded ring through an external bayonet.

The threaded ring assembly stays with the chock and engages with the roll through a bayonet. Once this is done, the RM tool attaches to the roll and threaded ring. It is pressurized to mount the bearing, and the lock ring tightened to lock it in place. The hydraulic pressure is removed and the RM tool taken off the roll. A locking segment is then inserted. Removal is achieved by reversing the procedure.

The Removable Mount has the same performance benefits as the HB mount, such as consistent mounting force, but at a reduced initial cost in multi-stand mills. Only one hydraulic mount/dismount tool is required per thrust bearing size. The mechanical locking components also result in shorter roll end than the traditional Hydraulic Mount design. Bolt-on roll end options make this mounting system a viable option for both retrofits and new mill installations.

BEARING OPTIONS: LOCKING

COMPACT BAYONET AND REMOVABLE MOUNT

APPLICATIONS
- All mills Compact Bayonet mount (CB)
- Multi-stand mills Compact Removable mount (CR)

MAIN BENEFITS
- Shortest possible roll length
- Easy operation and accurate mounting
- Consistent mounting force for improved strip quality
- Safe and quick mounting and dismounting
- No crane or external tools needed
- Mechanical locking feature
- Easy, accurate mounting
- Hydraulic mounting and dismounting

The CB and CR locks are similar to each other in the same way as the HB is similar to the RM. The CB contains all hydraulic components while the CR uses an external tool with the hydraulic components.

The Compact Bayonet mount (CB) allows for a shorter roll length than with the HB mount. This is because part of the sleeve ring and lock are under the thrust bearing. A thrust bearing with larger inner diameter is used to facilitate the positioning of components. The CB contains the same hydraulic components as the HB; however, the positioning under the thrust bearing allows the shorter roll length.

The CB-RM lock gives the shortest possible roll length. It is a combination of the CB lock and the RM. All hydraulic components are included with the RM tool. Shifting the location of these parts to the RM tool allows for even shorter rolls than with the CB.

Bolt-on roll ends can be used with either of these locks.
BEARING OPTIONS: LOCKING CONVERSIONS

**HM LOCK**

**APPLICATIONS**
- Oil film backup rolls: MORGOIL® 'QC' lock replacement
- Roller bearing backup rolls
- Work rolls with thrust bearings

**FEATURES**
- Fully hydraulic, double acting
- Lock encapsulated in chock for quickest operation
- Pivoting locking arms
- Mechanical lock nut which withstands severe axial forces
- Integral key prevents rotation
- Highest quality sealing
- Dedicated pump system with pressure control

**BENEFITS**
- Exact repeatable mounting force
- High force hydraulic dismount capability
- Quicker and much safer operation
- Eliminates crane tightening
- Improves mill productivity
- Improves finished product quality

**APPLICATIONS**
- Oil film backup rolls: direct MORGOIL® ‘TR’ lock replacement
- Roller bearing backup rolls

**FEATURES**
- Fully hydraulic, single acting
- Lock encapsulated in chock for quickest operation
- Pivoting locking arms
- Highest quality sealing
- Dedicated pump system with pressure control

**BENEFITS**
- Exact repeatable mounting force
- Quicker and much safer operation
- Eliminates crane tightening
- Improves bearing component lives
- Improves mill productivity
- Improves finished product quality

**APPLICATION**
- Work rolls: Replacement for mechanical locks with minor modifications

**FEATURES**
- Single acting hydraulic/spring loaded mounting
- Lock encapsulated in chock for quickest operation
- Pivoting locking arms
- Dedicated pump system with pressure control

**BENEFITS**
- Exact repeatable mounting force
- Quicker and much safer operation
- Eliminates labor intensive tightening requirements
- Improves bearing component lives
- Improves mill productivity
- Improves finished product quality
APPLICATIONS

• Additions to existing mills with KL® Bearings

MAIN BENEFITS

• Compatibility with existing bearings

The MORGOIL® KL® Bearing had been installed in many mills prior to the introduction of the KLX® Bearing. It has proven its capability and durability under all applications. MORGOIL continues to offer the KL Bearing for customers that wish to maintain compatibility with other existing bearings.

When first offered, the KL provided an advanced level of technology. It features a tapered neck, keyless sleeve, Hydraulic Bayonet lock, and DF® seal. The tapered neck permits easy bearing mounting and dismounting, as no special chocking equipment is needed. Additionally, all critical bearing parts are protected when the bearing is off the roll neck. The sleeve features keys that are located out of the load zone and therefore do not affect roll force variation. The Hydraulic Bayonet mount provides easy and consistent bearing mounting and is still an option offered with the KLX Bearing. The DF neck seal has been a proven sealing solution for many years and provides the basis for the current advanced sealing systems.

The KL Bearing should be selected over the KLX Bearing only when compatibility with existing equipment is an issue. In any other situation, the KLX Bearing is a better choice.

The KLX draws upon KL Bearing technology and moves it to a new level of cost-effective performance. The KLX offers more bearing performance in a smaller package at reduced cost.

1. DF neck seal
2. Coolant seal
3. Chock
4. Roll neck
5. Sleeve
6. Babbitt
7. Key
8. Bushing
9. Thrust bearing assembly
10. Hydraulic Bayonet lock
11. Locking segment

1. Bearing rating is per side of mill stand. Total stand force (TSF) is 2 x listed rating.
2. F dimension for plain carbon steel chocks-- consult MORGOIL engineering specialists for other materials.
APPLICATIONS
- Low to moderate separating force applications
- Cold mills
- Aluminum mills

MAIN BENEFITS
- High roll grinding accuracy
- Lower initial cost

For many years the primary backup roll bearing has been the MORGOIL® tapered sleeve and babbitted bushing design. This bearing has provided both the ease of assembly and the ruggedness needed in tough mill environments of all types of rolling applications. However, for cases of lightly loaded, moderate to high-speed mills, the robust tapered sleeve bearing may not be the most cost-effective option. As a result MORGOIL offers a design that uses no sleeve and runs directly on the roll neck, as shown in the accompanying figure. Because there is no sleeve to deflect and spread the rolling load, sleeveless N type bearings always have a lower load capacity than other bearings of the same size. However, sleeveless N type bearings are ideally suited for some applications.

Besides simplicity of design and existing proven MORGOIL technologies like babbitted bushings and hydrostatic assist, this bearing also offers lower initial cost since the number and complexity of components are considerably reduced. This bearing is ideal for low to moderate separating force applications such as high-speed aluminum mills and steel temper pass mills. This bearing can also be used in cold reduction mills and tandem cold mills where there is sufficient space to accommodate it. N type bearings are normally equipped with dual load zone bushings.

The N Bearing is ideal for applications requiring high roll grinding accuracy, since grinding directly on the backup bearing journals has been shown to result in the lowest total indicated runout. Due to the requirement of grinding directly on the roll journals, it is highly recommended that hydrostatic supports be used during roll grinding.

APPLICATIONS
- High accuracy cold mills
- Aluminum mills

MAIN BENEFITS
- Higher load capacity than N Bearing
- Highest degree of roll grinding accuracy

The SN Bearing is a sleeved straight neck bearing. It is similar to the N type bearing except that it uses a thin-walled sleeve shrunk onto the cylindrical neck of the backup roll. The thin-walled sleeve gives the SN Bearing a higher load capacity than the N Bearing. The thin sleeve on the SN Bearing is specially hardened for high wear resistance and long operating life.

The SN Bearing is ideal for any application requiring the highest degree of grinding accuracy. The backup rolls of SN Bearings are ground on the cylindrical sleeve surface to provide the minimum possible level of grinding runout. The hardened surface of the sleeve provides for the longest possible life of the bearing surface.

SN Bearings are supplied with dual load zone bushings as standard equipment. They are ideal for all types of high accuracy cold mills. They have also been successfully applied to hot aluminum mills.

BEARING ALTERNATIVES
N BEARING

BEARING ALTERNATIVES
SN BEARING
LUBRICATION SYSTEMS

Lubrication systems supply oil film bearings with the proper amount of oil, at the proper temperature, allowing the bearings to operate at peak capacity for many years. A properly designed and installed modern lubrication system will also run for many years with minimal maintenance. MORGOIL® supplies newly designed, preassembled lubrication systems built specifically for MORGOIL Bearings.

Recent design changes extended to the oil system include: the optional application of new super-demulsifying oil to speed the separation of oil and water; the optional application of vacuum dehydrators for emulsified water removal and reconfiguration of oil skid designs to reduce cost through lower cost components.

SUPER DEMULSIBILITY (SD) OILS

Oils that can shed water more quickly and minimize emulsification have been a goal of the lubrication industry for many years. These oils are now available for bearing applications through leading suppliers. Besides offering better water removal at lower temperature, SD oils also offer the chance to reduce the number of components needed in several classes of mills. For example, the traditional hot finishing mill would have two oil tanks - one in operation and the other in a “rest” or standby mode during which the oil temperature had been raised to take out the emulsified water. With SD oil a single tank can be used, thus saving space and cost of oil as well as power for heating.

SKID MOUNTED MORGOIL LUBRICATION SYSTEM

MORGOIL engineering has been working to provide oil systems that are more cost-effective. Figure 9 is a diagram of a typical new design skid-mounted MORGOIL lubrication system. Using similar components from a library of available parts, MORGOIL is now able to offer lower cost oil systems with very little installation effort at the site. The skid can be landed and piped to the stands with no need to assemble the components on site. Even for larger applications, such as hot strip mills, the prepackaged concept has both design and cost benefits.

The figure and photos show a multiple oil feed pump configuration skid. By using several same-size screw pumps of lower rating, the need for 100% pump redundancy is eliminated along with component cost reductions, because the smaller pumps are less expensive. It also saves customer electrical power reserve requirements since only a fraction of the total pumping power comes on at any one time. Also, because the motors and pumps are smaller, the cost of spares is reduced.

VACUUM DEHYDRATORS

Traditionally, centrifuges have been used to separate oil and impurities. However, because of the inherent mechanical reliability issues of centrifuges, much effort has been expended over the years to try and find a non-mechanical solution to oil treatment. The vacuum dehydrator now offered in the MORGOIL portfolio fills that need. The dehydrator uses vacuum and heat to extract the unwanted elements in the oil. Since there are only a few moving mechanical parts, reliability is significantly improved, and the system can be left in operation continuously. This system is offered in a portable version and in a skid-mounted version for permanent installation. Dehydrators are not necessary in systems that use SD oil.
HAGC CYLINDERS, SHIFTING AND BENDING BLOCKS

Just as MORGOIL® Bearings support the rolling mill separating force, Hydraulic Automatic Gauge Control (HAGC) Cylinders support this same load. These HAGC Cylinders must operate under conditions of extreme load and heavy impact in a difficult environment. Under these conditions, HAGC Cylinders must provide precise, accurate motion with fast response and minimum friction. For mills to maintain high levels of strip quality, these cylinders must be kept in top condition, which means rebuilding them at regular intervals. The MORGOIL team at Primetals Technologies excels at rebuilding HAGC Cylinders and works with many companies to develop preventative maintenance programs. The MORGOIL services portfolio has several levels of reconditioning to meet customer needs. As part of the rebuild procedure, cylinders are checked for leakage and friction-tested under load to meet rigorous standards and ensure like-new performance.

Over the past several years, MORGOIL engineers have reconditioned hundreds of cylinders for numerous customers. From reconditioning to total new designs, the MORGOIL engineering group can provide the high level of service that is required for this important component of your mill stand. Whether new or reconditioned, our customers can be confident that they will receive years of trouble-free cylinder performance.

Using the same manufacturing and testing facilities, MORGOIL experts recondition, engineer and manufacture other precision hydraulic units such as shifting and bending blocks.

TESTING FACILITY

The MORGOIL HAGC Cylinder test facilities at Primetals Technologies consist of restraining frames, hydraulic systems and instrumentation. The frames were designed using finite element analysis to simulate mill housings, and they react in an elastic manner to loads of up to 2275 MT (5,000,000 lbs).

SELECT CUSTOMER LIST

| AHMSA       | Jinan Steel   |
| AK Steel    | Lloyds Steel  |
| Alcan       | Logan Aluminum|
| Alcoa       | Mittal Steel  |
| Arcelor Mittal | Novelis    |
| Erdemir     | Nucor Steel   |
| Essar/Algoma | SSAB         |
| Gallatin Steel | Steel Dynamics |
| HYLSA       | Torium       |
| IPSCO Steel | US Steel      |
| ISPAT Steel | Wise Alloys  |

MANDRELS/REELS

With hundreds of references worldwide, on all types of mills, Primetals Technologies is the leading supplier of mandrels and reels for both hot and cold mill applications.

The mandrel/reel is one of the most complex and critical pieces of equipment in the entire rolling mill and is subject to some of the most hostile conditions. It is essential to have the most robust and reliable design, utilizing the finest quality materials for the longest operational service life, maximizing mill availability.

Finished coil quality critically depends on the design and condition of the mandrel, which must facilitate quick cinching of the head end, producing a tightly wound coil, free of impact marks and telescoping with minimum yield loss.

Primetals Technologies manufactures new state-of-the-art mandrels and reels within our world-class manufacturing facilities as well as providing a comprehensive re-conditioning service. Design improvements can be implemented during the reconditioning cycle, which will improve performance, reliability and maintainability.

MILL APPLICATIONS

- Hot strip mills and wide Steckel mills
- Cold strip mills (multi-stand and reversing)
- Strip processing and finishing lines

BENEFITS

- Maximize mill availability
- Optimize reliability and maintainability
- Improve finished product quality
UNIVERSAL DRIVES, GEAR SPINDLES AND GEAR COUPLINGS

Universal Drive systems have set the standard for the industry since they were first introduced. The Universal Drive system is a comprehensive spindle assembly designed for the challenging conditions and high performance standards of today’s rolling mills. At the heart of the Universal Drive system is the MX Universal joint, the latest generation design of the Primetals Technologies Universal joint. We handle all aspects of Universal Drive systems supply, from custom design and engineering through manufacture, installation and maintenance.

The Universal Drive system has been developed to offer state-of-the-art drive mechanisms for rolling mills. Every application is custom-engineered using modern CAD-CAM systems. High strength alloy steels are used for critical components such as cross pieces, yokes, intermediate sections and coupling hubs, to provide superior fatigue cycle characteristics ensuring reliability in operation. Today’s Universal Drive systems offer the highest torque capability available for a given swing diameter.

OPTIONS AND ADVANTAGES
• Available swing diameters up to 1300 mm (51.18 inches)
• Torque capacities up to 788 m-T (5,700,000 ft-lbs)
• Offset angles up to 15 degrees
• Removable bearing assemblies for lower cost and easier maintenance
• Splined or rigid intermediate sections to suit the specific application

Primetals Technologies equips all drive systems with the latest generation design of the Primetals Technologies MX Universal joint, the Universal Drive system is a comprehensive spindle assembly designed for the challenging conditions and high performance standards of today’s rolling mills. At the heart of the Universal Drive system is the MX Universal joint, the latest generation design of the Primetals Technologies Universal joint. We handle all aspects of Universal Drive systems supply, from custom design and engineering through manufacture, installation and maintenance.

SUPPLIED DRIVE ELEMENTS INCLUDE
• Advanced MT and MRK universal joints
• Splined shafts or fixed-length shafts
• Drive hubs and adapter plates
• Roll hubs with locking features, and with or without replaceable liners

GEAR SPINDLES

Primetals Technologies mill gear spindles are available with fixed or telescopic intermediated shafts capable of transmitting very high torques with working angles up to 3°. The innovative material and compact design make our mill gear spindles ideal for both unidirectional and reversible drives of stands throughout the mill.

GEAR COUPLINGS

Primetals Technologies FSG series gear couplings feature crowned gear teeth designed to ensure conditions of misalignment in a larger contact surface. The displacement of the used profile determines the increase of the thickness of the tooth and therefore the resistance of the teeth.

MORGOIL SERVICES

FULL SERVICE WORLD WIDE SUPPORT

INSTALLATION
When a new mill is being erected or there is a major mill upgrade, the Primetals Technologies service team is available on site to assist in the proper installation of MORGOIL® equipment. This can include complete bearing assembly, inspection of completed assemblies, and calibration of equipment. Mating mill equipment can also be checked to ensure proper interaction that can affect bearing performance.

It is our goal to deliver a flawless installation that will provide a timely mill start up.

SERVICE

Once bearings have been in operation, our MORGOIL service personnel are available to perform routine inspection of bearings and related equipment. These inspections can help to find any issues that could affect mill performance. The bearings can reveal the effects of other faulty mill equipment, so regular bearing inspections can improve mill uptime. Additionally, our service representatives can keep mill personnel abreast of the latest improvements in technique and equipment that can help improve mill efficiency.

TRAINING

It is important for roll shop personnel to understand bearing operation, bearing assembly techniques, bearing interaction with other mill equipment, and basic bearing troubleshooting. MORGOIL service engineers from Primetals Technologies are equipped to provide training seminars at individual mills to help roll shops in this endeavor. The goal is to eliminate any bearing issues that could arise from improper maintenance, helping to keep operational costs down.

PREVENTATIVE MAINTENANCE

Primetals Technologies has a field service group that specializes in mill equipment monitoring to assist with preventative maintenance. They can audit all mill equipment, not just the bearings, to assist the mill in maximizing uptime and minimizing equipment failure.

RECONDITIONING

Once it has been determined that mill equipment has worn past acceptable limits, the MORGOIL team can provide reconditioning services to bring this equipment back to like-new condition. These services can range from simple disassembly and inspection to total rebuild of chocks or other equipment. Primetals Technologies understands mill operation and machinery and can breathe new life into used equipment.

SPARES AND SERVICE AGREEMENT

The combination of our service expertise with our supply of superior quality spares result in MORGOIL spares partnership programs. This is the most cost-effective way to manage MORGOIL equipment.
PREDICTIVE MAINTENANCE SERVICES

MAXIMIZE MILL UTILIZATION

MAIN BENEFITS
- Maximize mill utilization
- Known equipment condition
- Reduce maintenance cost
- Plan maintenance activities with proper timing and parts
- Avoid catastrophic failures

Today, most flat mill operators realize the importance of designing and implementing a predictive maintenance program. The debate remains how to implement it, and to what extent predictive maintenance technologies include vibration monitoring, oil analysis, thermography, balancing of critical equipment, etc. Predictive maintenance tasks are performed online and do not require stopping or decreasing production. In a typical steel plant, critical equipment in most areas must be monitored, including steel making and casting areas, hot strip mills, cold mills and processing lines.

Predictive maintenance (PDM) is the practice of using noninvasive techniques (known machine parameters) to predict the failure of a machine or system. The use of predictive technologies led industry professionals to recognize that many failures give advance warning through changes of machine or system parameters, such as vibration and temperature. Predictive maintenance programs are designed to identify and adapt to the failure modes for each machine or component. A successful predictive maintenance program will result in increased equipment utilization, reduced spare parts inventory, elimination of catastrophic failures, increased productivity, and a more efficient maintenance organization.

VIBRATION ANALYSIS

Some major decisions are based on the results of vibration monitoring analysis, such as when to let equipment run, or when to rebuild, what spare parts to stock and when to shut down. The decision to partner with the best, most accurate and reliable provider will have critical implications for the performance of any mill, both long- and short-term.

ON SITE VIBRATION SERVICES
- Annual vibration contracts
- Vibration data collected by customer or our technicians, usually on a monthly basis
- Monthly reporting to customer
- Vibration analysis and balancing on mill site lubrication system audits and analysis
- Periodic oil sampling of critical lube systems, performed either by customer or field technicians
- Oil quality analysis, including cleanliness, water, viscosity, additives, and total acid number
- Determining lubricant condition through certified lab analysis
- Verifying system operation including pressure and temperature controls and regulation

ADDITIONAL SUPPORT
- Balancing and alignment
- Machinery diagnostics and root cause analysis
- Motor testing
- Oil analysis
- Infrared thermography
- Bearing failure analysis
- Mechanical and lubrication audits
- Field service assistance
- On site training
- Reconditioning services
- Engineering support/review
- Upgrades

MANUFACTURING

Primetals Technologies is ISO 9001 certified and has continuously strived to improve quality and customer satisfaction at its predecessor company’s Worcester, Massachusetts location for more than 125 years. MORGOIL products, first invented in Worcester, Massachusetts, USA, are manufactured today in a 280,000 sq ft facility that is uniquely qualified to handle all new and reconditioning work for any mill equipment, not just bearings. Our workshop is equipped with state-of-the-art turning, milling, drilling and grinding equipment, and our highly skilled machinists are able to consistently achieve the tight tolerances and fine finishes this equipment demands. Components are assembled to ensure proper fit and function, and our technicians can provide extensive testing that ensures the equipment meets customer requirements and will function correctly when installed.

In addition to our full service facility in Worcester, Primetals Technologies has subsidiaries that manufacture mill components in India, Brazil, U.K. and Shanghai, China. Equipment is supplied from the various locations based on local content, price, and delivery. All facilities are continuously monitored and maintain strict quality standards.

Shown on this page is the MORGOIL sleeve grinder that is currently installed in Worcester. This custom designed, precision machine can simultaneously grind the ID and OD of a sleeve providing wall thickness variation of less than 2.5 microns. A sister machine is also installed Primetals Technologies Shanghai, China.

Whether new or reconditioned, our customers can be confident that they will receive years of trouble-free operation with equipment supplied by Primetals Technologies.
Nearly 9,000 employees of Primetals Technologies are based in more than 40 company offices, engineering, workshops and service centers to provide immediate support to our customers whenever required. With the added backing from the international office network of the parent companies Siemens and Mitsubishi Heavy Industries, more than 300 group sites located in some 190 countries are at the service of our customers.
MORGOIL® Bearings are currently installed on approximately 3352 stands in 1178 mills, and remain the premier rolling mill bearing for the metals industry. They are installed in both ferrous and non-ferrous mills of all sizes. Below is a breakdown of mills by type.

### ACTIVE MORGOIL AND MESTA MILLS

#### HOT MILLS

<table>
<thead>
<tr>
<th>Mill type</th>
<th>Mills</th>
<th>Stands</th>
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</thead>
<tbody>
<tr>
<td>Hot strip mill</td>
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<td>1677</td>
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<tr>
<td>Steckel / Plate/ Rougher</td>
<td>216</td>
<td>236</td>
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<tr>
<td>ESP mill</td>
<td>5</td>
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<td><strong>Total</strong></td>
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#### COLD MILLS

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<tr>
<td>Temper mill</td>
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<td>247</td>
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<tr>
<td>Other</td>
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<td><strong>Total</strong></td>
<td>721</td>
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*Totals through 2015

### MORGOIL BEARING RECENT SELECT REFERENCE LIST

#### HOT MILLS

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