

BACK-UP ROLL BEARING UPGRADES FOR INCREASED MILL UTILIZATION¹

G.F. Royo²
T. C. Wojtkowski³
P. N. Osgood⁴

Abstract

Rolling mills have a very long and economical life. As a mill gets older however, advances in newer mills makes it difficult for older mills to produce the same high quality product at production levels of newer mills. MORGOIL Bearings realizes that companies have a significant investment in these older mills so has worked with mill operators to economically upgrade these mills with the latest technology. This helps 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. Case studies of mill upgrades will be reviewed and actual mill equipment will be shown. In the current economic climate, cost effective solutions are needed to keep mills competitive.

Key words: Back-up roll bearings; Oil film bearings; Mill upgrades.

¹ *Technical contribution to the 46th Rolling Seminar – Processes, Rolled and Coated Products, October, 27th-30th, 2009, Santos, SP, Brazil.*

² *Vice-President and General Manager, Morgan Construction Company, MORGOIL[®] Bearing Division*

³ *Director of Engineering, Morgan Construction Company, MORGOIL[®] Bearing Division*

⁴ *Manager of Product Development, Morgan Construction Company, MORGOIL[®] Bearing Division. Morgan Construction Compan. A Siemens VAI Business, 40 Crescent Street, Worcester, MA 01605*

INTRODUCTION

The MORGOIL[®] Bearing Division of Morgan Construction Company is constantly innovating and improving oil film bearings for flat mills. This new technology is always available on new bearings, but MORGOIL also strives to retrofit the improvements to older bearing designs, thus allowing older mills to increase the performance of their back-up roll bearings. This helps to ensure that an investment in MORGOIL bearings gives mills access to the latest technology throughout its life.

Bearing upgrades are driven by many factors.

Equipment has just become too old and worn to produce a quality product.

- A mill may want to produce tougher grades requiring higher stand capacities.
- A mill may want to increase rolling speed and production.
- A mill may be adding a processing line and have to run slower, perhaps stopping under load.
- An old mill is being sold and being brought up to current standards.
- Mills may want to upgrade to MORGOIL bearings from rolling element bearings or Russian oil film bearings to increase speed and capacity.

These upgrades are sometimes carefully planned and in other cases the upgrades come about due to demands of the market. This paper will briefly discuss available upgrade paths and then present three case studies where bearings were major design changes were required in order to meet current market demand.

COMMON UPGRADE STRATEGIES

Past papers have discussed various upgrade paths. These upgrades will be briefly reviewed because of their relevance to the case studies.

Sleeves: The original MORGOIL long key “T” type bearing can be converted to a “KT”, or short key design sleeve, figure 1. 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 .. If maximum capacity is needed the T bearing and the KT bearing can be upgraded to the latest KLX[®] bearing. 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. The new rolls are needed to cope with neck stress because of the large rating increase. This conversion is 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.

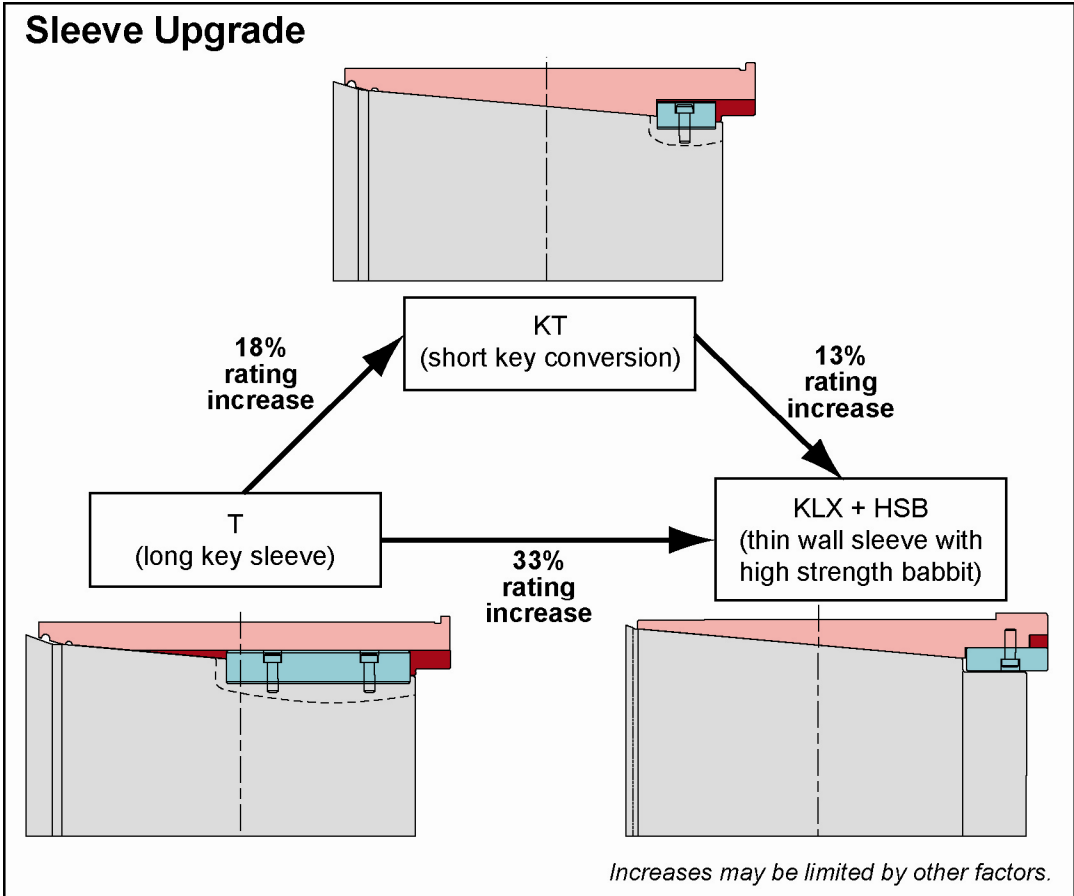


Figure 1: Sleeve Upgrade Path

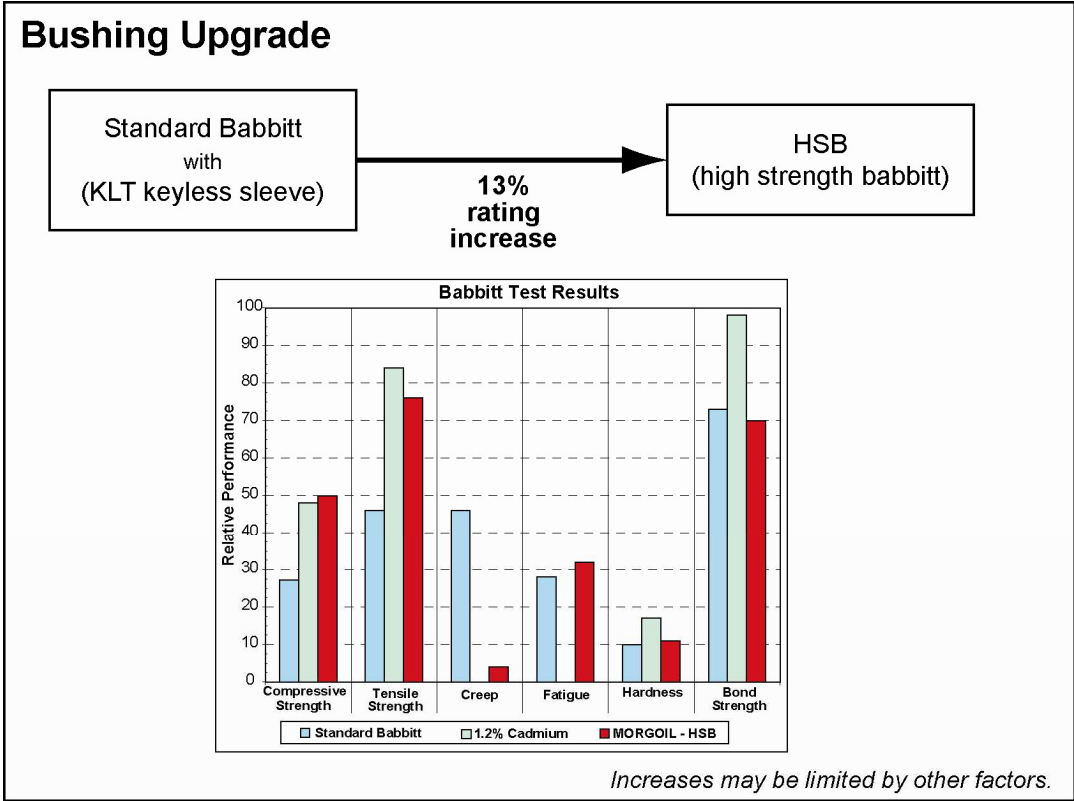


Figure 2: Bushing Upgrade Path

Bushings: Bearing rating can be increased through the use of High Strength Babbitt (HSB) bushings. High Strength Babbitt can 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%. The ratings of relatively modern KL[®] bearings can be increased by up to 13% with the use of HSB bushings, figure 2. All KLX bearings come with high strength Babbitt to enable them to reach their high ratings.

Seals: MORGOIL and MESTA[™] bearings can have their sealing systems converted to more modern designs to reduce maintenance time and increase effectiveness, figure 3. These conversions can be done by themselves, or in conjunction with other bearing upgrades. There is a class of large MESTA plate mill bearings where the existing sealing system limits discard back-up (BU) roll diameter. Changing to a more modern neck seal design allows the rolls to be turned down further, this will be explained more completely in Case Study 2.

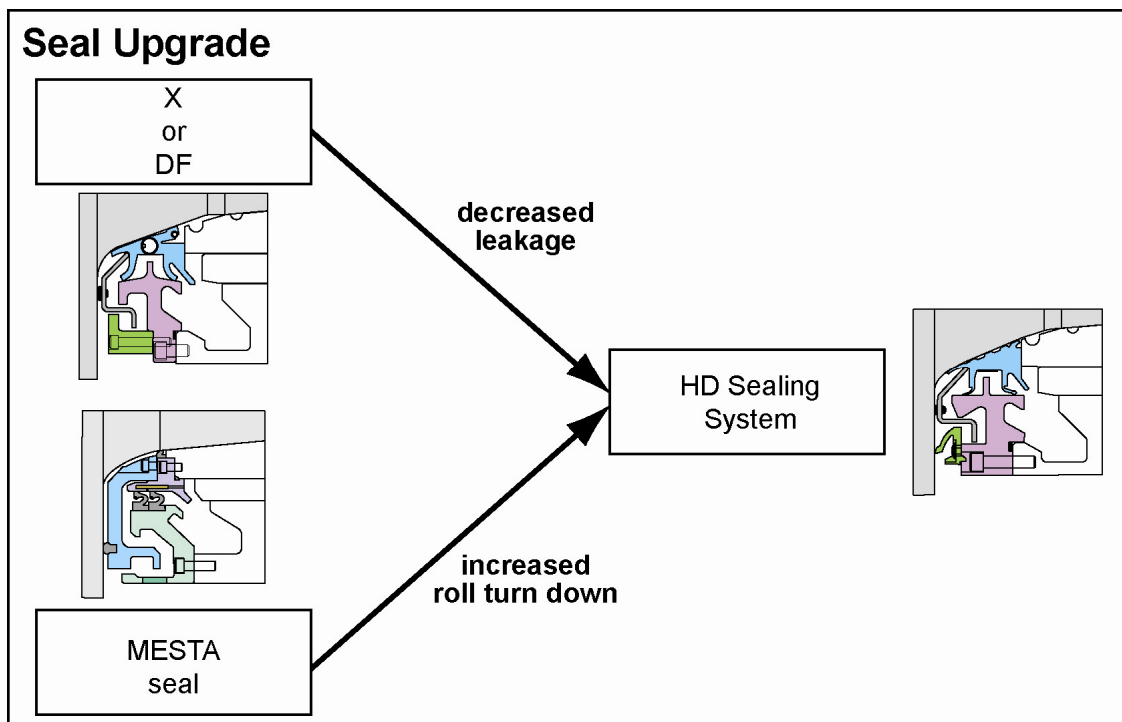


Figure 3: Seal Upgrade Path

Locking: Bearing locks have advanced significantly over the evolution of the MORGOIL bearing. The original Threaded Ring (TR) design and later Quick Change (QC) design have been replaced by more modern hydraulic concepts. On new mills one of three types of lock is standard: Hydraulic Bayonet (HB); Removable Mount (RM); or the Compact Bayonet (CB). Older mills with mechanical TR and QC can often be converted to Hydraulic Mount (HM) and LD[®] Locks, figure 4, increasing the repeatability and speed of the locking process and eliminating the need to use an overhead crane to tighten the locks.

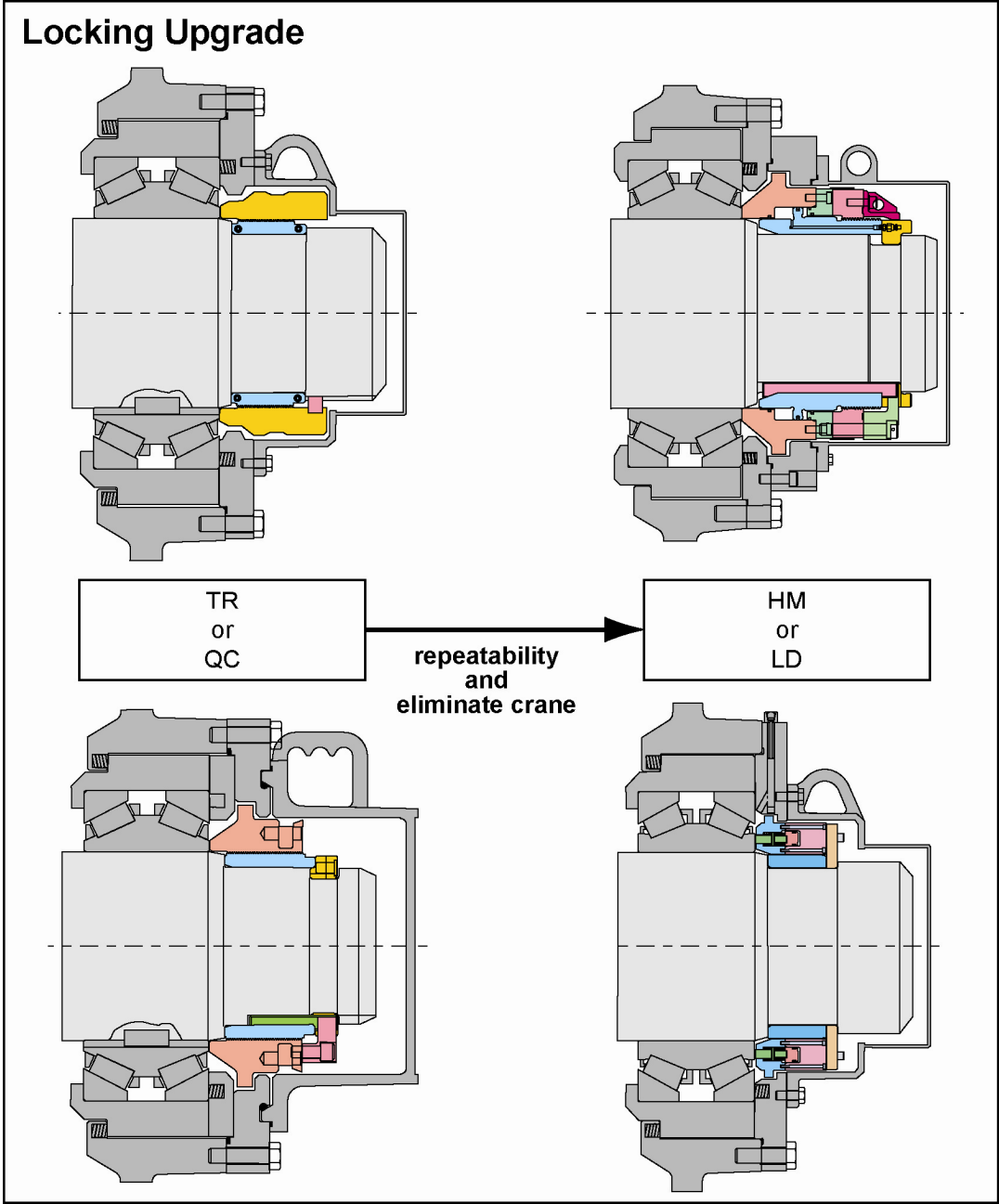


Figure 4: Locking Upgrade Path

Complete Bearing Conversion: In addition to upgrading various individual bearing components. MORGOIL can combine these upgrades for a complete bearings upgrade. The most effective of these is upgrading older style “T” and “K” bearings to the latest “KLX” bearing technology including High Strength Babbitt along with modern sealing and upgraded locks. This provides the maximum increase in performance and the greatest stiffness and lowest roll neck stress. It also provides better seal performance and the convenience of modern locking. This type of conversion is the primary subject of this paper.

CASE STUDY #1: HOT STRIP MILL LOAD CAPACITY INCREASE FOR ROLLING TOUGHER MATERIALS

A South American HSM with older style MORGOIL 42"-90 TRT bearings began experiencing serious roll neck breakage problems in 2007, as shown in Figure 5. Analysis showed that modern hot band requirements had driven the Total Separating Force (TSF) well above the rating of the bearing. Along with repeated roll neck failures the mill also experienced occasional sleeve failures.

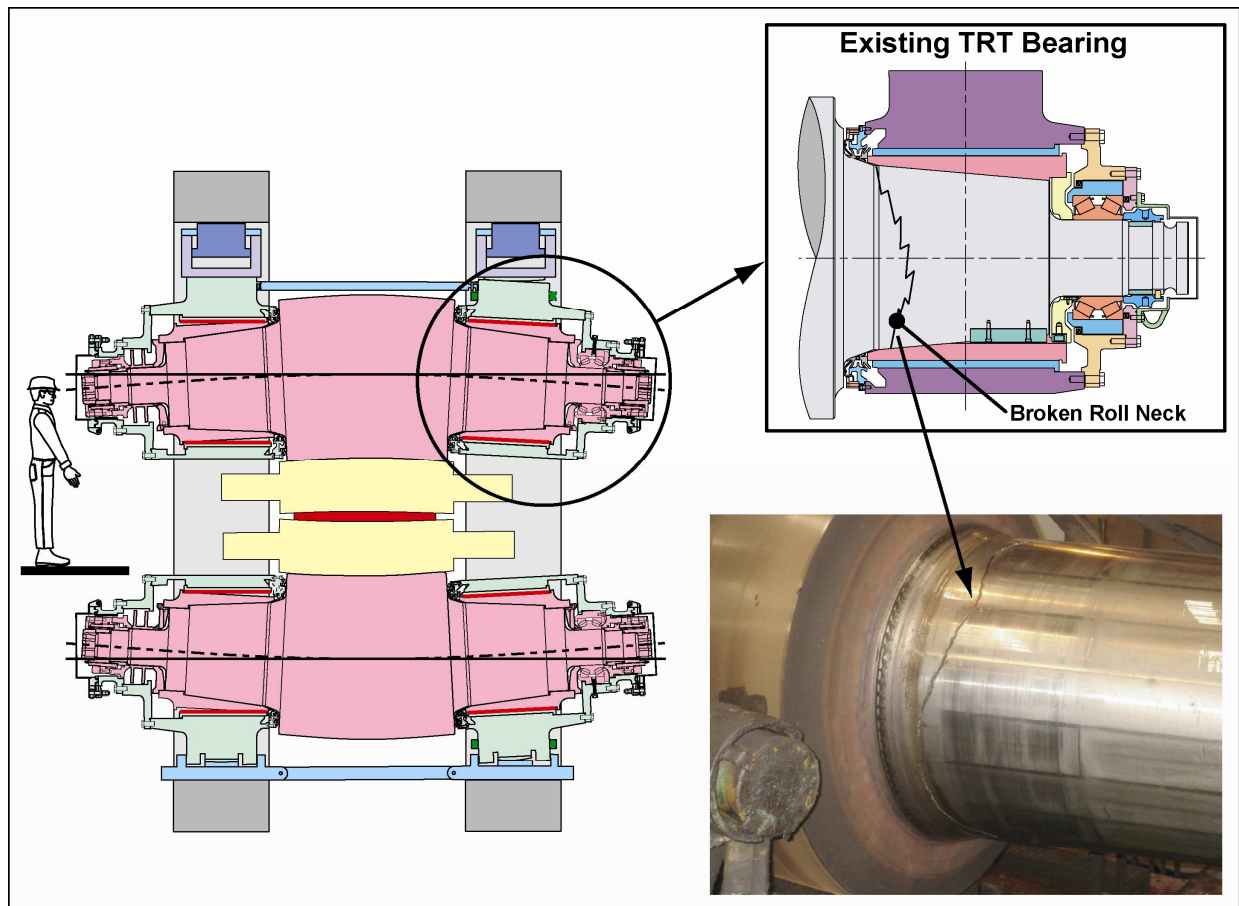


Figure 5: Roll Neck

MORGOIL Engineering studied the matter and recommended a complete bearing replacement based on a load analysis, as shown in Figure 6. It was clear the failures were occurring because the bearing loads had exceeded rating – the mill had originally been specified to operate in the yellow shaded area on the curve, and was now operating well above it. With very few modifications a 42"-86 KLX bearing could be fit into the existing chocks. The updated bearing would have a larger roll neck, shown in Figure 7, reducing the stress in the neck at the new, higher loads. As new rolls were required to replace the old, broken rolls, this design change avoided the main problem of most major bearing upgrades, which is the reuse of the existing back-up roll inventory.

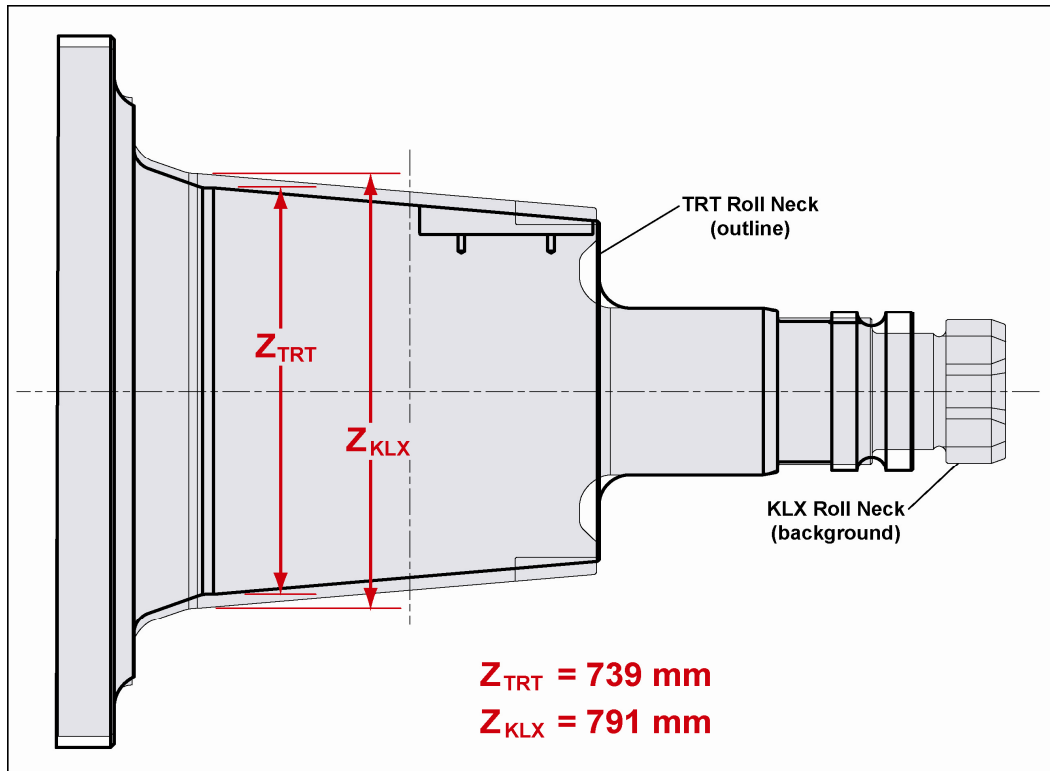


Figure 6: Bearing Operational Comparison

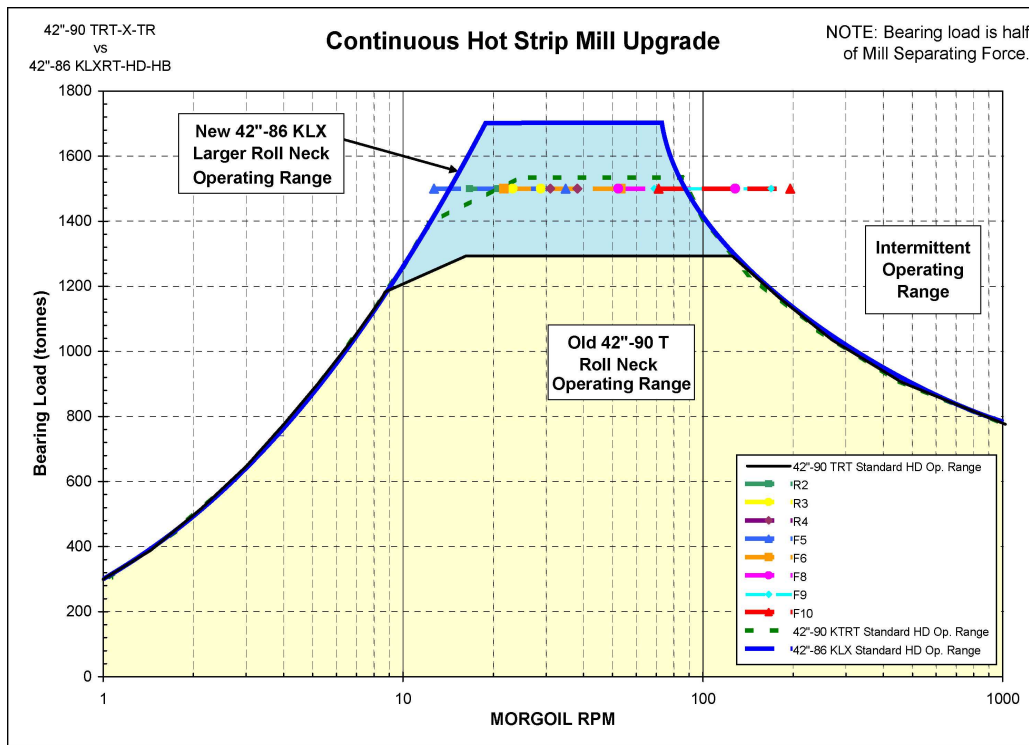


Figure 7: Roll Neck Comparison

The primary features of the complete upgrade are shown in Figure 8:

- The existing Chocks are used with minimal modification. The chock bores are machined slightly oversize to ensure that they are true.
- The old broken rolls are replaced with new rolls with larger necks, which are supplied to accommodate the KLX design.
- KLX Sleeves and Bushings result in the largest possible load capacity in the existing chock design.
- New Sleeve Ring accommodates the higher axial loads.
- New HD Neck Seal assembly with ground light metal ceramic sealing surfaces, vents, and drain-backs.
- The existing Chock End Plate and Thrust Bearing Assembly are used, saving considerable time and expense.
- A new HB Mount to complete the conversion.

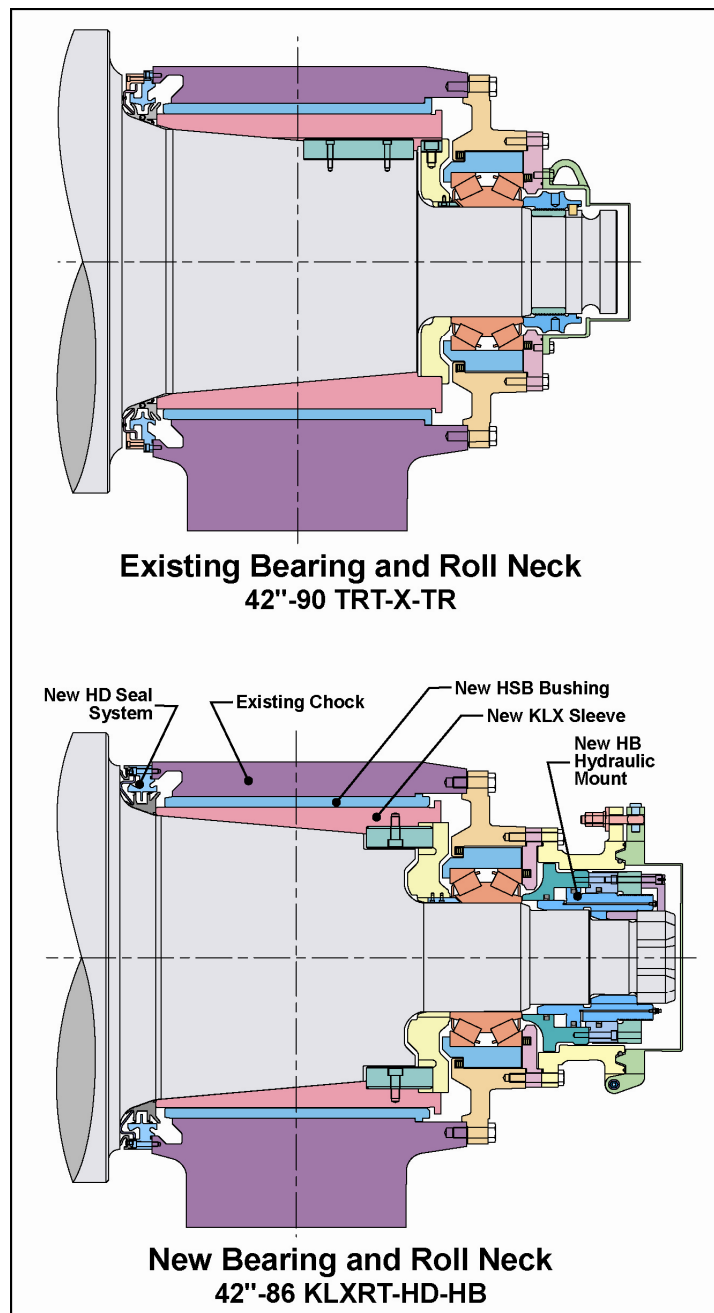


Figure 8: Upgraded Bearing Comparison

The combination of the above improvements result in an upgraded bearing that meets the most modern performance standards while using much of the existing chock and exterior bearing equipment, minimizing capital expense.

CASE STUDY #2: MORGOIL NECK SEAL UPGRADE TO MESTA BEARINGS TO INCREASE ROLL LIFE IN LARGE PLATE MILL

A 5.5 m Plate Mill in Japan uses back-up rolls with a 2400 mm initial diameter and a design discard diameter of 2200 mm. The operator approached MORGOIL Engineering asking if the existing sealing system could be modified to take up less space. The existing MESTA seal design was the limiting factor in a plan to decrease the discard size of the of the back-up roll, extending the life of these very expensive components, figure 9.

MORGOIL Engineering designed a special version of the HD Neck Seal and Coolant Guard for this unique mill. The new coolant guard had a contact diameter of 2010 mm. This allowed the mill to decrease the turndown of the back-up rolls to 2140 mm, adding an additional 60 mm of turndown. Stack height was maintained by using special, larger Work Rolls when the back-up rolls reached their old discard diameter of 2200 mm.

The increase in useful life of each back-up roll is 30%. Assuming a cost of \$1M US per back-up roll, this is an increase of utilization worth about \$300,000 US per roll. Each plate mill stand has 6 rolls, for a total increase of roll utilization worth \$1.8 M US per stand. As this is a 2-stand mill, the improvement in back-up roll utilization is estimated to be \$3.6 M US for the initial fleet of back-up rolls. This is also a cost improvement that stays in place for the life of the mill.

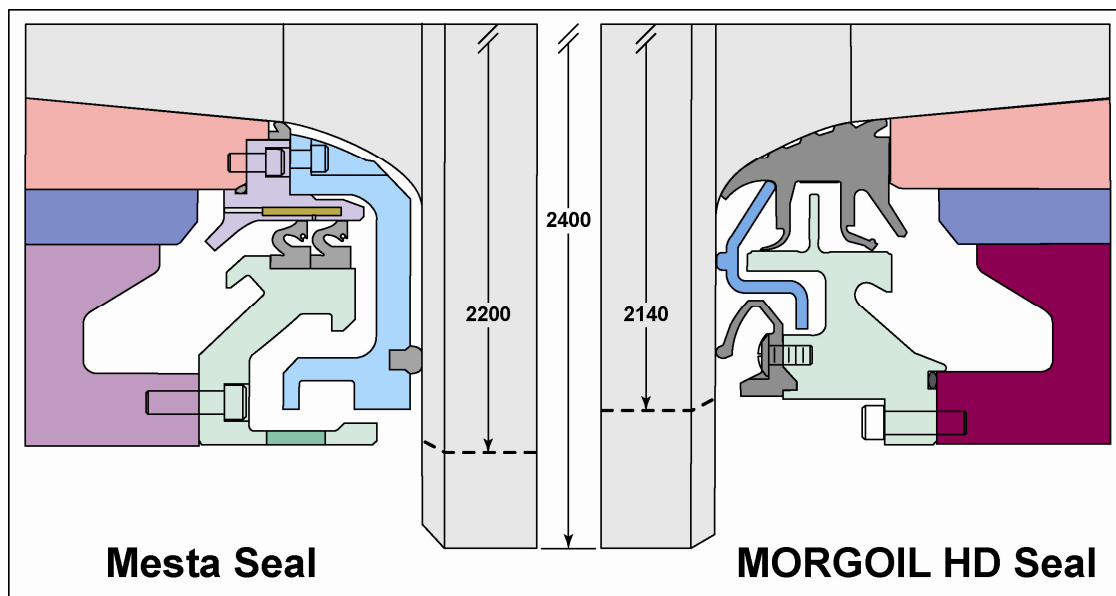


Figure 9: Mesta neck seal upgrade

CASE STUDY #3: MORGOIL KLX UPGRADE FOR A 2-STAND TANDEM COLD MILL

In the case of a European 2-stand DCR mill (similar to that shown in figure 10) equipped with old MESTA bearings, it made sense to upgrade Stand 1 to a special KLX bearing that made use of the existing hydraulic lock and thrust assembly. The new KLX sleeve and seal assembly also included a full MORGOIL neck seal conversion. A new typical HD neck seal conversion replaces the existing MESTA seal assembly with a MORGOIL HD sealing assembly consisting of the neck seal, seal end plate, and coolant guard. In this case, neck seals of both NBR and HNBR were used and evaluated for life. HNBR seals, while more expensive, typically yield a longer service life, usually on the order of 2:1 depending on the application. A main improvement resulting from this upgrade was reduction in manpower requirements in the roll shop. The old MESTA design required more than 8 man hours in the shop to change a seal assembly. The new neck seal can be changed in about 5 minutes.

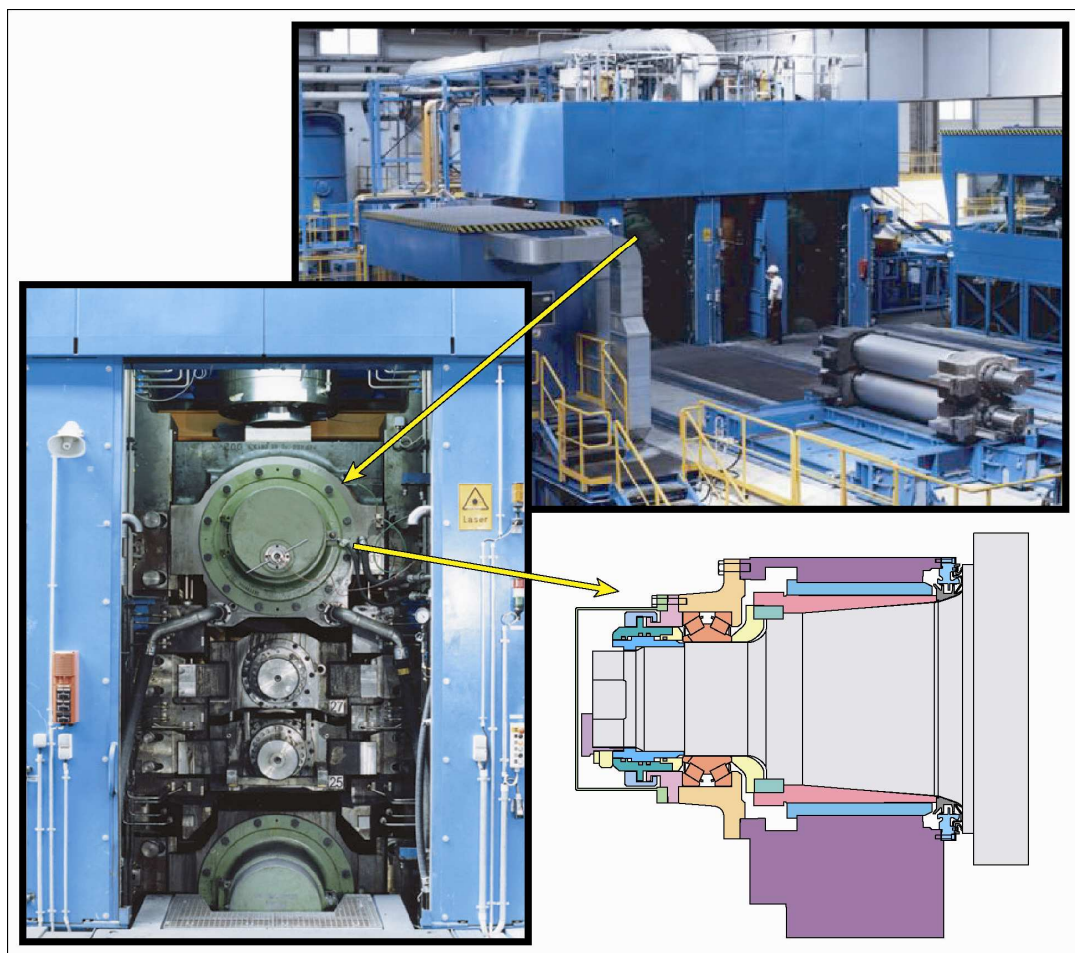


Figure 10: 2-Stand Tandem Cold Mill

CONCLUSION

Rolling mills have a very long and economical life. As a mill gets older however, advances in newer mills makes it difficult for older mills to produce the same high quality product at production levels of newer mills. MORGOIL Bearings realizes that companies have a significant investment in these older mills so has worked with mill

operators to economically upgrade these mills with the latest technology. This helps 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 back-up roll bearing upgrades, mills can increase capacity, allowing them to roll products that were not even considered decades ago. Both older oil film bearings and roller bearing mills have been successfully upgraded while reusing existing chocks and in many cases rolls. In other cases, back-up roll seals have been upgraded to the latest designs allowing mills to get more turndown from their rolls, thus extending roll life. Back-up roll bearing locking has also been upgraded to allow for more consistent and less labor intensive operation. Solutions are customized to the customer's equipment and goals.

The first case study described how a complete bearing upgrade is a cost effective solution if large capacity increases are required in existing space. In the case of a South American Hot Mill, a complete MOROGIL KLX conversion of their finishing stands allows the use of rolls with larger necks, with the goal of eliminating a roll neck breakage problem

Sealing upgrades can be economical for many classes of hot and cold mills. For some classes of large plate mills a MORGOIL Neck Seal can allow a reduction in back-up roll discard diameter, increasing the useful life of the rolls and producing large cost savings as described in case study 2. For cold mills, case study 3, a sealing conversion can reduce manpower requirements in the roll shop, keeping these critical cold mill components in the best possible operating condition with the least amount of man power expenditure.