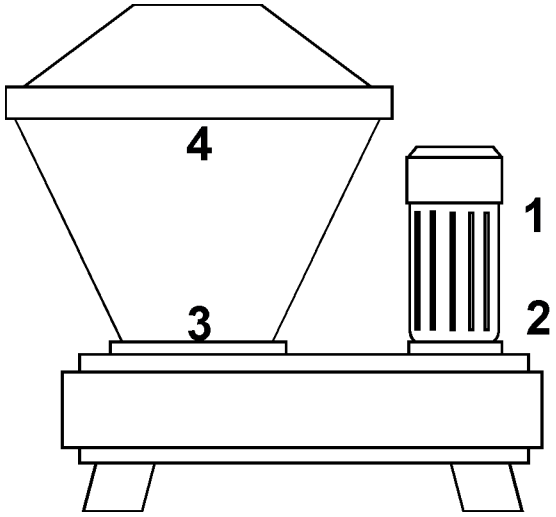
GM0001-L / 3C Grinding Mill #1

Synopsis

The asset is a vertically mounted, belt driven grinding mill, as shown in Figure 1. The drive spindle has three (3) bearings: two (2) cylindrical roller bearings and one (1) ball bearing. The mill is being belt driven by a 100 hp, two-pole motor. The mill normally operates at 3,150 rpm.



Legend

1. Outboard Motor Bearing
2. Inboard Motor Bearing
3. Inboard Mill Bearing*
4. Outboard Mill Bearing

* Bearing that was failing.

The mill rotor bearings, which are mounted in a steel housing, are two (2) cylindrical roller bearings, NU 316 ECM/C3, and one (1) grooved ball bearing, SKF 6316 C3. The bearings have failed several times over a period of two (2) years. Before this time, the mill had no recorded bearing failures (as confirmed by the CMMS).

Fault

In 2007, the vibration spectra began displaying excessive looseness. A work order was submitted by the vibration analyst, and the bearing assembly was rebuilt and reinstalled by on-site mechanics. (See Figure 2.)

In September 2009, the vibration data was again showing bearing defects. At this time, the old bearing housing, shaft, bearings, and seals were sent to a local precision mechanical shop for assembly. The on-site mechanics performed the replacement of the bearing assembly, rotor, sheaves, belts, and motor. (See Figures 3 and 4.)

In February 2010, the bearings failed again, this time with very little notice. A new bearing assembly was purchased from the manufacturer at this time. This assembly was again installed by the on-site mechanics. (See Figure 5.)

In November 2010, the bearings failed yet again. (See Figure 6.)

Note in the photographs in the Supporting Data section that all of the ball bearings (with the exception of the first one) failed in the axial plane.

Supporting Data
All of the photos in this report were taken, cataloged, and documented by the Allied analyst working at this location.

Figure 1: GM0001-L / 3C Grinding Mill #1.

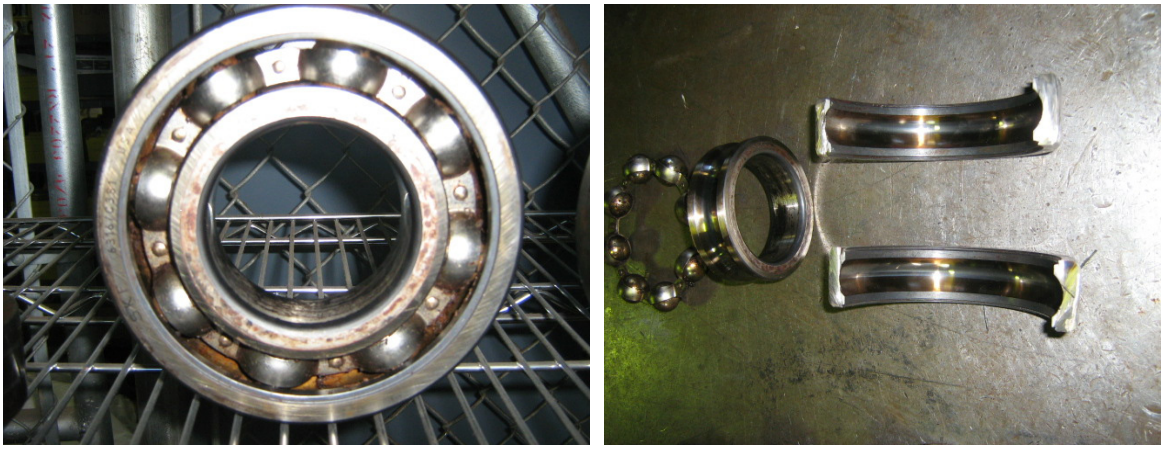


Figure 2: These are photos of the SKF 6313 C3 ball bearing that was replaced during the 2007 rebuild.

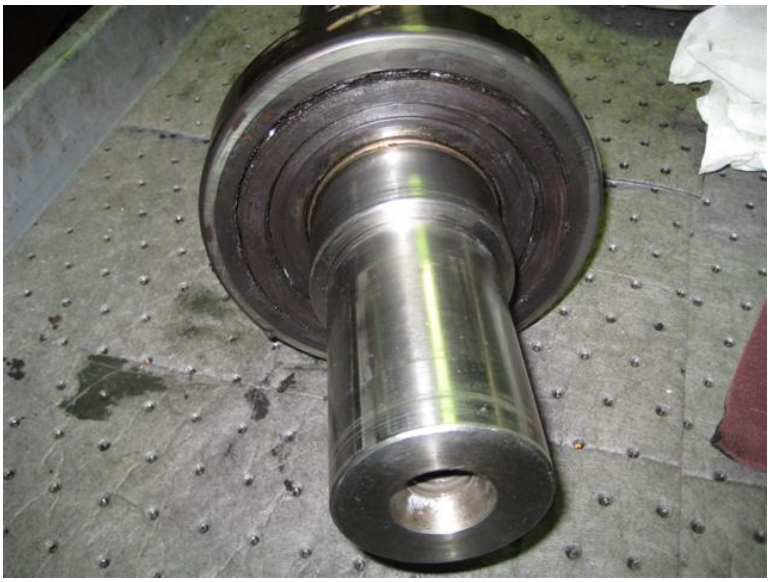


Figure 3: Photo of ball bearing that was removed during the 12/2009 rebuild.

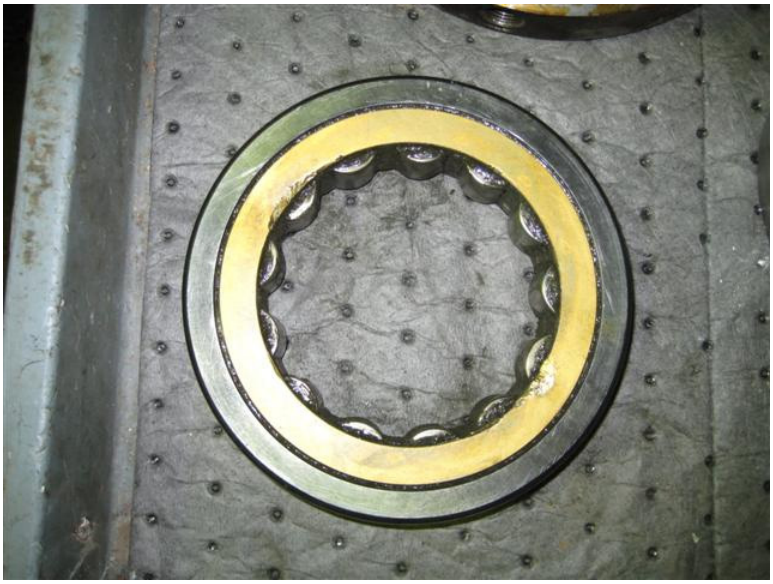


Figure 4: Photo of cylindrical roller bearing that was removed during the 12/2009 rebuild.

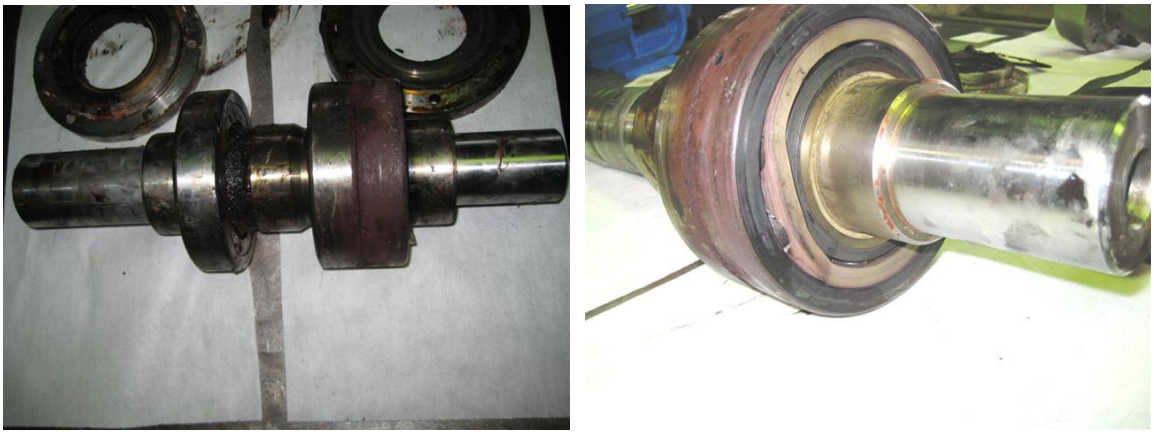


Figure 5: Photos of bearing/shaft assembly that was removed in 2/2010.

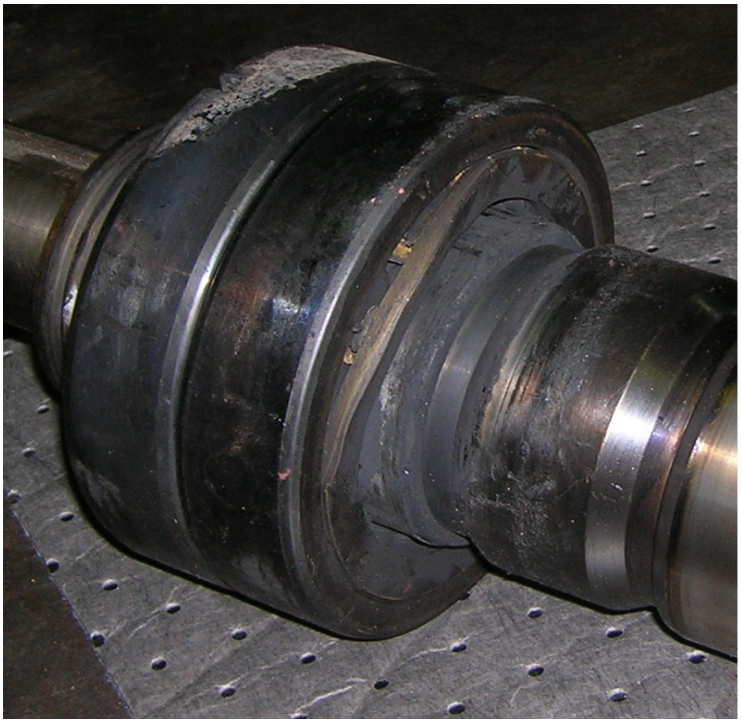


Figure 6: Photo of ball bearing removed during the 11/2010 failure.

Figure 7: Photo of the bearing assembly end cap. Please note the location of the lubrication channels.

Summary of Action

Due to the repeated failures, this asset triggered a Root Cause Analysis. The investigation eventually revealed the cause of the failures. During the investigation, we verified many different issues. Some of the most important issues were as follows:

- A discussion with the Lubrication Technician confirmed that the lubrication schedule and/or amounts had not changed.
- The vibration data recorded as far back as 2005 showed the operating speeds to have been unchanged.
- The bearing sizes and types were verified. During the bearing identification, we discovered the type of ball bearing had been changed during the mill rebuild in February 2007. The original drawing specified an SKF 6316 C3 bearing; however, the manufacturer had revised the original drawing and recommended a different ball bearing, part number SKF QJ 316 N2MA. The manufacturer had started selling the plant the new bearing in 2007.

Use	Ball Bearing Part Number
Original, pre 2007	SKF 6316 C3
In use since 2007	SKF QJ 316 N2MA

The bearing supplier's engineering consultants suggested the plant return to the old bearing style. In addition to the poor application of this new style of bearing, the lubrication was not entering the bearing due to the style of the cage (the old bearing was unshielded). (See Figure 7)

Re-qualification

- The bearing housing and shaft were sent out to a machine shop to verify all measurements were within tolerances.
- The ball bearing was replaced with the old style bearing.
- The cylindrical roller bearings were also confirmed to be the correct bearing for this application.

Conclusion

Root Cause Analysis Cost Information

Goal	Impact to the Goals	Costs (USD)
Production	120,000 lbs	$40,000.00
Maintenance	2,500 parts and hours	$2,500.00
Subtotal		*$42,500.00*
Frequency (Number of Times per Year)		3
Annual Total		**$127,500.00**

- The importance of documenting all of the data for any critical asset cannot be overstated.
- While the difference in ball bearings is obvious in all of the photos in this report, without the past failure data being catalogued and stored by the previous analyst, this bearing change out may have continued to go unnoticed.
- The analyst who was working at the facility had only been at that location approximately six months; however, due to the proper documentation by the previous analyst, he was able to do his job and compare the current data with the old data and find the change that started this chain of failures. It was while looking through photos of past failures that we first noticed the differences in the bearings.