ABSTRACT
An important industry question concerning the performance of shielded/sealed bearings is how long do they really last? This type of bearing is marketed to the end user as a sealed for life bearing which to many implies very long time of service. The limiting performance characteristic however for many of these bearings is how long the grease will last. Grease can have a relatively short service life compared to the bearing steel and is critical to bearing operation. Well performing bearings will fail rapidly when the lubrication fails.

INTRODUCTION
Double shielded bearings that had been in service in excess of 10 years were removed and disassembled for inspection to include testing of the used grease. Bearing condition and grease indicated that all bearings could have continued in service and that removal was pre-mature.

NOMENCLATURE
Stress Rheometer – Instrument used to characterize the physical Properties of grease.

Body/Discussion
A Population of 32 bearings from 16 motors that had been in service in excess of 10 years were cut apart and examined. These bearings were represented by their manufactures as ones that could be expected to provide 4-5 years of satisfactory service with grease the limiting performance factor. The motors are estimated to operate 90% of the time.

The bearings were installed in 200 hp horizontal motors located in the harsh environmental condition of a large 16 fan cooling tower. The motors are positioned in a manner that allows saturated air with a high mineral content to constantly circulate past them during operation. Minerals are carried in the air/water and deposit readily to form layers of a ‘hard chalky’ material on the exterior of the motors. Concern of migration of this foreign material into the bearings is the primary reason that shielded bearings were chosen for use in this application.

A grease pack which serves as an additional environmental boundary is placed around each bearing at the bearing cavity during original bearing installation.

The grease within each bearing was original factory fill and each as found bearing was verified to have double shields as expected. The bearings came from 3 manufactures and included SKF / NTN / FAG 6315, 6320, 6313 bearings.

Inspection Summary
Grease was selectively removed from the bearing cages and from the sides of some of the shields. The intent of this testing was to determine if grease had migrated from the hand pack outside of the bearing through the shield and also the condition of the grease at the sampling points. The greases were tested for accumulation of wear metals, for oil loss, contamination and rheological properties using a stress rheometer.
As the bearings were essentially sealed, a fairly homogeneous blend of stiff grease was expected. This was not found to be the case. Clear differences were found relative to the sampling point within the bearing. The grease from the cage samples were quite different that the grease found on the inside of the shields. The cage samples were much stiffer and contained much more wear metal.

**Environmental Grease Pack:** Two samples were drawn from the grease packs used as the environmental barrier. Both of these samples contained high iron levels (4000+ ppm Fe) with little to no Cr. One sample was resolved to allow microscopic examination and the predominant material observed was rust. The associated bearing was inspected and is shown in figure 1. Fretting wear can be clearly seen. Two other grease pack samples were drawn and had no wear debris and their associated bearings did not show exterior wear. The consistency of these greases were measured and they tested similar to new fresh grease. A stress rheometer was used to characterize the grease. (reference 1)

![Figure 1, Fretting wear](image)

The FTIR technique was applied to all grease pack samples and their corresponding interior greases to determine if migration through the shields to the cage/raceway was evident. It does not appear that a position concerning migration can be taken as all greases measured were polyurea and subtle FTIR peak differences could have been attributed to batch variations rather than lube type differences.

**Grease Inside Bearing:** The remaining samples were taken from inside the bearings from either the bearing cages or the inside surface of the shield. For 4 of the bearings, testing was done on both the cage and shield grease for comparison. The greases at the cages were stiffer than those at the shields with some of the shield grease properties in near new condition when measured with the Rheometer and FTIR. It appears that little mixing between the cage and shield grease has occurred and that all lubrication that occurred over the 10+ years was from the small volume of grease at the cages.

![Figure 2, Outer Race Wear](image)

Little wear metal was found in the shield greases which further confirm that this grease did not participate in bearing lubrication. This grease may have, however participated in providing an additional environmental barrier to foreign contaminants. Figures 2 and 3 are provided as worse case ring wear and typical ball bearing. The bearing races had little or just initiated surface fatigue and the balls were discolored with some minor surface damage.

![Figure 3, Typical Ball Bearing](image)

**Grease Rheology:** A stress rheometer was used to characterize the greases as the sample volumes were significantly less than that required by cone penetration testing. Reference 1 concluded that a measurement of 1617-2833 Pa was within the NLGI 3 scale. Most cage samples were within this range although towards the middle. Only 2 samples measured stiffer. The shield samples were typically (697-1221 Pa) in the NLGI 2 range.
The outboard bearing samples had stiffer grease than the grease of the inboard bearings. The outboard bearings are more heavily loaded.

**Conclusion:**

The double shielded bearings along with the environmental exterior grease pack kept the grease within the bearings clean. Lube cleanliness is believed to be a significant factor in the longer than expected service life. Grease from the pack did not appear to migrate into the bearing to refresh the grease at the cages. The bearings did not exhibit excessive wear and bearings configured as presented can be expected to operate longer than the OEM estimate of 4-5 years service.

**REFERENCES**

1. Johnson, B; The use of a stress Rheometer in lieu of cone penetration WTC 2005-64289