

## Improving Retention in Railroad Roller Bearings

by

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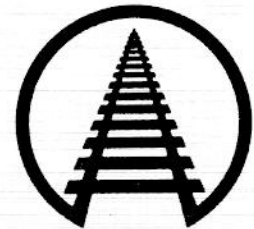
### Summary

*Bearing clamp load is one of the major factors in reducing loose bearing component failures. In an effort to improve bearing retention on the axle, and consequently reductions in hot box setouts and burnoffs, an investigation of bearing clamp load was performed at the AAR's Chicago Technical Center (CTC). This investigation has revealed not only the importance of lubricating cap screws, but also the importance of the type of lubricant used. An ongoing study at CTC has focused on the improvement of bearing clamp load. Results also indicated that used, undamaged screws had minimal effects on the clamp load developed, while cleaned used screws that were sand blasted or tumble cleaned can have an adverse impact on the clamp load.*

*This investigation also looked into the influence of locking plate coatings and hardness on the amount of clamp load developed. Results from these tests revealed insignificant differences in clamp load among the types or hardness of locking plates used.*

*Clamp load is the primary means of keeping the bearing tight on the journal. By increasing the clamp load, fretting wear will likely decrease. This fretting wear is most predominant at the interfaces of the inboard cone/seal wear ring, inboard seal wear ring/axle journal, and backing ring/journal fillet. Fretting wear is the main cause of loss of clamp, a condition that leads to loose components. Loose components, specifically cones, are the major cause of hot box setouts and burnoffs (AAR Report WP-146).*

*Past research on clamp load has shown that, in general, lubricated cap screws develop about twice the clamp load of dry cap screws. Subsequent to this study in 1989, mandatory lubrication of cap screws for railroad journal roller bearings was implemented.*



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## INTRODUCTION AND CONCLUSIONS

Maintaining bearing clamp and fit to the axle is essential for safe and proper operation of freight trains. It was observed during joint hot bearing teardown inspections performed in 1986 and 1988 that loose components were involved in approximately 50% of the hot bearing setouts [ref 1]. Once a bearing becomes loose on the axle, it deteriorates at an accelerated rate. This deterioration process has been observed in laboratory tests performed at the AAR-CTC Bearing Research Facility. Bearings in good condition were observed to fail (lock up) in a short period of time when mounted on axles that provided a loose fit.

Bearing retention comes from two sources, clamp load and interference fit. Clamp load is the primary contributor to bearing retention. It is clamp load that reduces or eliminates fretting wear. Fretting wear reduces the stack length and therefore relieves bolt tension. Eventually the result is loose components. It is therefore highly desirable to reduce or eliminate fretting wear. This is achieved by increasing the clamp load.

Tests were performed to determine the effect of dry condition, cap screw lubrication, locking plate material, screw condition (new and used) and joint conditioning on clamp load. A fixture (Class F bearing components and axle journal) was assembled to measure the clamp forces developed on the bearing stack that were transmitted by the cap screws alone. The spacer of the bearing was instrumented to perform as a load cell. The seal wear rings and the cones were manufactured to provide a slip fit on the test journal stub. By providing a slip fit, there are no bearing component reactive forces that would detract from the forces input by the screws. Thus, screw condition, lubrication type, end cap designs, and locking plate material are the only variables in the test.

This study resulted in the following conclusions:

- 1) Lubrication of cap screws, in general, provides approximately 50% more clamp load than does a dry condition.
- 2) Most lubricants performed similarly, that is, the clamp loads developed by each type of lubricant were grouped in a cluster. Some lubricants provided little additional clamp over that of dry conditions. One lubricant in particular provided superior clamp results compared to all other lubricants.
- 3) Lubrication of the washer face of the cap screw is critical in achieving high clamp loads.
- 4) Locking plate material and hardened washers had minimal effects on the clamp load achieved.
- 5) Undamaged, used cap screws with smooth, clean thrust surfaces performed as well as new cap screws. Extra care must be taken during the inspection of used cap screws.
- 6) Used cap screws that have been sand blasted or tumbled during the cleaning operation resulted in significantly lower clamp loads. This is due to the resulting rough thread and washer face surfaces.
- 7) Joint conditioning (applying, releasing, and reapplying the cap screw) slightly improves the clamp load.

## RESULTS AND ANALYSIS

The main goal of these tests was to determine factors that could maximize clamp load. These tests were performed on Class F axle and bearing components.

The test procedure included:

- 1) cleaning the screw holes,
- 2) sliding the bearing components on the journal stub,



- 3) applying test parameter, ie. lubricant, locking plate, end cap design, screw condition, and
- 4) applying test torque (390 ft-lb) and recording load cell (spacer) output.

Several lubricants were evaluated. The two lubricants that yielded the best results were 30-W oil and bearing grease. These lubricants effectively increased the clamp load by 48% over that of dry conditions. This is shown in Exhibit 1.

### DRY vs LUBRICATION

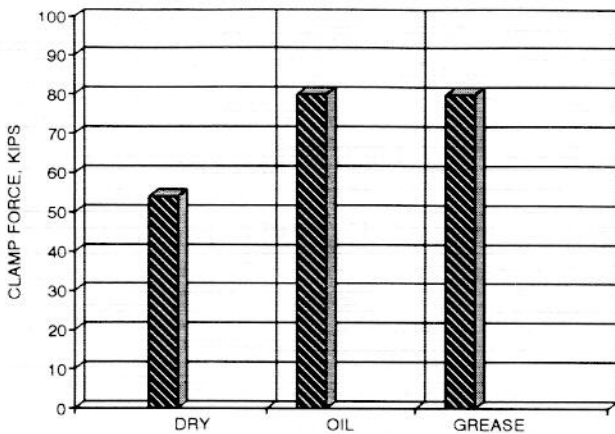


Exhibit 1. Effects of Lubrication

Another factor that influenced the clamp load was joint conditioning. This was more apparent for used cap screws than for new cap screws. Joint conditioning is the operation of applying the screws to a predetermined torque, removing the torque, and then torquing to the recommended range (390 ft-lb for these tests). This is shown in Exhibit 2.

Standard locking plates deform under the head of the cap screw. To measure this effect on clamp load, hardened washers were used in place of the locking plate. Locking plate material and hardened washers

did not result in a significant variation of the clamp load as shown in Exhibit 3.

### JOINT CONDITIONING GREASE LUBRICATED

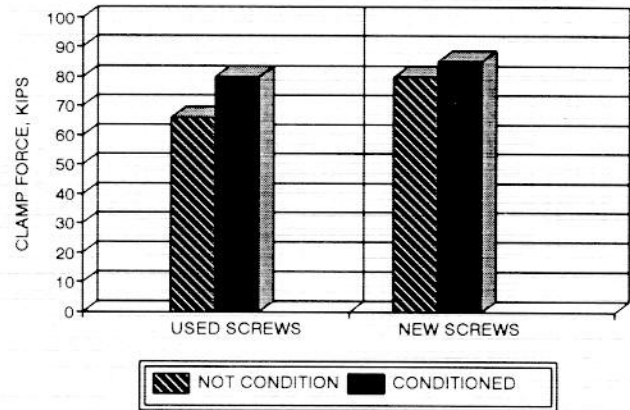


Exhibit 2. Effects of Joint Conditioning

### LOCKING PLATE MATERIAL GREASE LUBRICATED

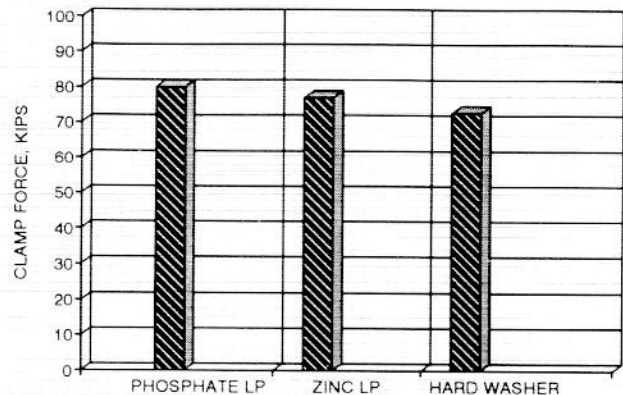


Exhibit 3. Effects of Locking Plate Material



### Future Research

Recent tests with coated cap screws resulted in an increase in clamp load of 65% higher than any other lubricant. These loads were 140% higher than the dry condition. These results are shown in Exhibit 4. This lubricant is currently under investigation at the CTC and TTC. Test plans include the evaluation of this product in a captive revenue service fleet of cars and in the FAST/HAL fleet at the TTC.

Due to the high stresses generated in the cap screws under these higher clamp loads, the current Grade 2 screw is of insufficient strength. Within the current range of recommended torque, the cap screw currently specified for bearing application may permanently stretch. An evaluation of higher strength Grade 5 cap screws is included, therefore, in the ongoing investigation.

### Reference:

1. Fec, Michael C., AAR Report WP-146, "Journal Roller Bearing Defect Populations," January 1991.

Note: Contact M. Fec (312) 808-5416 with questions or comments about this document.

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### DRY vs LUBRICATION

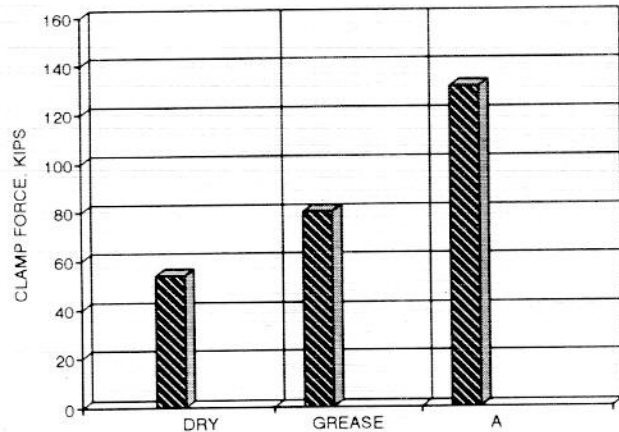


Exhibit 4. Effects of Coating "A"