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Roller Bearing Inspections Based on Acoustic Detector Removals

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Summary

In 2002, 186 roller bearing inspections were undertaken in cooperation with railroads and roller bearing manufacturers under the auspices of the Association of American Railroads' (AAR) Technology Implementation Strategic Research Initiative Program. The roller bearings were identified by *TADS™, Transportation Technology Center, Inc.'s (TTCI) acoustic bearing detector, then inspected with about 97 percent success, as determined by the presence of an AAR shop condemnable defect in the bearing. The type of defects found included cup spalls, cone spalls, roller spalls, water etched components, brinells, loose cones, and cracked components. The purpose of these inspections was to identify the capability of this new detector system as related to a future proposal for an AAR minimum standard for acoustic bearing removals from service.

After detection, the appropriate wheelset was removed from the identified car, and the roller bearing was subsequently removed from the axle for visual inspection. Each bearing was dismantled, washed, inspected, and photographed. An inspection form was prepared for each bearing.

The visual inspections revealed the presence of a shop condemnable defect (per AAR *Manual of Standards and Recommendation Practices,* Section H-II) in at least one bearing component (e.g., cup, cone, roller) of 180 of the 186 bearings. In some cases, the mate bearing (same wheelset, opposite side) was also defective. The defects varied widely in size. The most common defect type was spalled cups, varying from a single spall to multiple barline spalls to a large section of the raceway spalled. A significant minority of the bearings exhibited defects that would indicate a bearing in greater distress (i.e., closer to overheating and service failure). The majority of the defects would not be considered in immediate distress, but condemnable upon reconditioning. TADS is designed to identify defects before they generate heat and cause train-stop or burn-off. TADS currently is functioning as a pro-active tool for planned removal of defective bearings. Any industry-wide minimum defect removal criteria will have to consider the ability to isolate the more distressed bearings.

Bearing inspections were hosted by the Burlington Northern Santa Fe Railway (BNSF) at its facility in Lincoln, Nebraska, by Timken Roller Bearing Services in Mascot, Tennessee, and by Brenco Quality Bearing Services in Petersburg, Virginia. Railroads that participated in the removal and inspection process included BNSF, CSXT, and Norfolk Southern. Additional support came from Progress Rail, who removed many of the bearings from the affected wheelsets before inspection.

* *TADS™ is a trademark of the Transportation Technology Center, Inc., a subsidiary of the Association of American Railroads (AAR).*

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TTCI Transportation Technology Center, Inc.

INTRODUCTION AND CONCLUSIONS

An objective of the New Technology Implementation Strategic Research Initiative is to support the industry-wide implementation of new wayside detector technologies, such as truck performance detectors, wheel profile monitoring, and acoustic bearing detection. This research program also supports new car component implementations like electronically controlled pneumatic brakes and advanced design trucks. The support for the acoustic bearing detection work in 2002 consisted of support for bearing inspections. The data is being used to support a minimum AAR interchange standard for bearing removals based on this technology.

The 186 roller bearing inspections that took place in North America during 2002 suggest that the development of this technology is maturing and has a strong potential for reducing service failures through earlier detection of internal bearing defects. Before 2002, only one acoustic bearing detector was operating in North America. Three additional systems were installed in the fourth quarter of 2002, with a fourth site installed in early 2003. Two more sites are planned for the second quarter of 2003. Therefore, the experience with these detectors is growing rapidly, with significantly more inspections expected in 2003. A proposal for a minimum interchange standard is expected to be ready by late 2003 or early 2004. A railroad Technical Advisory Group has been established to oversee this effort.

METHODOLOGY

TTCI's acoustic detector is still a production prototype device. This means that additional development work is ongoing, specifically in the area of defect sizing. The equipment already has the capability to detect the presence of a cup, cone, or roller defect, and identify the affected component. However, in order to support a minimum defect removal standard, additional development is needed for a means to determine defect size. TTCI is funding and performing this development work.

During 2002, the majority of the bearings identified for inspection was found by the TADS site in Middlesex, New Jersey, with the remainder from one of the new sites installed in the fourth quarter. The purpose of the inspections at that time was to see if the system could identify internal bearing defects consistently and reliably. There was no intent or capability to identify other than defect presence. Subsequently, the technology has matured beyond that intent, and currently the newer TADS sites are identifying bearings according to defect presence and component location. An attempt to determine information related to defect size is underway. Capability to size the defect by type is a critical element in the proposal of an industry-wide removal criterion. The ultimate purpose of the detector is to remove defects that pose a risk if left in service, not just to find shop condemnable defects that do not necessarily pose a serious service risk.

RESULTS

Table 1 lists the defective bearing types found during the 2002 inspections. As shown, the defect types have been broken down into several categories.

Table 1. 180 Defective Bearings Categorized

Defect Type	Qty.	Comments
Smaller cup spalls	112	Condemnable spall up to three barline spalls
Larger cup spalls	25	Four barline spalls or large area spalled
Cone spalls	53	Condemnable spall to multiple barlines
Roller defects	32	Spalled, seamed, missing
Brinells	16	Cup almost exclusively
Water etched components	18	Cups, cones, or rollers
Loose cones	2	Sign of turning on journal
Miscellaneous	4	Cracked cup or cone
Cone Face Wear, bore	10	Minimum of .008 inch wear or oversized cone bore
Heat	5	Signs of heat on cone or rollers

Table 1 shows that a significant number of AAR condemnable defects were found in the 180 bearings. There are duplicate entries in the table based on multiple defects in some bearings. The categories have been broken down along bearing component lines for the most part, and the comments field provides some additional information on the defect category. Since there are so many cup spalls, they have been broken into two groups, by size as shown. It is realized that the industry may not want to remove smaller cup race spalls in the absence of other defects. The further development of TADS is aimed at differentiating between spall sizes for cups and cones, though it is generally thought that cone spalls pose a greater risk than cup spalls.

Some defect categories in Table 1 are not acoustically detectable, such as loose cones, cracks, wear (cone bore or back face wear). These defects were found due to other detectable defects in these bearings. A study made some years ago by the AAR found that 90 percent of spun or loose cones had other defects that were acoustically detectable (spalling, water etching, and

brinelling).[1] To date, the TADS detector at Middlesex, New Jersey, has found six loose cones in this manner.

Of the 180 bearings with defects, 69 or 38 percent had multiple condemnable defects (defects in more than one component). This tends to indicate that many of the bearings were in some distress, although none is known to have alarmed at a hot bearing detector (HBD). The inspection reports also found that many of the bearings detected at the Middlesex site were older bearings, some of which were original applications over 15 years old. For some years, the industry has discussed whether a bearing age limit is useful in purging poor performing bearings (e.g., bearing components over 30 years old). The data has not generally supported this idea. However, TADS would seem to provide a means of removing older bearings with significant defects before they trigger a HBD alarm.

Figures 1 through 6 show typical defects found during the inspections.

Figure 1. Multiple Cup Spalls

Figure 2. Large Cup Spalling

Figure 3. Cone Barline Spalls

Figure 4. Cone Spalls

Figure 5. Multiple Roller Spalls

Figure 6. Spalled Roller

FUTURE WORK

The bearing inspections to support a minimum interchange removal criteria based on acoustic detections will continue. The future inspections will be geared more to finding bearings with larger defects; i.e, those that pose a greater risk in service. This must be done reliably to support minimum removal criteria that the industry can support. This effort will require an iterative process involving TTCI, TADS site owners, and private car owners. The process will consist of the use of new detection algorithms to select additional bearings and verification of performance through inspections.

CONCLUSIONS

- Ninety-seven percent of the detected bearings were defective.
- TADS found a broad range of the common defect types.
- TADS provide a means of identifying defective bearings in service based on performance measures other than heat.
- Many of the bearings had shop condemnable defects (under AAR MSRP H-II), not necessarily representing significant service distress or risk.
- About 38 percent of the bearings did have multiple defects (involving multiple components) indicative of some distress.
- The acoustic technology is maturing, and offers the industry a potential for reducing bearing service failures and hot bearing train stops.
- The railroad industry will ultimately have to address the need for a minimum defect criteria for bearing service removals under AAR *Field Manual* Rule 36, other than hand roll or requiring confirmation of internal defect (WMC 04) by inspection.
- Further improvements of TADS must be driven by the industry's need to address minimum removal criteria.

Acknowledgements

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References

1. Fec, Michael, "Journal Roller Bearing Defect Populations," Association of American Railroads, Report No. WP-146, January 1991.