GROUP	E
EXHIBIT	
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NATIONAL TRANSPORTATION SAFETY BOARD
Investigative Hearing
Norfolk Southern Railway general merchandise freight train 32N derailment with subsequent hazardous material release and fires, in East Palestine, Ohio, on February 3, 2023

Agency / Organization

Technology Digest

Title

Exhibit 8- TD-02-007 March 2002

TECHOLOGY DIGEST

Timely Technology Transfer — 02-007

Canadian National Railway

Warm Bearing Trend Analysis

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Summary

The Canadian National Railway (CN) has developed a communication network of hot bearing detectors (HBD). In addition to monitoring traditional hot bearings that require a mandatory train stop, the network also tracks warm bearings, which fall below traditional alarm levels. This network includes operating rules and procedures that allow corrective action to be taken on trains experiencing abnormal journal bearing performance.

Preliminary data analyzed from the HBD network suggest that a prediction can be made, within limits, on how bearings may behave in service. Mechanical officers use real time data analysis of bearing temperature along with automatic car identification (AEI) readers to track warm bearings at HBD sites. Transportation Technology Center, Inc. (TTCI) is presently determining the feasibility of tracking warm bearings to make operational predictions. This project is part of the Association of American Railroads' (AAR) Strategic Research Initiative (SRI) Wayside Detection Program.

Bearing failure from overheating is the leading mechanical cause of derailments in North America. Therefore, enhancing safety is the primary objective for researching wayside detector networks. The CN Railway has tracked the predictive characteristics of journal-bearing performance since April of 1997. Since that time, the CN has shown significant improvements in safety and operational efficiencies.

CN Network Operation Today

- Mechanical staff (RTCMech's) manually track suspect bearings using an HBD network based on established alarm criterion and operating policies.
- The HBD network has significantly reduced hot bearing alarms and burned-off journals per 2.5 million axles scanned since its inception in April of 1997.
- Bearing teardowns confirm significant number of suspect bearings (warm) having internal defects.

CN Network Operation in the Future

- Develop a virtual system to track cars between AEI readers to improve accuracy in tracking car histories.
- Automate trending analysis for repeated warm bearings, requiring additional algorithms for improved operating policies.
- Extend automated trending to look at earlier car and bearing history to predict hot bearing alarms and risk of failure.

*Canadian National Railway

Suggested Distribution:

- ❑ Maintenance of Way
- ❑ Mechanical Officers
- ❑ Planning & Analysis
- ❑ Track Maintenance
- ❑ Safety

Work performed by TTCI Transportation Technology Center, Inc.
a subsidiary of the Association of American Railroads

INTRODUCTION AND CONCLUSIONS

Hot bearing detectors (HBD) have played a major role in keeping the number of bearing-related derailments at a relatively constant level over the past several years. Although they have contributed greatly to the prevention of derailments, they have also contributed significantly to train delays. Solutions to these problems require the identification of bearings in their earliest stages of deterioration, well in advance of the bearing running in a dangerous condition forcing a train stop or causing a derailment. Early detection would provide a railroad with the opportunity to repair or replace the defective bearing at optimal locations before problems occur. Improvements in predictive detection systems can reduce bearing failures in service, increase track capacity, and potentially decrease train delays on North American railroads.

Predictive or condition detection systems detect degrading conditions of critical components during system operation and allow operators to plan corrective action before an in-service breakdown. Predictive component failure requires complex information systems as well as accurate measurement technology. Predictive component failure represents a relatively recent technological development in operating strategies. As this work has shown, the nature of the new technological developments and the resulting complexities associated with the decision process make applying the corrective action regimes especially advantageous.

CN bearing data was analyzed using time histories of bearing temperature at sequential HBD sites on cars set out by a warm bearing alarm. Preliminary results show that the other bearings are in control when the suspect bearing is identified as exceeding a warm bearing threshold. The process used to analyze bearing performance was three sigma statistical process control (SPC) charts to determine if each bearing on the suspect truck was in control relative to the suspect bearing. The standard deviation of the normal bearings on the suspect truck showed close dispersion, while the suspect bearings maintained a wide dispersion that consistently exceeded the average control limits set by the normal bearings. This is an important result because it shows that the process is in a reasonable degree of statistical control independent of the suspect bearing. CN has observed warming trends on most suspect bearings. The experience is that most cars identified with a suspect bearing are tracked and show warming trends. Therefore, preliminary results suggest that developing algorithms based on warm bearing trends is feasible at this point.

BEARING TREND ANALYSIS

As Exhibit 1 shows, three of the four bearings on the suspect truck display normal temperature displacement variation. The average is around 6.0 millimeters (mm) and the upper natural process limit is around 8.5 mm. Typically speaking then, normal bearings have an average of approximately 6.0 mm of temperature displacement and rarely have more than 8.5 mm.

The suspect bearing displays a behavior that is different in several ways. It has an average that is significantly higher than normal. Early in its history, the displacement exceeds the average at five consecutive sites. Next, the displacement exceeds the maximum expected level (8.5 mm) five consecutive times. This trend is consistent with other samples analyzed thus far, in terms of normal bearing behavior. One observation from Exhibit 1 is that four successive readings above the average may indicate that the bearing will continue to increase in temperature. The implication of this example trend is that the next site may trigger a mandatory train stop at 15 mm HBD deflection (174°F above ambient). Therefore, by observing patterns of suspect trucks, policies may be developed based on warm bearing trends using SPC charts.

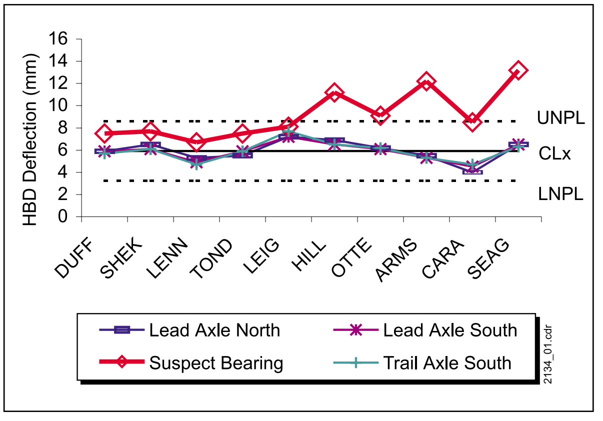

Exhibit 1. Normal Temperature Displacement Variation on 3 of the 4 Bearings on the Suspect Truck

Normalizing bearing temperature by speed may improve our ability to detect suspect bearings. Once again, the three normal bearings display normal displacement variation, as Exhibit 2 shows. The average is around 0.13 (mm/mph) and the upper natural process limit is around 1.9 (mm/mph). If this is typical, then we can say the normal bearings averaged approximately 0.13 (mm/mph) and rarely have more than 1.9 (mm/mph).