TECHNOLOGY DIGEST

TD-18-035

©NOVEMBER 2018

TIMELY TECHNOLOGY TRANSFER

The work described in this document was performed by Transportation Technology Center, Inc., a wholly owned subsidiary of the Association of American Railroads.

Hot Bearing Detector Tests to Evaluate Temperature Variations of 7 1/4-inch and 9-inch Configurations

Steven Belport, Dustin Clasby, and Tony Sultana

Summary

Transportation Technology Center, Inc., (TTCI) measured bearing temperatures using hot bearing detectors (HBD) at 7 1/4-inch and 9-inch configurations to determine which of the two distances from rail for a typical HBD produced the most accurate bearing temperature readings. Testing indicated that geometric obstruction is a problem for HBD sensors placed at a 9-inch configuration.

Testing was conducted on the High Tonnage Loop (HTL) at the Facility for Accelerated Service Testing (FAST), Pueblo, CO, using nine cars equipped with F, G, K, and E class bearings. Traditional HBD scan a single small area of the bearing by viewing 45 degrees upward from horizontal as the bearing moves past at 7 1/4 inches from the rail gage point. With normal lateral movement of the wheelset, this scan may miss the bearing cup and read the bearing seal, possibly resulting in a false high temperature reading.

Railroads participating in this research elected to test the same detector technology adjusted to the 9-inch configuration, with the same 45-degree viewing.

A train made 50 laps around the loop with the temperature of each bearing recorded once per lap by the traditional HBD system and co-located reference temperature system. The first 27 laps were completed with the HBD at 9-inch configuration (lateral distance from gage face). The last 23 laps were completed with the HBD at 7 1/4-inch configuration. Each configuration was tested until the temps stabilized so an equal number of laps would not have changed the results.

The HBD sensor placed at the 7 1/4-inch configuration obtains more stable readings with much less variance than the 9-inch configuration. This study shows that temperature blockage is a significant problem for HBD sensors placed at a 9-inch configuration. The readings from that position are sporadic and often are reported much lower than the actual (reference) temperature of the bearing, an indication that at the 9-inch position, the sensor has trouble distinguishing the bearing from its surroundings (ambient).

Please contact **Steven Belport (719) 584-0668** with questions or concerns regarding this *Technology Digest.* E-mail: Steven_Belport@aar.com.

INTRODUCTION

Railway companies use wayside HBD to monitor the temperature of bearings on rolling stock. Current HBD technology was tested with different scan distances toward the center of the bearing. Traditional HBDs scan a single small area of the bearing by viewing 45 degrees upward from horizontal as the bearing moves past, at 7 1/4 inches from the rail gage point. With normal lateral movement of the wheelset, this scan may miss the bearing cup and read the bearing seal, possibly resulting in a false high temperature reading.

Railroads participating in this research elected to test the same detector technology adjusted to the 9-inch configuration, with the same 45-degree viewing angle as the 7 1/4-inch configuration. In previous testing at FAST, the 9-inch configuration showed some improvement over the standard 7 1/4-inch configuration. However, at the 9-inch configuration, computer-aided drafting (CAD) modeling has indicated that there may be blockage with some equipment types.

The objective of this test was to determine which of the two configurations for a typical HBD (7 1/4 inches or 9 inches) produced the most accurate temperature readings. To capture the full range of measurements, known defective bearings were used to generate high bearing temperatures. The difference between the traditional HBD and a reference temperature was calculated to find the configuration with the smallest overall difference and variation.

TEST METHOD

Two HBD systems (one traditional and the other as the reference temperature) were installed wayside in Section 6 of the HTL loop at TTC. The systems were located a few ties away from each other to limit differences in the bearing conditions during measurements. Figure 1 shows the placement of the sensors on the track. The view in Figure 1 is facing south.

The test train consisted of five cars. The first car after the locomotive, CTRN 601520, was empty and equipped with F-class bearings. The second car, UP 33160, was loaded and equipped with G-class bearings. This car also has frame brace mounts located on the bottom of the truck. The next two cars were empty: a CSXT 376881 and a CSXT 400865 Both had K-class bearings, and the trucks were equipped with frame keys that secure the bearing to the side frame. The last car, TTAX 76878, was an empty spine car equipped with 12 axles in 6 trucks and E-class bearings. All three were unloaded.

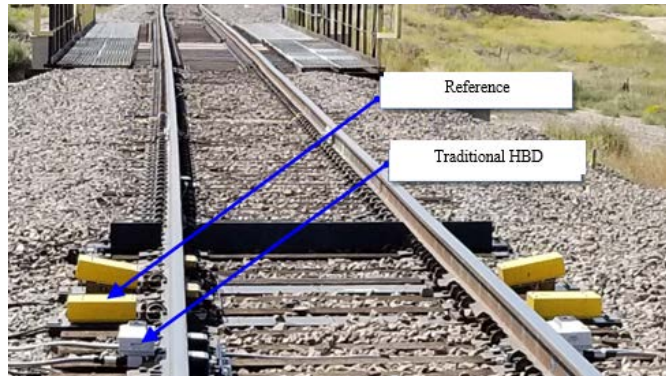

Figure 1. Image of sensor placement

One warm-up lap for each run was used to reach the HTL track operating speed of 42 mph. The train traveled clockwise around the loop, which means that it crossed the sensors traveling south. The HBD was installed at the 9-inch configuration for the first 27 laps. The HBD was then set to the 7 1/4-inch configuration and the runs repeated.

TEST RESULTS

The temperatures, recorded as above ambient, are presented for axle 14 (UP 33160) of the train in Figure 2 and Figure 3. The top chart shows the readings of the west rail, and the bottom chart shows the readings of the east rail. The HBD at the 9-inch configuration temperature readings are shown in red, and the 7 1/4-inch configuration readings are shown in green. The measurements are compared to the multi-beam scanner, which is considered the true temperature of the bearing for each lap. These reference temperatures are shown in blue.

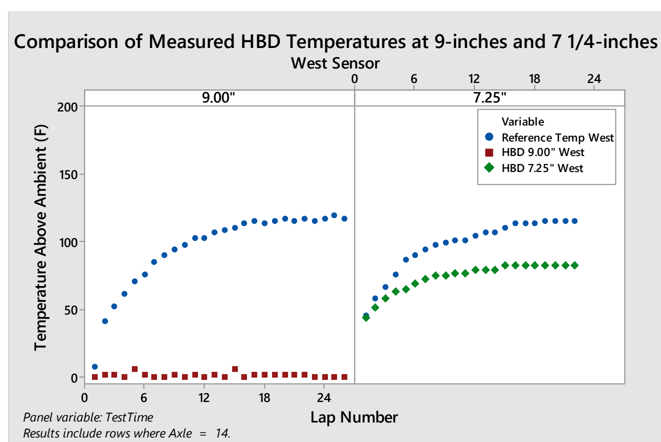

Figure 2. Axle 14 bearing temperatures for each lap — west

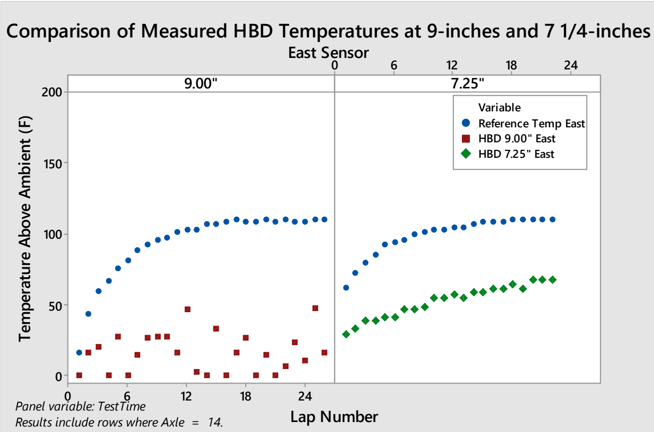

Figure 3. Axle 14 bearing temperatures for each lap — east

Figures 2 and 3 show that the 7 1/4-inch configuration gives temperature readings lower than the reference temperature, but matching the trend of rising temperature. This lower offset may be explained by the different methods of the systems to obtain the ambient temperature. The 9-inch configuration does not obtain temperature readings close to the reference temperatures. It gives many readings of zero, an indication that at the 9-inch configuration, the sensor has trouble distinguishing the bearing from its surroundings (ambient). This may be related to blockage.

The results for axle 14 are representative of the results for the full train. Figures 4 and 5 show the temperature readings for the entire train on lap 10 of each run. The chart on top provides temperatures from the HBD at the 7 1/4-inch configuration, and the bottom chart provides the readings from the HBD at the 9-inch configuration. In these charts, Channel 1 is the west rail sensor and Channel 2 is the east rail sensor. The sensor at 7 1/4-inch configuration gives varied temperatures of bearings in normal operation. The sensor at the 9-inch configuration gives low temperature readings close to ambient.

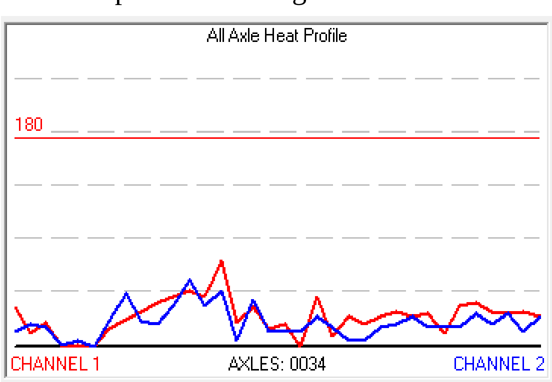

Figure 4. Temperatures of all bearings on train for one sensor pass — 7 1/4-inch distance

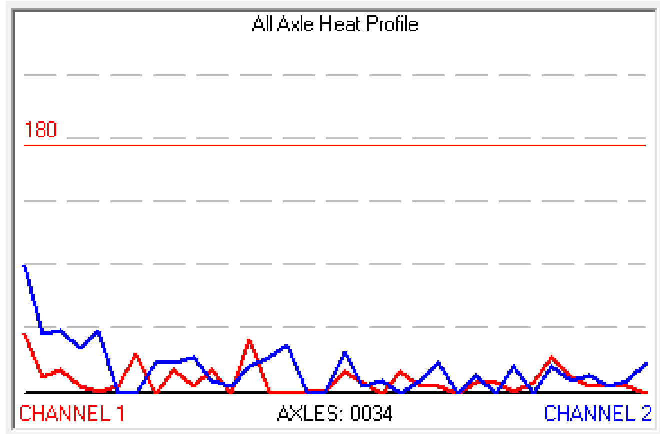

Figure 5. Temperatures of all bearings on train for one sensor pass — 9-inch distance

Figure 6 shows a histogram of the differences between the reference temperatures and the HBD reported temperatures for all axles of the train during all laps. The HBD readings at 7 1/4-inch configuration exhibit less variation than the 9-inch configuration.

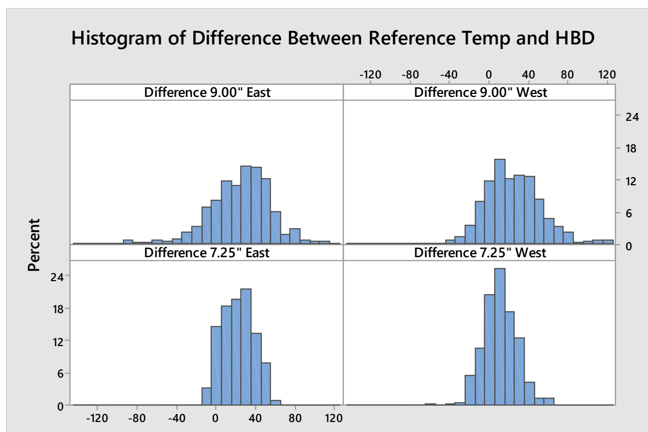

Figure 6. Histogram of differences between reference temperature and HBD temperature for all laps

Processed bearing profile data was obtained from the traditional HBD. The data shows many readings across the bearing for each individual bearing pass over the sensor. Figure 7 shows a sample of the bearing readings as one bearing passed over detectors. The left chart shows the bearings on axle 14 during a single pass as they crossed the east and west sensors, top and bottom respectively, in the 7 1/4-inch configuration. The right chart shows the same bearings on a single pass over the 9-inch configuration.

The chart illustrates that the 7 1/4-inch configuration captures a smooth reading of the bearing as it passes over the sensor, which then allows the recording of an accurate temperature. The 9-inch configuration captures the temperature of the bearing for a shorter period of time and more sporadically than the 7 1/4-inch configuration.

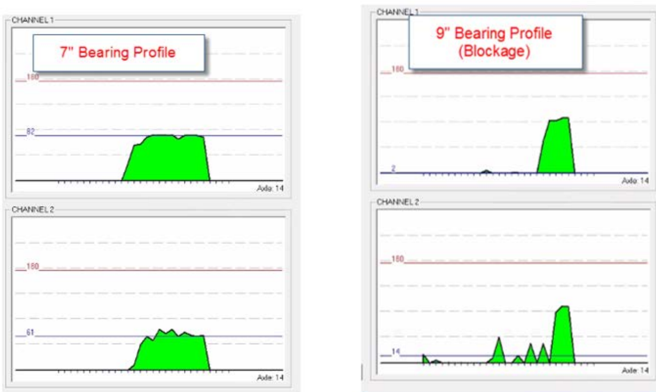

Figure 7. Bearing profile temperature readings

The temperature recorded for this position is therefore much lower than the actual bearing temperature. If too little of the bearing is observed, the recorded temperature does not change from ambient. This chart shows a clear sign of blockage that prevents the 9-inch configuration from reading the correct temperature of the bearing. Axle 14 was equipped with frame bracing mounts, which obscured the view of the sensors, resulting in low temperatures reported. Figure 8 shows a three-dimensional model of the frame brace mount and how its position on the truck can block the sensor's view of the bearing.

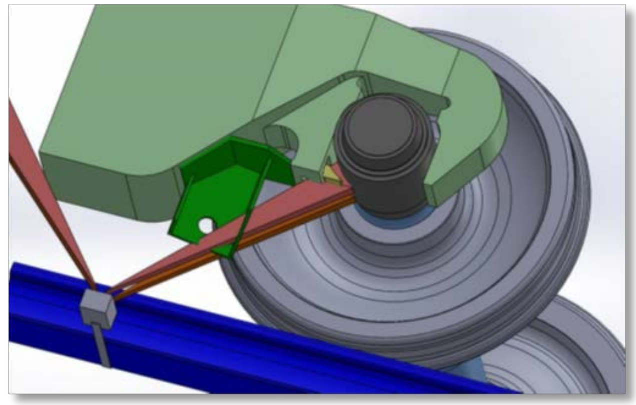

Figure 8. 3D model depicting sensor blockage from frame brace mounts

CONCLUSION

Geometric obstruction is a problem for HBD sensors placed at a 9-inch configuration. The temperature readings from that position are spurious, and are often reported much lower than the actual temperature of the bearing. The sensor at a 9-inch configuration is unable to get a good reading of the bearing, if it can view the bearing surface at all.

The HBD sensor placed at a 7 1/4-inch configuration obtains stable readings of the bearing, with much less variance than the sensor placed at the 9-inch configuration.

ACKNOWLEDGEMENT

TTCI thanks the suppliers for their support of this research.

References

1. Carter, Daniel and Dustin Clasby. "An Analysis of Obstruction of the Scan Area of Hot Bearing Detectors with 3-D Modeling." *Technology Digest* TD-17-007, April 2017, TTCI/AAR, Pueblo, CO.