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Brake System Evaluation Using Wheel Temperature Detector Data

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Summary

As part of the Association of American Railroads' Strategic Research Initiatives Program, Transportation Technology Center, Inc. conducted a study where repairs were completed on cars previously diagnosed as cold wheel cars. These cars were subsequently monitored for several months after the repair using wheel temperature detectors (WTD). This approach has effectively identified cars with specific problems related to leaks at pipe flanges, leaks in the brake cylinder, and diagnosing specific rigging problems. It has not been evaluated for diagnosing poor valve performance.

Using specific parts of the single car air brake test (SCABT) and additional testing methods, researchers confirmed defects that could be linked to cold wheel indications. The majority of discovered defects were air leaks around pipes or pipe fittings. Other key components addressed with this test were related to the brake cylinder.

Of the 37 cars inspected using WTDs to detect cold wheel indications, 13 cars were repaired based on the inspection done by the researchers. The other 24 cars did not qualify for repairs based on the researchers inspection, but were inspected and repaired if necessary by certified carmen. These repairs focused on components that did not require a full SCABT after the repair was complete. Of the 13 cars repaired, 10 flange or pipe leaks were repaired, 8 cylinders were repaired (including packing cups), and 1 slack adjuster was replaced. Some cars had multiple repairs. The test and a subsequent repair resulted in 7 of 13 cars showing consistently effective braking behavior. Two of the remaining 6 cars showing cold wheels had less than 3 cold wheel indications after 50 or more passes of the WTD.

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INTRODUCTION

As part of the Association of American Railroads' (AAR) Strategic Research Initiatives Program, Transportation Technology Center, Inc. (TTCI) conducted a study where repairs were completed on 37 coal gondola cars previously diagnosed as cold wheel cars. These cars were subsequently monitored for several months using wheel temperature detectors (WTD) to establish whether the repairs were effective or not. This procedure has shown to be effective for finding cars with specific problems related to leaks at pipe flanges, leaks in the brake cylinder, and diagnosing specific rigging problems. It has not been evaluated for diagnosing poor valve performance.

Background

Wayside detectors are being deployed in North America. The use of these detectors has provided the railroads the ability to evaluate cars while in motion. One such detector is the WTD. Figure 1 shows a ballast mounted version of WTD. WTDs collect the temperature of each wheel as it passes the detector. Wheel temperature has a direct relationship to the brake effectiveness, because heat is generated between the brake shoe and the wheel tread during a brake application.

Photograph Courtesy of Progress Rail

Figure 1. WTD on Wayside

WTDs can be used to find a brake that is either applied or released when it should not be. Cold wheel readings are readings where the wheel is expected to be warmer because of a brake application. By placing the WTD in a location where the standard operating procedure is for the brakes to be in an applied position, underperforming brake systems can be identified. Since each wheel is measured independently, possible issues can be identified for each wheel, each truck, or each car.

Cold wheel algorithms rely on statistical analysis to identify outliers. When an outlier is identified, that reading is recorded in a database. Because a single reading for a wheel can be influenced by load condition, operating differences, position in the train, and other factors, trending of multiple wheel passes tends to be a more effective way of identifying cars that require a brake system inspection.

After a car is identified as needing repairs, the car is typically diagnosed using a single car air brake test (SCABT). However, it is possible to diagnose and properly repair certain components without the SCABT. Using the information from WTD and alternative testing methods, it is possible to increase the efficiency while not affecting the effectiveness of the repair. This research was conducted to define and evaluate how to best combine the information from WTD and alternative brake system test methods.

Car Selection

Researchers targeted cars for inspection with specific criteria. Inspections were conducted over three different trips and the car selection method evolved based on the objective of that trip. A car was determined to have a cold wheel if it was flagged by the Union Pacific Railroad (UP) algorithm for identifying cold wheels. In order to increase the likelihood of the car not being altered during the monitoring period, all cars selected had a SCABT within 12 months of being selected. Due to the nature of the traffic at the WTD site, all cars selected were coal gondolas.

The initial inspection trip was conducted in March 2014, and it was designed to better understand some of the symptoms of cold wheel cars. During this trip, cars were selected with recent cold wheel indications based on readings from the Sheep Creek WTD.

During the second trip, conducted later that summer, researchers again focused on cars with sustained cold wheel indications, but also added some cars with recent hits but no sustained cold wheel behavior.

During the final trip, conducted the following winter, researchers looked for cars with sustained cold wheel indications. The final trip was conducted specifically when colder temperatures were expected to compare the effectiveness of the procedure.

A total of 37 cars were evaluated by researchers. During the first trip, 19 cars were stopped. The next two trips stopped 12 and 6 cars, respectively.

Car Inspection

Each car was inspected using a process outlined by researchers prior to the trip. The inspection was designed to expose areas of the brake system that may not be behaving as expected, which could be identified while the car was still in a train and could be related to a cold wheel indication.

Though targeted at in-train inspection and repair, for this test all of the inspections occurred on the repair in place track, and any repairs were done by qualified carmen to ensure safe work and to minimize disruptions to terminal operations. If the repair required a SCABT (for example, due to a leaking control valve that required replacement), the test was performed and appropriate repairs made. However, if the car was so repaired during the test, it was excluded from the study.

Many of the tools used during the inspection are already part of an airman's standard equipment. The equipment included a pressure gage, a spray bottle filled with approved fluid for identifying leaks, a SCABT device to control the air in the car, a pry bar that could be used to check brake shoe application, and tools used to make appropriate repairs.

Because each inspection was conducted on the repair in place track, charging each car for the test took the majority of the time. After the charge was complete, the test could be conducted in approximately 20 minutes. Some defects could be detected without conducting any brake applications, such as a leak between the valve and auxiliary reservoir or emergency reservoir. Figure 2 shows one such leak at the auxiliary reservoir flange.

Figure 2. Auxiliary Flange Leak Indicated by Leak Detection Fluid

Final Testing Procedure

The testing procedure could be conducted with the car in the empty or loaded condition. If the car was empty, an additional full service brake application was conducted with the empty load device set to the loaded position. If the car was believed to indicate cold wheels in a particular load condition, it was tested in that condition. The test could be conducted with a stationary source of air or in a train using the locomotive as a source of air.

After the car had been secured, it was charged to 90 psi. If a stationary air source was used, the car was connected through a SCABT device to control the airflow. If this test was conducted while the car was in a train, the car simply needed to be charged to operating pressure. While the car was charging, the carman attached a pressure gage to the brake cylinder pressure tap. The carman also sprayed all flanges with leak detector and inspected the car for existing leaks.

A minimum service reduction was then applied to the car. Generally this was about 7 psi. At this stage, all flanges were sprayed with leak detector again and inspected for bubbles. The carman also sprayed the openings around the brake cylinder and checked for air escaping the cylinder. All locations indicating leaks were noted. The carman verified that the brake cylinder pressure was above 12 psi. A brake application of 20 psi was set. The process of inspecting flanges and the brake cylinder was repeated. The brake cylinder pressure needed to be above 40 psi with this application.

Repairs and Monitoring

As stated previously, 37 cars were inspected. Of those 37 cars, 13 cars were repaired based on the inspection done by the researchers. The other 24 cars did not qualify for repairs based on the researchers inspection, but were inspected and repaired if necessary by certified carmen. These repairs focused on components that did not require a full SCABT after the repairs were complete. Some of these components included: flange connections, flange gaskets, packing cups in the brake cylinder, and a slack adjuster.

When possible, researchers observed the repair and the cars subsequent verification test for that repair. Additional repairs were monitored through car repair tracking databases.

These cars were not restricted to a specific route. Because the route of each car varied, all WTDs across the UP system were used to monitor the cars. If the car received a SCABT during the monitoring period, the readings up to that SCABT are reported.

Results

Of the 13 cars repaired, 10 flange or pipe leaks were repaired, 8 cylinders were repaired (including packing cups), and 1 slack adjuster was replaced. Some cars had multiple repairs. This information is summarized in Table 1 and includes all relevant brake system repairs either observed by the researchers or reported by the railroad from the time the cars were showing repeated cold wheel behavior through the end of the "Post Repair Behavior" period.

Table 1. Summary of Brake System Repairs

	Repairs		
Car	Brake Cylinder	Slack Adjuster	Pipe or Flange Leak
A			1
B			1
C			1
D			1
E	1		
F			1
G	1		
H	2		1
I	1		1
J		1	
K	1		2
L			1
M	2		

Though many of the leaks did not produce a significant bubble, large bubbles could be produced after more than 5 seconds. One such leak is shown in Figure 3. Upon further inspection, this leak was caused by a pinched flange gasket. Figure 4 shows the damaged gasket on the left and a new gasket on the right.

Figure 3. Larger Leak between Flange and Pipe Bracket Highlighted by a Yellow Circle

Figure 4. Damaged Gasket and New Gasket

Of the nine cars with flange or pipe leak repairs, three cars had multiple repairs identified by the researchers. For the six cars repaired with leaks, four did not have another cold wheel indication.

Damaged packing cups were also a common find during this research. Packing cups are a rubber diaphragm located at the back of the brake cylinder piston which seals the cylinder so pressure can build behind it. The primary defect found for the packing cup were rips and tears in the exterior rim or near the center. Many of these cups were original to the cylinder and likely have not been serviced for some time.

These packing cups may not have been serviced, because it may require additional testing methods to find them. To find a torn packing cup required a minimum brake application because higher pressure applications seal the cup. The current Class 1 and Class 1A tests call for a 20 psi brake pipe pressure reduction, which is significantly deeper than a minimum service application. It should be noted that the torn packing cups found during this research would not likely affect a high pressure application, because the cups did seal at higher pressure brake cylinder applications.

Figure 5. Torn Packing Cup

Of the four cars identified with torn packing cups, three had additional repairs. Two of the four cars with packing cup repairs did not have another cold wheel indication. One car had one intermittent indication. The fourth car had multiple failures.

Two cars were diagnosed with poor truck mounted cylinder behavior. Both cylinders were replaced on these cars. The car with only cylinder repairs showed no additional indications. The car with a flange leak and bad cylinders showed multiple additional indications. One malfunctioning slack adjuster was also identified. After the slack adjuster was repaired, the car showed 1 cold wheel indication in 50 readings.

CONCLUSION

Test results have shown WTDs to be effective for finding cars with specific problems related to leakage at pipe flanges and in brake cylinders. Researchers evaluated 37 coal gondola cars on three separate trips using the WTDs installed in the same UP track to detect cold wheel behavior.

The test and a subsequent repair resulted in 7 of 13 cars showing consistently effective brake behavior. Two of the remaining 6 cars showing cold wheels had less than 3 cold wheel indications after 50 or more passes of the WTD. If the methods outlined above were used in-train, the 9 cars (24 percent of the cars inspected) would be repaired before causing future delays and possible set outs.

Test results have shown WTDs to be effective for finding cars with specific problems related to leakage at pipe flanges and in the brake cylinder. It has not been evaluated for diagnosing poor valve performance.