TECHNOLOGY DIGEST

Timely Technology Transfer — 98-027

Preliminary Performance Evaluation of a Wayside Truck-Defect Detector

by Robert Swearingen, John Mazza, and Gerald Anderson

Summary

Preliminary testing by Transportation Technology Center, Inc. (TTCI), has demonstrated that a truck-performance or defect detector has the potential to be an effective tool for identifying poor performance in three-piece freight-car trucks. The measures of performance include vertical and lateral wheel forces, lateral-to-vertical force ratios, wheel-set angle of attack, and lateral position of the wheel set. A wayside system to detect truck defects was installed in a 5-degree curve on the Norfolk Southern (NS) Railroad in December of 1995. The system has been continuously collecting and storing data, with integration of car identification since May 1996.

In order to begin the process of detector evaluation, a series of cars was selected for mechanical inspection, based on measurement data provided by the wayside detector and minimum AAR Standards for vehicle certification (i.e. Chapter XI). Eight poorly performing cars and three properly performing cars were chosen. Mechanical inspection of the trucks and wheel sets revealed that some wheels had "hollow-tread" profiles (generally producing poor performance), some wheel profiles were mismatched from side to side on an axle, the center bowls were generally dry, and the trucks were in relatively good condition (1992 manufacture). These inspections, though informative, failed to fully demonstrate why these trucks were performing poorly. Clearly, more work is required to properly relate vehicle performance, as measured by these wayside systems, to the physical condition of the vehicle/truck.

Wheel-rail lateral force data has also been used by the NS to study track lubrication at the detector site. In addition, the ability to store vehicle/truck data over extended periods will allow a car owner to quantify equipment performance or to schedule maintenance. The data collected from the NS truck-performance detector and other similar detectors will be the source of ongoing industry study for some time to come. This data will be used to determine:

- Physical causes of poor performance
- Appropriate repairs to restore truck condition
- An optimized detector system and site
- Acceptable truck-removal and repair criteria based on detector output

Suggested Distribution:

- ☐ R&D/Test Department
- ☐ Equipment/Rolling Stock
- ☐ Track Maintenance
- ☐ Safety

Work performed by TTCI Transportation Technology Center, Inc.
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INTRODUCTION

A wayside truck-performance and defect-detection system has been demonstrated in a preliminary revenue-service evaluation as a potentially effective tool for identifying and locating poorly performing railroad vehicles. The development of the wayside truck detector was a strategic research initiative of the Association of American Railroads (AAR), and the work was performed at the Federal Railroad Administration's Transportation Technology Center near Pueblo, Colorado. This project was based on the need to identify "bad-actor" cars both as a safety concern and to improve operating efficiency.

A major objective of the wayside truck-defect detection program is to ultimately provide sufficient data to support the establishment of a safety and economic "performance-based" removal criteria for identifying poorly performing vehicles.

Transportation Technology Center, Inc., (TTCI) installed the wayside detection system at Eggleston, Virginia, with the cooperation and support of the Norfolk Southern Railroad in December 1995. The system was installed in both tangent and 6-degree curved track. Exhibit 1 shows typical track-sensor outputs to measure vertical and lateral forces, wheel-contact position, and angle of attack of wheel sets.

The track-sensor data is collected and processed at the measurement location. A data-communication link via phone line was established with TTCI. Data is stored at TTCI and input into a database for analysis. An Automatic Equipment Identification (AEI) system was installed in May 1996. TTCI integrated the AEI information with the track-sensor data to provide car identification.

To automate data presentation and selection of "bad-actor" vehicles, a daily report was prepared. This report contained a histogram of each measurement for the previous day's traffic. Also reported are the identification of cars that exceeded specific performance criteria and the number of prior times of exceeding the criteria.

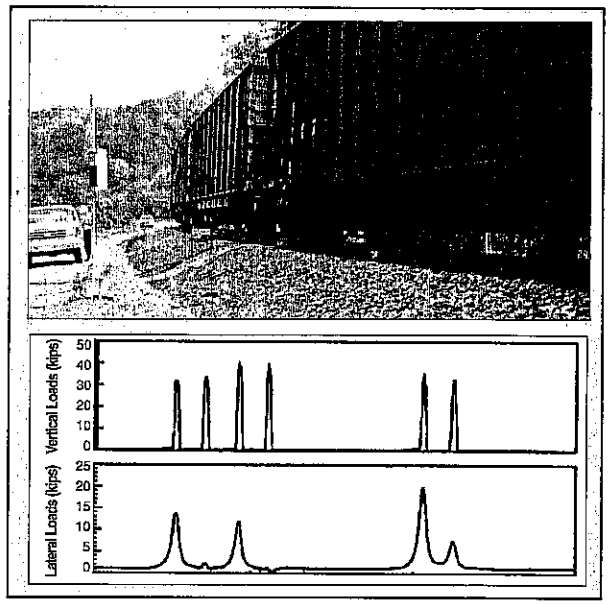

Exhibit 1. Loaded Hopper Cars Passing Curve-Zone Detection Site and Actual Representative Wave Shapes of Force Data

In order to begin a demonstration of the ability of the wayside defect detector to identify "bad-actor" vehicles, an inspection of selected vehicles was performed. Car groupings were selected via input from Norfolk Southern, the truck manufacturer, and TTCI. From the car groupings a series of poorly performing cars was selected based on a truck side lateral-to-vertical wheel-to-rail force ratio of 0.6 or greater and multiple occurrences. If a car had that distinguishing characteristic, the process went to looking at the individual wheel lateral forces, angle of attack, warp angles, and wheel position. In all, the following criteria were used based on multiple exceedances of one or more elements:

- Truck side L/V Ratio — >0.6
- Lateral wheel forces — > 25 Kips
- Wheel L/V ratio — < -1 or > +1
- Angle of attack — < -12 milliradians or > +12 milliradians (6-degree curve data)
- Truck warp — < -6 milliradians or > +6 milliradians
- Wheel position — contact to field or gage side

- Trail axle lateral force: > 50 percent of lead-axle lateral force

Vehicle/truck inspections were conducted at the Norfolk Southern shops in Williamson, W.Va., and Roanoke, Va., as shown in Exhibit 2. The inspections were performed by investigators from TTCI, Norfolk Southern, and truck and side-bearing manufacturers. The inspections consisted of car and truck visual inspections, mechanical wear measurements on trucks, visual inspections and mechanical measurements of car-body and truck-center plates and wheels, and side-bearing heights and contact measurements.

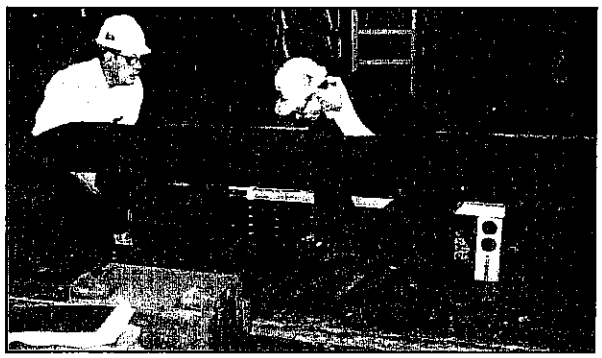

Exhibit 2. Truck Dismantled for Inspection

INSPECTION REPORT

Car NS 10508 was chosen for inspection by exhibiting high lateral forces in the tangent and curve, primarily on the trailing truck. Angle-of-attack and truck-warp measurements on this car agreed with the resultant lateral forces. The data for the A-end truck showed more occurrences of high angles of attack, truck warp, and lateral forces.

The inspection results for this car are rather typical of the "poorly performing" group inspected. The results revealed that center-plate liners were dry, and wear patterns indicated that liners rotated both in bowl and about body center plate. Wheel R2 had an approximate 2 mm (0.08 inch) tread hollow-worn profile and thin flange as shown in Exhibit 3. In addition, physical inspection of bearings by manual cup turning suggested the presence of internal spalls in the L4 bearing.

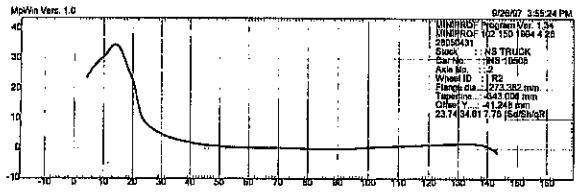

Exhibit 3. Wheel Profile of R2

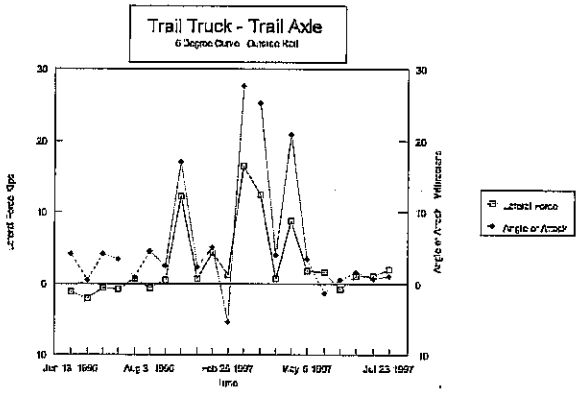

Exhibit 4. Plotted Data for Lateral Forces and Angle of Attack before and after Inspections and Corrective Actions

Corrective action performed included replacing the No. 2 wheel set and L4 bearing, and lubrication of both center bowls. Exhibit 4 shows plotted data from NS 10508 before and after corrective action. The lateral force and angle-of-attack conditions exhibit a less-erratic pattern with values more acceptable for proper curving.

ADDITIONAL WAYSIDE DETECTOR USES

Norfolk Southern has gleaned informative data from the wayside detector for various train operation projects. The capability of the wayside database to identify vehicles and their operating conditions over varying time periods gives the user many choices for action. The following are examples of database use in 1997.

Bad Actor Detector: The detection of poorly performing "bad actors" is shown by Exhibit 5. This graphic shows an abrupt change in trailing-axle lateral forces produced under a 100-ton coal car in a 6-degree curve. The ability of the long-term monitoring of cars can give a previous his-

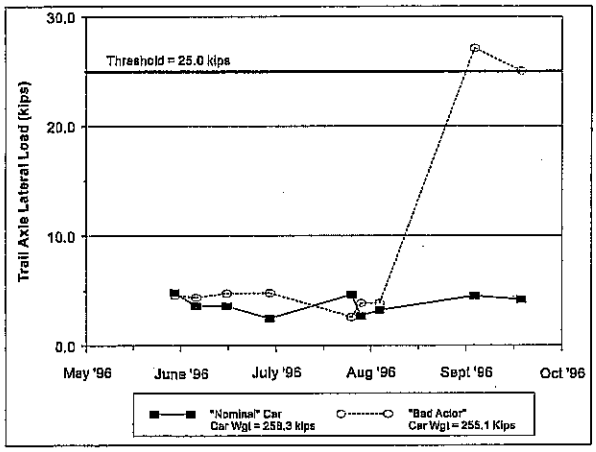

Exhibit 5. Sample of "Bad Actor" Detection via Measurement of Lateral Forces

tory of the car's operating conditions; and, when a change occurs, corrective or preventative action can be taken.

Lubrication Studies: The evaluation of onboard lubricator performance can be enhanced by comparison of lateral forces of trains preceding the train with the onboard test lubricator and the trains following the test train as shown in Exhibit 6.

Vehicle Comparisons: The detector information can be used in making dynamic performance comparisons between vehicles with different components (such as trucks) or by vehicle type. A railroad can use this information to assess the performance of various vehicle or major vehicle components in use in its fleet.

CONCLUSIONS

The wayside truck-defect detection system on the Norfolk Southern has provided valuable information during its preliminary performance evaluation. TTCI, NS and the railway industry will continue to improve the reliability of these systems. In addition, the data collected from this performance detector and other similar detectors will be the source of intense industry study. Data will be used to determine the physical causes of poor performance and appropriate repairs to restore truck condition, as well as to determine an acceptable industry criteria for removal of trucks and vehicles from service.

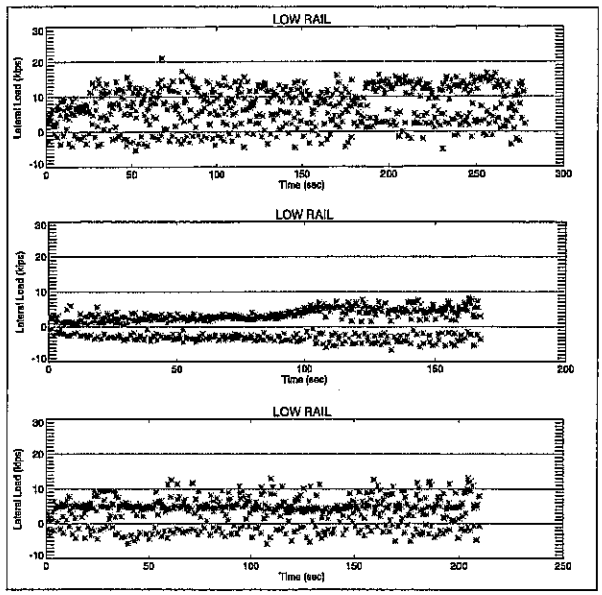

Exhibit 6. Train Lateral Forces before, during, and after Lubricator

ACKNOWLEDGMENTS

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