TECHNOLOGY DIGEST

Timely Technology Transfer — 01-023

# Evaluation of Two Types of Trucks under 315-kip Cars in Revenue Service

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**Summary**

Revenue service performance tests of two types of trucks indicate that the premium suspension, improved steering design had lower wheel wear than the standard three-piece, improved lateral stability design under similar service environments. The test was conducted by Transportation Technology Center, Inc. (TTCI) in conjunction with Union Pacific Railroad using 315-kip gross vehicle weight limit cars. TTCI assessed wheel-wear performance measurements from two car fleets equipped with these trucks over 150,000 to 300,000 miles of operations. Conclusions drawn from the study include:

- The premium suspension trucks are performing better in steering, with average flange wear rate approximately half that of the standard trucks. Tread wear rate for the premium suspension trucks is also about 20 percent less than the rate measured on standard trucks.
- Analysis of the effect of wheel location (i.e., axle number and vehicle side) revealed that both trucks are performing consistently, with few outliers. Outliers would suggest that the improved steering mechanism has failed.
- There are relatively small differences in wear rates between the diagonal pairs of wheels in a truck. Large differences would suggest truck warping or failure to steer properly. However, the standard trucks have a higher percentage of outliers.
- There is little lead-to-trail axle difference in tread or flange wear. This suggests that the cars are frequently turned and do not run with a particular end leading.
- There is little difference in wear between wheels on the right and left sides of either vehicle. Thus, effects of route or truck orientation (or set) are random.
- Car maintenance and component replacement records to date suggest the two trucks require about the same maintenance effort.


The cars in the study are coal gondolas that are currently being loaded to 286 kips. The cars are operated on long haul routes over 1,000 miles, and all loads originate in heavy curvature and heavy grade territory. A comparison of profiles measured in 2000 to the nominal new profile was made on 111 wheels in 315-kip cars equipped with standard trucks and 48 wheels in 315-kip cars equipped with premium suspension trucks. Total wear and long-term wear rate were calculated from the profiles. The 2000 measurements were made after 150,000 to 300,000 miles on the wheels.

**Suggested Distribution:**

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


Work performed by Transportation Technology Center, Inc.

a subsidiary of the Association of American Railroads

## INTRODUCTION AND CONCLUSIONS

A revenue service test of two premium performance trucks in 315-kip gross vehicle weight limit cars was conducted by TTCI in conjunction the Union Pacific Railroad. The two truck types are a standard three-piece truck with improved lateral stability and a premium suspension steering truck. TTCI assessed truck performance by measuring wheel wear of the two car fleets over the initial 150,000 to 300,000 miles of operations.

This revenue service test is a supplement to the Improved Suspension Truck Performance Evaluation done at the Facility for Accelerated Service Testing (FAST) under the Heavy Axle Load (HAL) experiment. This project, jointly sponsored by Association of American Railroads and Federal Railroad Administration, evaluated the performance of three improved suspension truck types and their effects on track degradation. The FAST test was successful in demonstrating the reductions in lateral forces and component degradation that are possible. For example, average lateral loading in curves was reduced by 43 percent. However, the tests were limited to about 100,000 miles of operation (about 30 percent of a typical freight car's wheel life). This revenue service study looks at the long-term performance of the trucks under revenue service conditions.

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The cars in the study are coal gondolas that are currently being loaded to 286 kips. The cars have served a variety of coal shippers in Colorado and Utah; with destinations in the Midwest and West coast. The route history of each car may be unique, but the general characteristics of each route are similar. All are long haul routes of more than 1,000 miles and all loads originate in heavy curvature and grade territory.

Preliminary conclusions from the study include:

- A mileage effect on wheel wear is reflected in older wheels showing lower long-term wear rates. This is attributed to a high initial break-in rate and more mileage under 263-kip loading.
- The premium suspension trucks are performing better in steering, with the average flange wear rate approximately half that of the standard trucks. Tread wear rate for the premium suspension trucks is also about 20 percent less than the rate measured on standard trucks.
- Analysis of the effect of wheel location (i.e., axle number and vehicle side) revealed that both trucks are performing consistently, with few outliers. Outliers would suggest that the improved steering mechanism has failed.
- There are relatively small differences in wear rates between the diagonal pairs of wheels in a truck. Large differences would suggest truck warping or failure to steer properly. However, the standard trucks have a higher percentage of outliers.
- There is little lead to trail axle difference in tread or flange wear. This suggests that the cars are frequently turned and do not run with a particular end leading.
- There is also little difference in wear between the wheels on the right and left sides of either vehicle. Thus, the effects of route or truck orientation, or set, are random.
- Car maintenance and component replacement records to date suggest the two trucks require about the same maintenance effort.

## METHODOLOGY

Wheel wear rates are a function of many track, vehicle and operating parameters including wheel load, train speed, rail profiles and vehicle/truck suspension characteristics. The assumption made in this study is that the operating and track characteristics are the same for both truck types. The cars are similar and are in similar service. This leaves truck type as the independent variable in the wheel wear study. To determine the performance of the two truck types, wheel profiles were measured from all eight wheels of a sample of cars from each type. Union Pacific provided the mileage history for each car. Wear for each wheel was determined by comparing the measured profile to the nominal new AAR1-B narrow flange profile. TTCI has developed software that aligns profiles for comparison and calculates tread and flange wear as area loss.

Exhibit 1 lists comparisons made between wheels. These comparisons were done to better determine any performance differences of the truck types and to verify the study assumptions. The following comparisons were done for each truck type.

Average tread and flange wear rates: This involved using all wheels from each car measured.

Truck side differential wear rates: Comparing the average of the four "A" (left) wheels to the four "B" (right) wheels. Large truck side differential wear would indicate poor steering trucks or route-specific problems.

Lead/Trail Axle Differential: Comparing the average wear of the wheels on the lead axle to the average wear of the wheels on the trail axle. Large values would indicate poorly steering trucks or car directionality issues.

TTCI = Transportation Technology Center, Inc.; AAR = Association of American Railroads

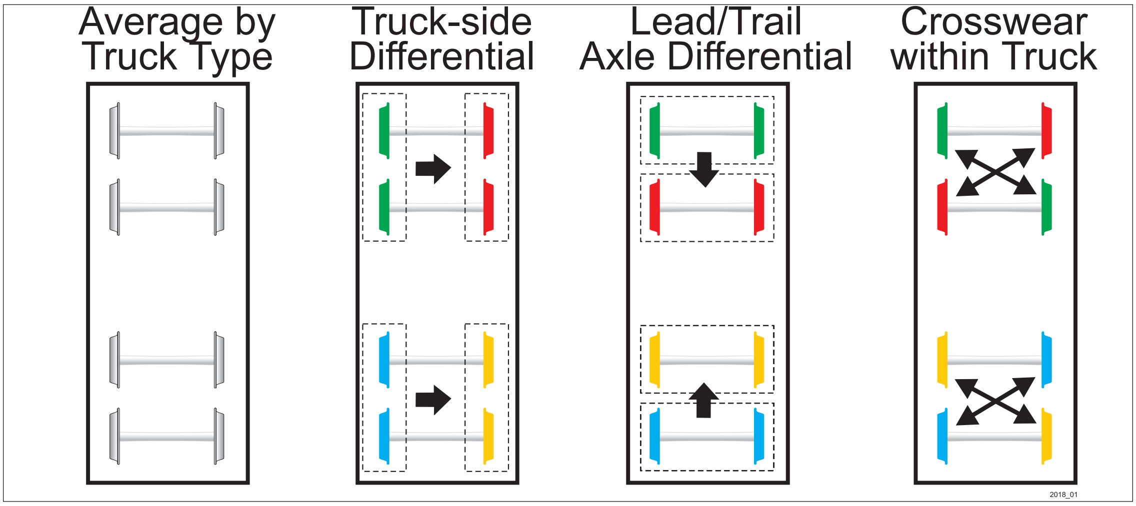


**Exhibit 1. Wheel Wear Comparisons to Determine Truck Performance**

Crosswear within Truck: Comparing the average wear on wheels 1A and 2B with the average wear on wheels 1B and 2A. Large values indicate warping trucks.

## RESULTS

There is an effect of mileage on both tread and flange wear rates. This is illustrated in the tread wear data for the trucks shown in Exhibit 2. The long-term wear rates are affected by the initial "break-in" wear rate and the initial period of 263-kip loading. The more mileage, the less effect either factor has on long-term wear rate.

There is also a difference in average wheel wear rate between the truck types. Exhibit 3 shows the differences between the two groups. The standard trucks have significantly higher flange wear rates (about 100 percent) and 20 percent higher tread wear rates. These figures agree with long term studies done by Canadian Pacific[1] under 286-kip cars. The CP studies suggest that premium suspension trucks can reduce flange wear by 70 percent as compared to conventional three-piece trucks. This study has shown a 50 percent reduction in wheel wear for premium suspension trucks compared to the standard trucks.

As shown in Exhibit 4, the two populations are similar in variation but different in average flange wear rate.

Diagonal crosswear, in which the lead axle has higher wear on one side and the trail axle has higher wear on the other side, is an indicator of poor steering performance. An analysis of tread and flange diagonal crosswear was conducted for both truck types. The result of the analysis for flanges is shown in Exhibit 5. Both trucks show similar patterns of differentials with a rather wide distribution in each case. There are a few premium suspension trucks that have differentials that are near the average wheel flange wear rate. Since the wear rate is higher for standard trucks, the relative amount of cross wear is smaller.

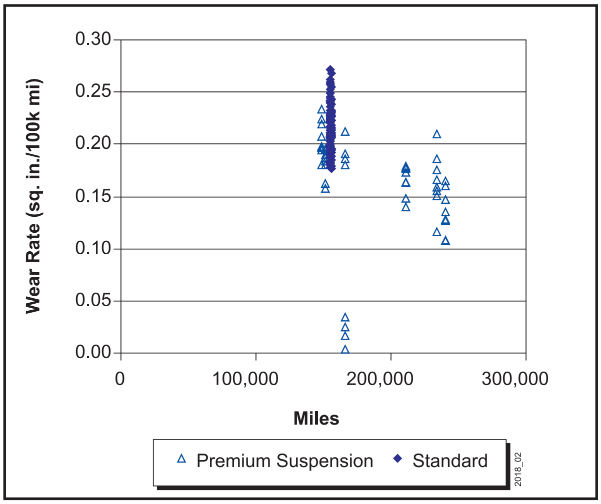


**Exhibit 2. Tread Wear Data for Both Trucks**

**Exhibit 3. Comparison of Wheel Wear Rates in 315-k Cars on Union Pacific Railway**

| | Premium | Standard | Ratio |
|---|---|---|---|
| Number of wheels | 48 | 111 | NA |
| Tread wear (sq. in/110 k mi) | | | |
| Average | 0.17 | 0.21 | 0.80 |
| Std. Dev. | 0.03 | 0.02 | |
| Flange Wear (sq. in/100 k mi) | | | |
| Average | 0.08 | 0.15 | 0.50 |
| Std. Dev. | 0.02 | 0.03 | |

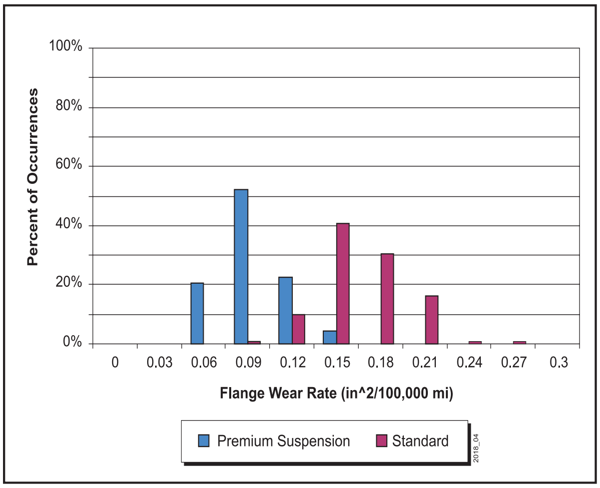


**Exhibit 4. Flange Wear Rates of Premium Suspension and Standard Trucks**

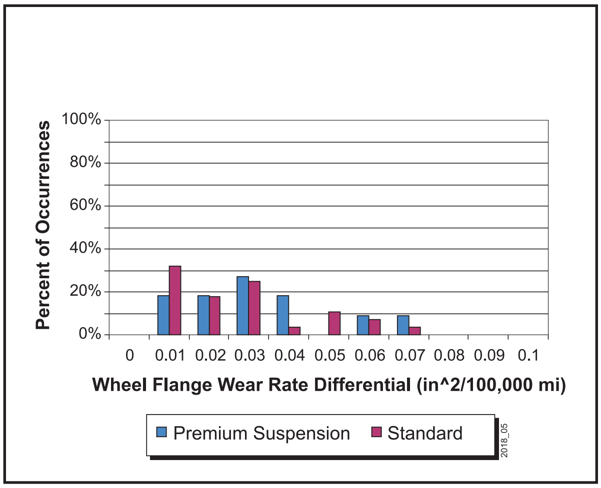


**Exhibit 5. Comparison of Diagonal Crosswear between Truck Types**

A similar comparison for diagonal crossover was done for tread wear rates. The premium suspension trucks have a smaller range of differentials (about .04 square inches per 100,000 miles). The standard trucks have a wider distribution with values up to .07 square inches per 100,000 miles. Thus, in terms of tread wear, the premium suspension trucks are performing better.

The truckside differential analysis results for flange wear are shown in Exhibit 6. There are small differences in wheel flange and tread wear between the left and right sides of the trucks. Both trucks show relatively small differences. The standard trucks have a few outliers with larger differentials. The data suggests that the trucks are performing well; no trucks are taking a "set" that causes wear on one side. The route characteristics are also not causing more flange wear on any particular side.

Comparison of lead to trail axle wear suggests that the cars are frequently turned. There is no large difference in either flange or tread wear between the first and second or fourth and third axles.

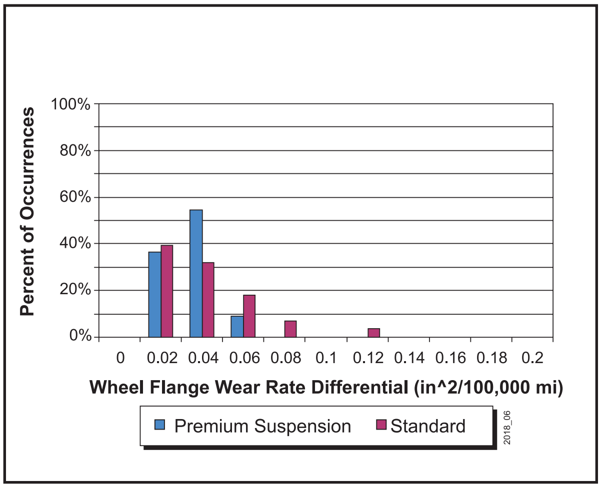


**Exhibit 6. Flange Wear Rate Truck Side Differential Comparison**

## FUTURE WORK

Additional measurements are planned to determine a steady state wear rate under 286-kip loading.

## REFERENCES


1. Roney, Michael D. and David K. Meyler, A Case Study of Wheel/ Rail Cost Reduction on Canadian Pacific Railway's Coal Route, 7th International Heavy Haul Conference, Brisbane, Australia, June 2001.



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