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FAST Heavy Axle Load Testing Update

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Summary

Ongoing evaluations of the effects of operating 315,000-pound (39-ton axle load) cars at the Facility for Accelerated Service Testing (FAST) during Phase V have revealed increased track-component wear under cars equipped with standard three-piece trucks running on lubricated rail compared with Phase III and IV operations at FAST, where improved suspension trucks were fitted to the same cars.

This report briefly documents the findings from Phase IV of the program and provides an early look at Phase V results. The table below highlights milestones of this project to date.

Results from Phase IV, as compared to Phase III, include:

- A 40 percent reduction in lateral forces in the 6-degree curve.
- An increase of nearly 300 percent in rail wear.
- A similar increase in wheel wear.
- A dramatic increase in wheel flange shelling.

Early Phase V results, as compared to Phase III, have shown:

- A 45 percent increase in lateral forces in the 6-degree curve.
- An increase of nearly 600 percent in rail wear.
- Increased tie-plate cutting and more screw spikes working out.
- More spalling on the low rail.

Phase	Timeframe & Tonnage	Description
I	1988-1990 160 MGT	Initial 39-ton axle load testing, standard trucks and standard track
II	1990-1995 300 MGT	Standard trucks, premium track components
III	1995-1998 425 MGT	Improved suspension trucks, premium track components
IV	1999 55 MGT	Improved suspension trucks, premium track components, no rail lubrication
V	1999-2002 415 MGT/pro- jected	Standard trucks, premium track components, (predominately) standard rail lubrication with other lubrication practices tested, periods of underbalance speed operations (planned)



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November 2000



INTRODUCTION

The testing of the performance of track components under 39-ton axle loads at FAST began in 1988 with joint funding from the Federal Railroad Administration (FRA) and the Association of American Railroads (AAR), and significant contributions from the railroad supply industry and individual railroads. The objectives of the program are to determine the effects of operating 39-ton heavy axle load (HAL) cars on track performance, test and develop practices that will minimize any adverse effects, and advance the safe and economical operations of HAL cars. The program has led to the development of improved techniques and materials for managing HAL effects, and has advanced safe, economical freight-rail operations.

From 1988 to 1995, the HAL train was equipped with standard three-piece trucks. Then in 1995, improved suspension trucks were installed under the HAL cars for FAST Phase III. The 425 million gross tons (MGT) of Phase III operations demonstrated that the trucks steer better, reducing lateral curving forces and wheel set angles-of-attack. The improved steering and primary suspension resulted in reduced gage widening degradation of softwood ties, reduced rail wear, reduced wheel wear, decreased fuel consumption, and less rail-end batter at welds and joints. Low-rail spalling in a 5-degree curve and rail corrugations that developed under standard trucks were not observed while the Phase III train was in operation.

Phase IV Background

After the benefits of operating the improved suspension trucks had been well documented and reported,^{1,2} Transportation Technology Center, Inc. (TTCI) engineers planned the next phase of testing. NUCARS modeling and a basic understanding of the performance characteristics of the improved suspension trucks suggested there could be benefits from operating the trucks without rail lubrication. The increased friction available on the gage-face of the high rail should increase the positive steering moment and further improve the steering of the trucks. Phase IV was intended to provide information on the effects of operating the FAST/HAL train equipped with improved suspension trucks, without rail lubrication, and lasted 56 MGT.

The gage-face of the high rail at FAST is normally lubricated with calcium-based curve grease with less than 20-percent graphite, and the top of the low rail is lightly contaminated with 90 weight gear oil. The way-side lubricators on the High Tonnage Loop (HTL) were turned off at the start of Phase IV. The measured coefficient of friction quickly increased to 0.50 to 0.55 on both rails. This compares with typical lubricated values of 0.25 to 0.35 on the top of the outside rail, 0.15 to

0.20 on the gage face of the outside rail, and 0.30 to 0.40 on the top of the inside rail.

PHASE V BACKGROUND

Though the benefits of the improved suspension trucks were clearly demonstrated, their introduction into revenue service use has been slow. The costs and benefits of purchasing and operating these cars are not always evenly distributed between the owners of the cars and the operators, so relatively few have been purchased. For Phase V, in order to make the train more representative of trains operated by North American railroads, the train is once again equipped with standard three-piece trucks, and the rail is again being lubricated. The suspension pads and cross braces were removed from the Phase III trucks. New three-piece trucks were installed under 13 cars. Thus far, 150 MGT of the 415 MGT planned for Phase V have been completed.

RESULTS

Lateral Forces

One method of quantifying the curving performance of trucks is the measurement of lateral forces in curves. These forces are measured at FAST with a Transportation Technology Center, Inc. developed truck performance detector on the HTL. The results here are from the 6-degree curve. The rail is not ground at this location, and the rail profile is conformal to the shape of the FAST wheels. The lateral loads from about 100,000 lead axles were measured near the end of Phase III, during Phase IV, and again in Phase V. The train operation was basically the same during the three phases, and rail lubrication practices for Phase V are the same as for Phase III. The 40 mph speed results in a cant deficiency of about 1.7 inches at this location. Exhibit 1 shows a median lateral load of 8.5 kips in Phase III, 5.1 kips in Phase IV, and 12.3 kips in Phase V. Lateral forces at the 10 percent exceedence level were 12.6 kips in Phase III, 10.8 kips in Phase IV, and 18.1 kips in Phase V. The results show that after about 100,000 miles of FAST operations, the improved suspension trucks continued to provide better curving performance than standard trucks. And operating improved suspension trucks on non-lubricated rail further enhanced vehicle steering, as predicted by mathematical modeling using TTCI's NUCARS model.

Increased Rail Wear

The increased friction that resulted in improved vehicle steering in Phase IV also had negative consequences. Without lubrication to protect the rail, wear increased dramatically. Exhibit 2 shows that average wear for the rails in the 5-degree reverse curve was nearly 300 percent higher in Phase IV than in Phase III. Because of

the reverse curve, the high rail receives less lubrication than the high rails on the other curves. Gage face friction levels of about 0.35 are typical in this curve. The difference in rail wear would likely have been even greater if the rail in this curve had previously been lubricated normally.

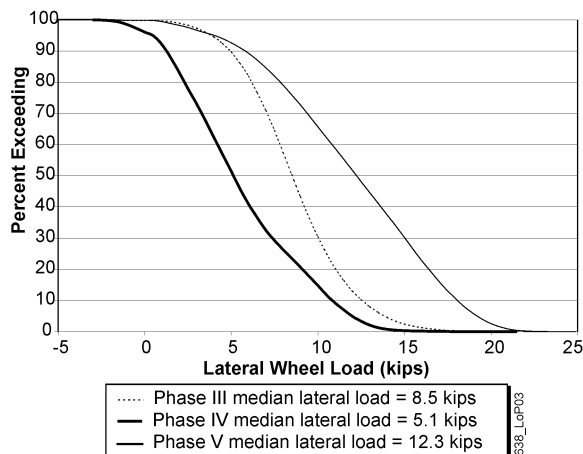


Exhibit 1. Lateral Force Comparison Phases III, IV and V

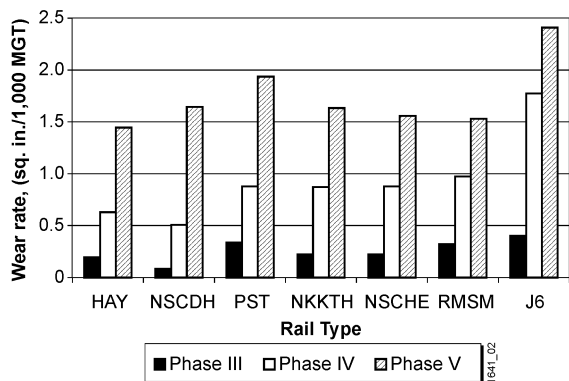


Exhibit 2. Rail Wear Comparison Phases III, IV and V

Exhibit 2 also shows rail wear for Phase V. Because the standard three-piece trucks do not steer as well as the improved suspension trucks, rail wear has significantly increased. Wear with these trucks is nearly 600 percent higher than it was during Phase III. And, it is nearly twice as high as in Phase IV, even though the rail is lightly lubricated in Phase V, and was not lubricated in Phase IV. Another change that became evident in Phase V is the effect of rail hardness on rail wear. During Phases III and IV, when wear rates were relatively low, there was no measurable effect of hardness

on premium rail wear. In fact, one of the hardest premium rails had the highest wear rate, while one of the softest had a lower wear rate. This is not the case in Phase V where the harder rails have the least wear. Possible reasons for this include:

- Wear was so slight during the earlier phases that most of the wear was probably in the decarburized layer of the rail. This layer is softer than the parent metal, and the thickness of the layer varies slightly from manufacturer to manufacturer. Wear in this layer would not be representative of wear in the parent metal.
- Wear rates were so low because of the improved suspension trucks that factors other than rail characteristics may have dominated. This could include minor, discrete differences in track conditions in the test zone.

PHASE IV AND OTHER FAST EXPERIMENTS

The effect of the change in rail lubrication on other experiments was minimal. One test that would be expected to show benefits from lower lateral loads is the cross-tie and fastener test. But, degradation of these components usually occurs over a long period of time. The short duration of Phase IV did not allow for the measurement of any change in tie/fastener degradation. Other major experiments, special track work, low track modulus, rail welds, and steel bridge were not expected to be affected by the change in lubrication, and no changes in performance were noted.

PHASE V AND OTHER FAST EXPERIMENTS

The degraded curving performance and resulting increase in lateral loads under the three-piece trucks used in Phase V has led to increased degradation of various track components. More tie-plate cutting is evident, more screw spikes are breaking and/or working out (Exhibit 3), and more rolled-steel tie-plates are breaking.

In addition to the increase in rail wear, rail surface deformation has also increased. Spalling on the low-rail of a 5-degree curve has reappeared. This spalling on premium rail had not been observed since Phase II — the last time that the train was equipped with standard three-piece trucks. Exhibit 4 shows rail after 60 MGT of Phase II (No. 1), the same rail after 100 MGT of Phase II with an additional 370 MGT of Phase III tonnage (No. 2), and the same rail again after Phase III was completed and 70 MGT from Phase V had been added (No. 3). The spalling evident in Phase II wore away in Phase III without rail grinding.

Fuel consumption (gallons/MGT) in Phase III was about 25 percent lower than it was in Phase II. An exact



Exhibit 3. Tie-Plate Cutting and Loose Screw Spikes in Phase V

comparison between Phases III and V is difficult because two of the four locomotives are different from those used in Phase III; average train length is slightly shorter and the top of rail has been lubricated periodically in Phase V. Fuel consumption has increased, however, as would be expected when the train is equipped with trucks that do not steer as well as the improved trucks. These results will be updated as more tonnage is accumulated.

One of the objectives of Phase V is to test track components under rolling stock typical of that currently used by North American railroads. This is being done, and the load environment is more severe than it was under the improved suspension trucks. The “Accelerated” in Facility for Accelerated Service Testing has been re-emphasized. Phase V has also served to reinforce earlier test results showing the benefits of improved suspension trucks compared to standard three-piece trucks.

References

1. Read, David and Semih Kalay “Initial Results of FAST/HAL Phase III Testing,” *Technology Digest* 96-025, Transportation Technology Center, November 1996.
2. Read, David and Semih Kalay “HAL Results after 300 MGT with Improved-Suspension Trucks,” *Railway Track and Structures*, February 1998.

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No.1



No.2



No.3



Exhibit 4. Rail Surface Deformation Phases II, III and IV

Note: Please contact Joseph LoPresti at (719) 584-0589 with questions or comments about this document.

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