

### "INITIAL RESULTS OF FAST/HAL PHASE III TESTING"

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TD 96-025

#### Summary

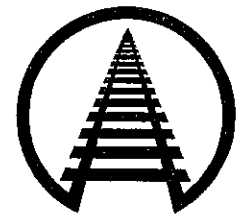
Initial results of Phase III testing at the Transportation Technology Center, Facility for Accelerated Service Testing (FAST), suggest that improved suspension trucks will substantially improve the economics of operating 315,000-pound freight cars. Benefits include reduced fuel consumption, less wheel/rail wear and other reductions in track damage. Data collected during Phase III has enabled the FAST engineering staff to determine, for the first time in recent railway research, the overall savings in track and operating costs due to improved truck suspension systems. Prior to this experiment, benefits were estimated through models and expert opinion.

FAST Phase III operations with improved suspension trucks began in November 1995 and have produced 145 million gross tons (MGT) of traffic to date. The test trucks were designed primarily to reduce lateral wheel/rail forces through improved curving performance. A cursory look into fuel consumption at FAST indicates the improved trucks provide up to a 27-percent reduction in fuel usage as compared to previous operations with standard trucks. Savings in fuel and track damage costs achieved at FAST may translate into less savings, although still very significant, in revenue service.

Initial results also indicate that lateral forces measured on medium degree curves (5 degree to 6 degree) at FAST are approximately 50 percent of those measured previously with standard suspension trucks. Rail wear, especially gage face curve wear, has also been reduced at least 50 percent for both standard and premium rails. The improved curving performance appears to have also reduced rail corrugation development. Rail corrugations, which were visible at 60 MGT of standard truck operation, are not evident after 140 MGT of improved suspension truck operation. Gage widening of softwood ties on curves has also been reduced by slightly over 50 percent due to the improved curving characteristics.

#### Suggested Distribution:

- Equipment/Rolling Stock
- Track Maintenance
- Maintenance of Planning
- Maintenance of Way



Association of American Railroads  
Research and Test Department

November 1996



## INTRODUCTION AND CONCLUSIONS

Phases I and II of the Heavy Axle Load (HAL) program at the Association of American Railroads (AAR), Transportation Technology Center, Facility for Accelerated Service Testing (FAST), Pueblo, Colorado, investigated track performance under 315,000-pound vehicles (39-ton axle loads) equipped with standard design three-piece freight car trucks. Phase I, in which 160 MGT of traffic was accumulated over the 2.7-mile High Tonnage Loop (HTL), quantified the effects of 39-ton axle loads on standard track components and provided a comparison with track performance previously measured under 263,000-pound vehicles (33-ton axle loads). Results of Phase I indicated that 39-ton axle loads could operate on a standard track structure, but with increased track maintenance costs of approximately 30 percent.

During Phase II, premium track components were introduced to determine if an improved track structure would reduce the maintenance penalty measured in Phase I. After 300 MGT of Phase II testing, results indicated that premium materials, especially head-hardened rail, concrete ties with dual durometer or "sandwich" tie pads, high integrity frog castings, premium thermite welds, and hardwood ties with elastic fasteners would improve the safety, efficiency and economics of 39-ton axle load operation.<sup>1,2</sup>

As Phase II was in progress, planning for a third phase of the program was initiated to determine the benefits of operating 39-ton axle loads with improved suspension trucks. Ten potential truck designs were evaluated analytically using the NUCARS model and then field tested to AAR Chapter XI New Freight Car Service Worthiness criteria.<sup>3</sup> From this group, three designs were selected in early 1995 for Phase III operations, the FAST train was re-equipped during the summer and operations began in November 1995. Current Phase III tonnage is 125 MGT with 160 MGT expected by the end of 1996.

In general, all three trucks are designed for improved curving response with enhanced wheel set steering capability and resistance to truck warp. Steering is provided by the longitudinal and lateral stiffness of the shear pads and the

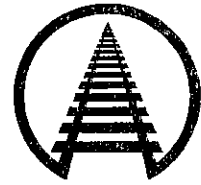
steering arms of the AR-1 truck. Truck warp is controlled by the cross bracing of the S-2-HD trucks and the increased friction wedge surface of the XC-R VII truck. In addition to improved curving, the elastomeric characteristics of the primary suspension pads have the potential of attenuating high frequency vertical forces. Other than the hydraulic dampers on the Buckeye and ASF trucks, secondary suspension designs are not substantially different from the standard design trucks. Low frequency vertical forces, therefore, are not expected to be reduced, particularly at non-resonant vehicle speeds.

### Phase III Initial Results

Dynamic rail force data was collected in the 6-degree curve of HTL Section 25 after accumulation of 110 MGT to quantify curving performance of the improved trucks. Similar data had been collected from the standard truck consist at the same location and under comparable wheel/rail profile and lubrication conditions a year earlier for comparison purposes. Exhibit 1 compares the median (50th percentile) and 90th percentile lead axle lateral forces measured under the standard and improved trucks. The force values in Exhibit 1 were measured on the high rail with the gage face of the high rail lubricated and the train operating at 40 mph. The data shows the lead axles of the improved trucks are generating lateral forces at the measurement site approximately 50 percent lower than the standard trucks.

Wheel set angle-of-attack was also measured at the same 6-degree curve location used to measure lateral forces. The lead axle of a standard freight car truck will generally assume an angle-of-attack relative to the curve radius in milliradians roughly equal to the degree of curvature while the trail axle tends to remain radial to the curve with a very small angle-of-attack. In Exhibit 2, a comparison of 50th percentile and 90th percentile lead axle angle-of-attack data is shown. The data indicates a 50 percent reduction in lead axle angle-of-attack for the improved trucks.

The improved curving performance has resulted in a 50 percent to 60 percent reduction in rail wear. Rail wear was measured on a variety of



rail types, including head-hardened and standard rail, in the 5-degree curve of Section 07 during the last 85 MGT operation of the standard trucks. Identical rail types were installed in the same curve and wear measured during the initial 85 MGT of improved operation. The average total wear measured under both truck types is shown in Exhibit 3 and a comparison of standard rail profiles from Section 07 measured after 85 MGT is included as Exhibit 4. The percent reduction in gage face wear agrees closely with the percent reduction in curving forces.

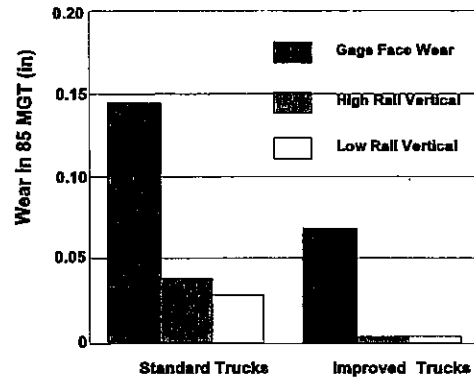


Exhibit 3. Comparison of Average Rail Wear

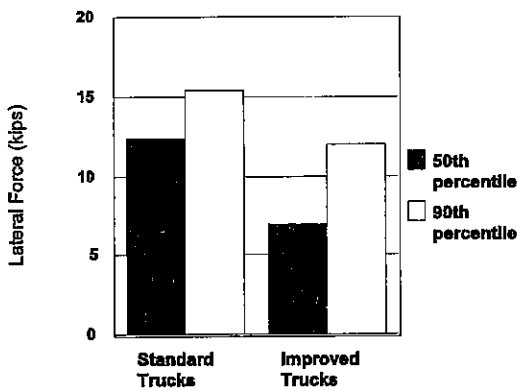


Exhibit 1. Comparison of 50th and 90th Percentile Lead Axle Lateral Force Values

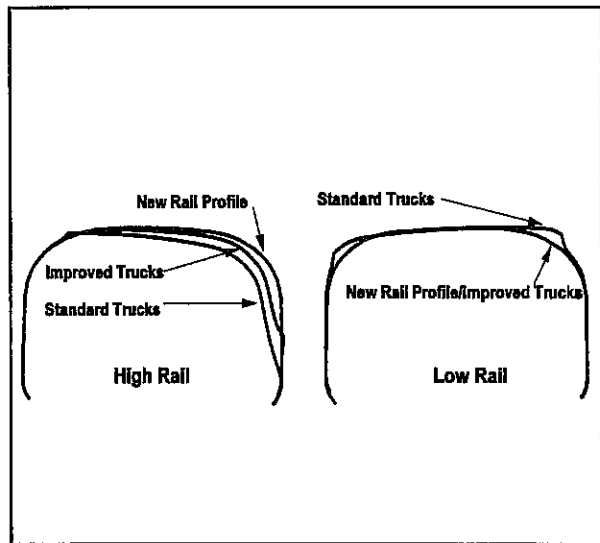


Exhibit 4. Comparison of Standard Rail Profiles After 85 MGT

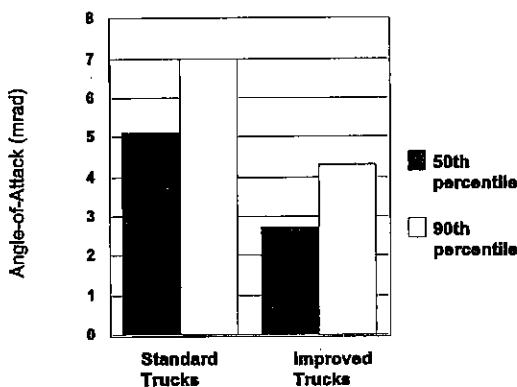


Exhibit 2. Comparison of 50th and 90th Percentile Lead Axle Angle-of-Attack Values

In addition to reduced rail wear, improved curving performance has deterred development of rail corrugations, reduced fuel consumption and reduced gage widening of softwood ties. Measurable corrugations were present in the standard rail in Section 07 beginning at 60 MGT during the standard truck operation. However, no



corrugations were apparent after 100 MGT of improved truck operation in the same curve. It is conjectured that improved truck steering has resulted in lower wheel/rail longitudinal forces and contact stresses and, therefore, reduced the tendency toward corrugation formation.

Fuel consumption dropped approximately 27 percent from an average of 3,750 gallons/MGT during the final 32 MGT of Phase II to an average of 2,740 gallons/MGT during the initial 100 MGT of Phase III. The locomotives were identical for both Phases and the consist weight varied between 11,500 tons and 12,200 tons. A back-to-back comparison of gage widening on southern yellow pine ties located in Section 25 showed a substantial reduction of about 60 percent with the improved trucks.

Other preliminary results suggest that the primary suspension pads are effective at attenuating high frequency vertical forces at thermite welds and rail joints. After 60 MGT of standard truck operation, the average batter measured at thermite welds located in a 5-degree curve was 0.040 inches as compared to 0.012 inches measured after 60 MGT of improved truck operation over similar welds installed at the start of Phase III on the same curve. The average rail end batter in mechanical joints installed in a tangent section and a 5-degree curve was also reduced by about 70 percent with the introduction of the improved trucks.

Note that the savings in fuel and track damage costs achieved at FAST may translate into less savings (although still very significant) in revenue service. This is due largely to the fact that the FAST experiments are well controlled and the track and equipment maintenance procedures are unique to the FAST operating environment.

## SUMMARY AND FUTURE

Data collected during the first 100 MGT of Phase III operations indicate that the improved suspension trucks are:

- Generating lower lateral forces on medium degree curves
- Providing significant reductions in rail wear, fuel consumption, gage widening and rail corrugation development
- Producing less batter at rail joints and thermite welds

However, the trucks are all new and operating at near optimum performance. More mileage is required to determine if the initial results will diminish as the trucks wear. Phase III is currently planned to continue through 1998 and generate an additional 300 MGT of traffic. A preliminary economic analysis is currently underway to determine whether the cost savings can justify the added investment due to improved trucks as well as to quantify the effects on overall HAL operations.

## REFERENCES

1. Read, D.M. and S. Kalay, "Results of Phase II Heavy Axle Load Tests at FAST," *American Railway Engineering Bulletin* 757, Vol. 97, Oct. 1996.
2. Hargrove, M., T. Guins, D. Otter, S. Clark, and C. Martland. "Economics of Increased Axle Loads: FAST/HAL Phase II Results," *A World of Change: 1st Annual AAR Research Review*, Vol. 1, Nov. 6-9, 1995.
3. Klauser, P., C. Urban, and R. Florom. "On-Track Test Results for the Heavy Axle Load Alternative Suspension Project," AAR research report R-896, Oct. 1996.

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