TECHNOLOGY DIGEST

Timely Technology Transfer — 98-019

Effects of Heavy-Haul Traffic on Turnout Components in Revenue Service

by Ryan McWilliams and David Davis

Summary

Long-term studies from the Union Pacific's Powder River line in the North Platte subdivision indicate that the average life of turnouts and turnout components has steadily increased under heavy-axle-load (HAL) traffic in revenue service. No detrimental effects that can be directly or indirectly attributed to the introduction of the HAL traffic on turnouts or turnout components have been observed to date. In fact, contrary to expectations, a significant increase in the average life of components has been observed. This is largely credited to the advancement of special track work and material improvements.

The HAL (286,000-pound gross rail load) revenue-service program was initiated in 1992 by the Association of American Railroads to monitor the rate of introduction and the effects of heavier axle loads over revenue-service lines. These studies provide the railway industry with valuable information on turnout-component life and maintenance issues. Results from the ongoing study on the Powder River line are as follows:

- Annual HAL traffic has increased from 0.5 percent in 1992 to 38 percent in 1997.
- Average car weight per train is steadily increasing with the increase in HAL trains.
- Maintenance and material improvements are increasing frog life and negating detrimental HAL effects.
- No. 20 RBM high-integrity frogs are lasting three times longer than standard No. 20 RBM frogs, even as conditions degrade as a result of heavier axle loads.

Suggested Distribution:
- ❑ Maintenance of Way
- ❑ Planning & Analysis
- ❑ Track Maintenance
- ❑ Safety

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INTRODUCTION AND CONCLUSIONS

Long-term revenue-service testing has shown an increase in the average lives of turnouts and turnout components under heavy-axle-load (HAL) traffic. Studies on the Union Pacific's (UP) Powder River line in the North Platte subdivision have monitored the effects of HAL traffic on turnouts and components since the introduction of the 286,000-pound traffic in 1992. Prior to 1993, traffic on this line was almost exclusively composed of 263,000-pound cars. Both axle loads and average car weights have been steadily increasing with the rising percentage of overall HAL traffic. Exhibit 1 shows that HAL traffic has increased from 0.5 percent in 1992 to 38 percent in 1997. It also shows that both the total traffic and the HAL traffic on this line have increased steadily since 1992, only to slow in the past year.

NO. 20 HIGH-INTEGRITY FROGS

One area of major concern for the railway industry is turnout performance under heavier axle loads. Investigation into the UP Powder River line shows that there has been no detrimental effect observed on average turnout life that can be directly attributed to HAL traffic. Concurrently, since the introduction of the high-integrity frog in 1990, we are observing an increase in mean frog life.

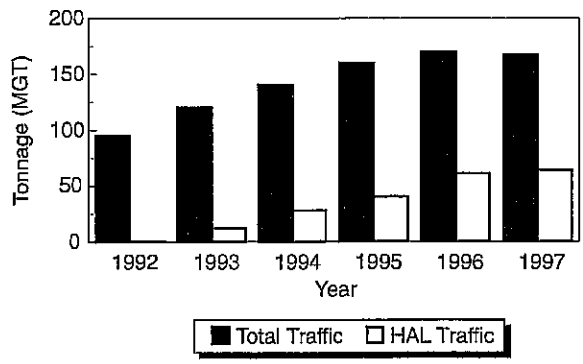

Exhibit 1. Annual HAL Tonnage

Weibull analysis of high-integrity No. 20 Rail Bound Manganese (RBM) frogs estimates an average mean life of 454 million gross tons (MGT) of traffic over frogs installed between 1990 and 1997. Exhibit 2 shows that there has been an increase in frog life with the improvement of materials and casting procedures. The mean life of frogs installed from 1994 to 1997 (580 MGT) is more than 30 percent higher than those installed between 1990 and 1993 (384 MGT), showing that improvements are still being made since the introduction of these high-integrity castings. Both groups of frogs have Weibull slopes (beta values) greater than two. This indicates that the frogs are behaving in the classic wear-out/fatigue failure pattern. The early failures of both groups are similar.

This is a significant improvement over standard casting frogs, but further improvement to obtain longer life is still an industry goal. The improvement over standard frog castings is due in part to the fact that high-integrity castings have thicker walls and less porosity problems. This greatly reduces detrimental anomalies. Also, the estimated mean

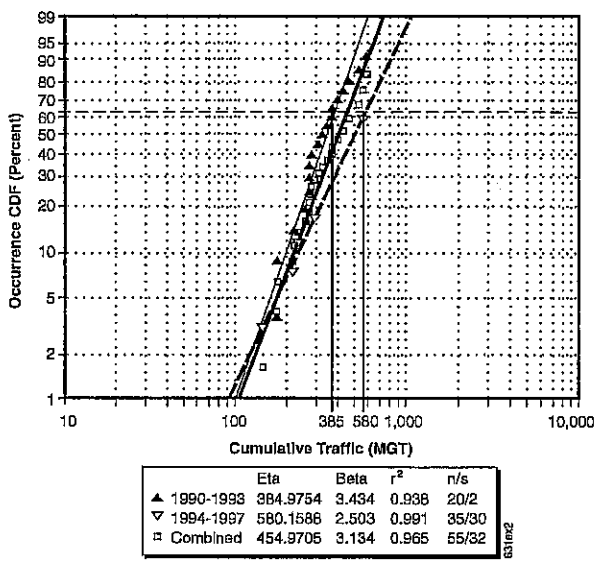

Exhibit 2. Weibull Plot of Frog Life

life of the high-integrity frog is still increasing, and has not yet reached its steady state. As the number of still-in-service frogs and frogs removed before failure decrease, we are expecting a rise in mean life (Eta) and a very slight decrease in Beta values. Most of these are high-tonnage frogs.

Other factors such as improved maintenance practices, heavier base plates with elastic fasteners, joint elimination, gage plates, and extended-length guardrails may be contributing to the increase in frog life. With all data considered, it is safe to state that the No. 20 high-integrity frog is showing that it has more than compensated for the expected increase in degradation attributed to HAL traffic.

WELD MAINTENANCE

Maintenance issues are also a growing concern for the railway industry. Frog-weld maintenance has 'become a concern with respect to frequency and trends.

Exhibit 3 shows that in 1995 the amount of tonnage between repairs actually increased dramatically. This result is attributed to the replacement of a significant number of frogs at that time, which prove to have longer initial lives. This is to say that the amount of tonnage accrued before the first repair is much higher than the tonnage accrued between repairs thereafter. Exhibit 4 depicts this trend.

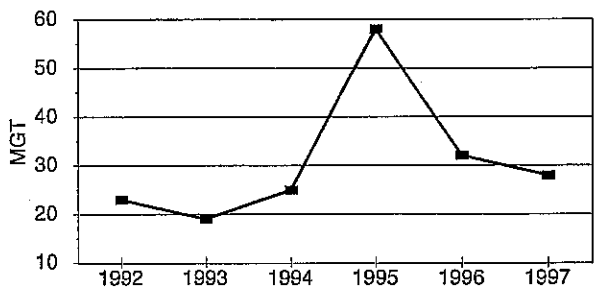

Exhibit 3. Average MGT between Repairs from 1992 to 1997 on No. 20 High-Integrity Frogs

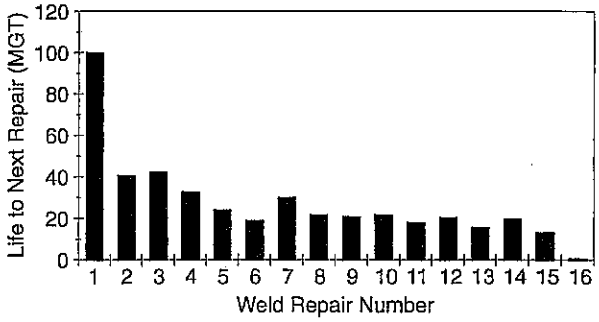

Exhibit 4. Average Weld Life of No. 20 High-Integrity Frogs

The other phenomena being observed is the increasing time between weld repairs after the first repair. No. 20 high-integrity RBM frogs installed from 1990 to 1993 have an average life between weld repairs of 22 MGT, while those installed between 1994 and 1997 have an average life between repairs of 38 MGT. Therefore, even with the increase in total traffic and axle loads, repair life has increased by 40 percent after the first repair, as shown in Exhibit 5.

NO. 10 SPRING-RAIL FROGS

As shown in Exhibit 6, spring-rail frogs have an average life 10 times longer than the average life of standard No. 10 RBM frogs on this line. At this time, there are only two No. 10 spring-rail frogs left in this section of track. There are few branch or industrial tracks on this line.

Both No. 10 frogs in service have an upgraded design and are continuing to accu-

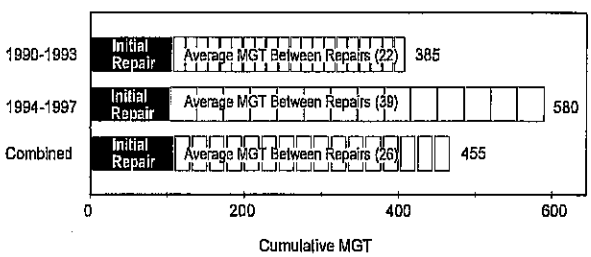

Exhibit 5. Frog Weld Maintenance

mulate tonnage, virtually all on the mainline route. These frogs are constructed of fully heat-treated rail, use a flexing wing rail, and are fully welded into track with no toe or heel joints. They have seven wing-rail hold-downs, as opposed to the three utilized in a standard American Railway Engineering and Maintenance of Way Association (AREMA) design, and employ large base plates and several braces ahead of the toe. In addition, both are protected by 39-foot guardrails on the mainline side, instead of the 16.5-foot guardrail specified under AREMA guidelines. There have been no detrimental effects observed since the introduction of HAL traffic.

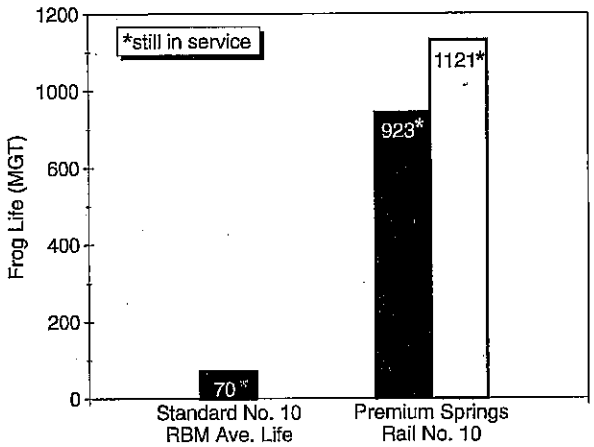

Exhibit 6. Frog Life for No. 10 Premium Frogs

CONCLUSION

Although many variables are simultaneously and constantly changing, there has been a dramatic increase in frog performance overall. The premium No. 10 spring-rail frogs, like the high-integrity No. 20 RBM frogs, prove to perform much better than frogs of standard design in heavy-haul service. In spite of increased HAL traffic and train speeds, the average life of premium No. 10 spring-rail frogs remains exceptionally high. This indicates that for No. 10 frogs, as well as No. 20 frogs, the use of premium design materials and improved maintenance practices can make up for the expected performance degradation associated with increasing wheel loads.

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