TECHNOLOGY DIGEST

Timely Technology Transfer

Life of Rail-Bound Manganese Frogs in Revenue Heavy Haul Service

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Summary

High-integrity frog castings are showing a significant increase in life over standard frog castings in No. 20 turnouts in revenue heavy haul service. This is observed from data collected on the Chicago & North Western Powder River Subdivision as part of the Association of American Railroads' Heavy Axle Load Revenue Service Monitoring program. Preliminary results show at least a 60 percent greater average life for frogs with high-integrity castings, using data collected for the past 10 years under 100-ton traffic (263,000 pounds). This figure is likely to increase as more tonnage is accumulated on frogs still in service.

Average life of rebuilt No. 20 frogs is nearly 90 percent of the average life of standard No. 20 frogs. Average life of standard No. 10 frogs is only about 55 percent of the average life of standard No. 20 frogs.

The orientation of a frog with respect to the direction of heaviest tonnage has little or no influence on the average frog life. On a line with about 80 percent of the tonnage moving in one direction, frogs in both facing point and trailing point turnouts have nearly equal lives.

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INTRODUCTION AND CONCLUSIONS

Frog Life Comparisons

Frogs are one of the most expensive parts of the turnout and require the most maintenance. Improvements in frog life can lead to savings in turnout maintenance costs. The recent introduction of high-integrity frog castings is one such improvement. As compared to a standard frog casting, a high-integrity frog casting has thicker walls and more risers. The high-integrity castings have improved metallurgy in that they have less porosity and fewer inclusions. In heavy haul service, the most common frog is the rail-bound manganese (RBM) frog, in which a manganese frog casting is surrounded by wing rails typically made of head hardened rail. Some of the most common frogs in heavy haul service are in No. 10 and No. 20 turnouts. No. 20 turnouts are typically used for junctions, crossovers, and passing sidings, while No. 10 turnouts are typically used for industrial sidings and other lightly used tracks.

Exhibit 1 shows the average life for various types of RBM frogs. Note that on the line monitored for this study, the high-integrity No. 20 frogs are showing more than a 60 percent increase in average life compared to standard No. 20 frogs. To date, the experience with life of high-integrity frogs in revenue service compares well with the experience at the Facility for Accelerated Service Testing (FAST). Because the high-integrity frogs were introduced in 1990, only a few have been removed from service to date. Those that have been removed are likely to have been from the lower end of the life distribution curve. This is demonstrated by the fact that the average life of high-integrity No. 20 frogs still in service exceeds the average life of those already removed from service. Therefore, the calculated average life of high-integrity No. 20 frogs is expected to increase until a steady state condition of high-integrity frog replacement is reached.

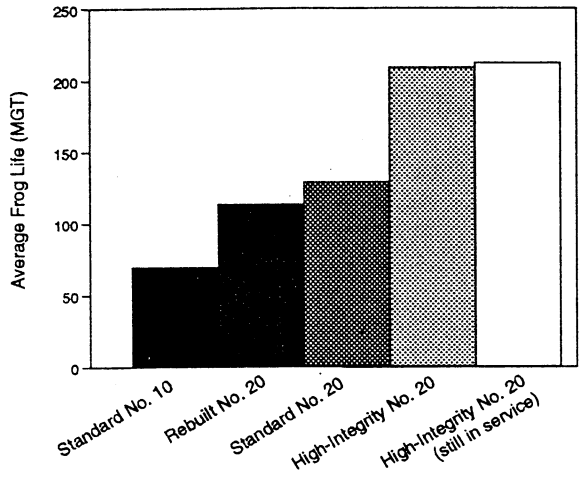

Exhibit 1: Average RBM Frog Life in Revenue Heavy Haul Service

Exhibit 1 also shows that rebuilt No. 20 frogs last nearly as long as standard No. 20 frogs. Average life of the rebuilt frogs is almost 90 percent of the average life of the standard frogs. The rebuilt frogs included in this study were all rebuilt from standard frogs. The rebuilding process consists of shop grinding and welding of the casting, and restoration or replacement of the wing rails. The Chicago & North Western (C&NW) performs all rebuilding in-house, making use of field maintenance records. No data is available yet for rebuilds of high-integrity frogs.

As shown in Exhibit 1, standard No. 10 RBM frogs have a significantly shorter average life than a comparable No. 20 frog. This difference is probably due to the larger frog angle and smaller wheel transfer zone of a No. 10. Life of a standard No. 10 averages only 55 percent of the life of a standard No. 20 frog. Little data is available at this date on either rebuilt or high-integrity No. 10 RBM frogs. Two premium quality No. 10 spring-rail frogs currently in service are performing very well with more than 500 MGT of traffic over one, and more than 300 MGT over the other.

The cumulative life distribution curves for selected frog types are shown in Exhibit 2. The relatively short life of the No. 10 frogs compared to the No. 20 frogs is very evident. Both the standard and rebuilt No. 20 frog distributions exhibit slight bimodal tendencies. With the standard No. 20 frogs, about 40 percent fail before about 90 MGT, while the remaining 60 percent last about 130 MGT or more. With the rebuilt frogs, about two-thirds fail before about 110 MGT, while the remaining third last 140 MGT or more. There is not enough data available at this date to construct meaningful distribution curves for the high-integrity No. 20 frogs.

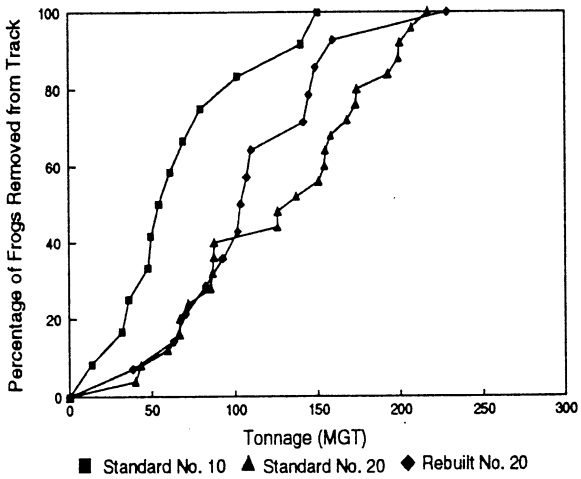

Figure 2: RBM Frog Life Distributions

Exhibit 3 summarizes the statistics for life of various types of RBM frogs. While there is not yet conclusive evidence, there is a strong possibility that the high-integrity No. 20 frogs will exhibit a much higher minimum life than standard or rebuilt No. 20 frogs. They may also exhibit a smaller variation in frog life as a percentage of average frog life. This lower variation would allow better prediction of frog life and thus better maintenance planning.

Exhibit 3: RBM Frog Life Statistics

Frog Type	Number of Samples	Frog Life (MGT)			
		Average	Standard Deviation	Maximum	Minimum
Standard No. 10	12	70	40	150	14
Standard No. 20	25	129	55	217	40
Rebuilt No. 20	14	114	46	229	39
High-Integrity No. 20	4	209	35	259	175
High-Integrity No. 20 *(still in service)	12	212*	56*	272*	55*

Effect of Direction of Heaviest Tonnage

Exhibit 4 shows that the orientation of a frog with respect to the direction of heaviest tonnage makes little or no difference on the life of the frog, for both standard and rebuilt No. 20 frogs. Tonnage is split about 80 percent in one direction, and 20 percent in the opposite direction on this heavy haul route. Whether a frog is in a facing point or trailing point turnout, with respect to the dominant tonnage direction, its life is about the same. Standard No. 20 frog data shown in Exhibit 4 represents 10 facing point and 15 trailing point frogs. Rebuilt No. 20 frog data represents eight facing point and six trailing point frogs. There is not enough data available to draw any conclusions about the effects of tonnage direction on high-integrity frogs.

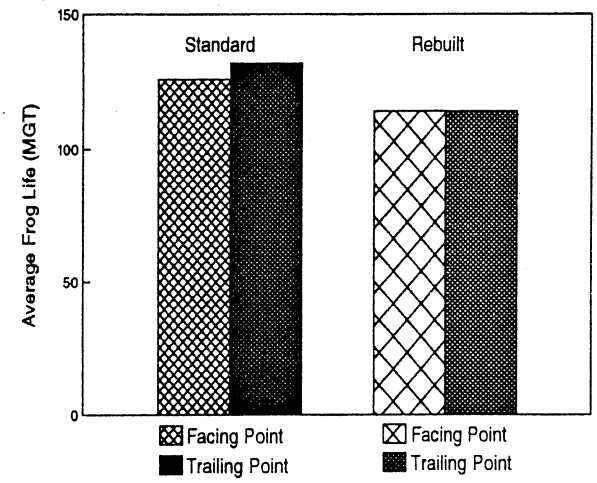

Exhibit 4: Effect of Primary Tonnage Direction on No. 20 RBM Frog Life

TRAFFIC, TRAIN OPERATIONS, AND MAINTENANCE PRACTICES

This data was collected by C&NW on the Powder River Subdivision, between Horse Creek, Nebraska, and Shawnee Junction, Wyoming, over the past 10 years of operation. Traffic is almost exclusively unit coal trains. The loads make up about 80 percent of the tonnage, all moving in the eastward direction, while the empties make up the remaining 20 percent of the tonnage, in the westward direction. Annual tonnage for 1993 is expected to exceed 100 MGT on this line.

The line is single track with sidings. Speed limit on the line was originally 40 mph in each direction, but over the past two years it has been raised to 45 mph for loads and 50 mph for empties. Through the diverging routes of the No. 20 turnouts, speed is limited to 25 mph. As a general practice, when trains meet, loads hold the main line, while empties take the siding. Therefore the loads rarely go through the diverging routes.

The route being studied currently contains 16 No. 20 turnouts and 3 No. 10 turnouts on the main line. Two of the No. 20s are at junctions, with negligible traffic on the diverging routes. The remainder of the No. 20s are at passing sidings. Because of the current operating practice on this route, none of the No. 20s carry a large fraction of the tonnage over the diverging route.

Several improvements have been made in frog maintenance on this line, including installation of longer guard rails, frog gage plates, larger frog base plates, and elastic fasteners. Warped switch ties are promptly replaced and tamping, welding, and grinding practices are continuously improving.

Quality control is emphasized in field maintenance. A frog is removed from service when it is deemed more economical to replace than repair in track. Frog life results could be considerably different on routes with different traffic mixes, tonnage characteristics, and operating and maintenance practices.

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Note: Contact Duane E. Otter at (719) 584-0594 with questions or comments about this document.

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