TECHNOLOGY DIGEST

Timely Technology Transfer

"COMPARISON OF WELD REPAIRS FOR STANDARD AND HIGH-INTEGRITY RAIL BOUND MANGANESE FROGS IN HEAVY HAUL SERVICE"

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TD 96-012

Summary

As part of the Heavy Axle Load Revenue Service Monitoring and Special Trackwork Research programs, the Association of American Railroads evaluated the performance of weld repairs under the current baseline traffic of mostly 100-ton cars. Results indicate that the use of high-integrity frogs provides significant improvements in frog performance and subsequent service reliability.

Using maintenance records from Union Pacific Railroad's former Chicago & North Western Powder River Subdivision, the following conclusions can be made concerning the performance of standard and high integrity frogs:

- The original casting life and repair life of No. 20 high-integrity frogs are approximately double the casting life and repair life of frogs.
- The nose and main wing repairs made to the high-integrity No. 20 frogs are longer but shallower than repairs made to standard No. 20 frogs.
- As with standard frogs, the location of each additional repair on high-integrity frogs generally overlaps the previous repair. The short-lived weld repair is weaker than the casting.
- The repair distribution between the nose and the main wing was the same for both the No. 20 standard and high-integrity frog types. Specific repair locations did vary. Thus, the failure modes of standard and high integrity castings are likely to be the same.

High integrity frogs last longer than standard frogs, yet they both fail in the same manner. Weld repair life is still comparatively short. The weld repair process needs improvement as it currently is the source of the next frog failure.

Suggested Distribution:
- ❑ Maintenance of Way
- ❑ Research and Development
- ❑ Track Maintenance
- ❑ Maintenance Planning

Association of American Railroads
Research and Test Department

May 1996

INTRODUCTION

As part of the Heavy Axle Load Revenue Service Monitoring and Special Trackwork Research programs, the Association of American Railroads evaluated the performance of weld repairs under the current baseline traffic of mostly 100-ton cars. Results indicate that the use of high-integrity frogs provides significant improvements in frog performance and subsequent service reliability.

In an earlier digest, TD95-002, the performance of weld repairs was analyzed using standard and high-integrity frog data. The data was largely from standard integrity frogs and no comparison between standard and high integrity frogs was made. Data was collected from the former Chicago & North Western (C&NW) Powder River Subdivision between Horse Creek, Nebraska, and Shawnee Junction, Wyoming. This line carries almost exclusively 100-ton and 110-ton unit coal trains. Background data and more recent C&NW maintenance records will be examined. Moreover, the differences in performance between standard and high-integrity frogs will be discussed.

The frogs in this study are all rail bound manganese (RBM) steel castings. They are classified into two categories, standard and high-integrity, based on the manufacturing process. High-integrity castings, which meet specific quality standards for solidity are made by improved casting technology such as better mold design (e.g. more risers, better sand binders, etc.). C&NW began installing high-integrity frogs on this line in 1990.

ANALYSIS

Exhibit 1 compares the various service life components of a standard No. 20 frog and a high-integrity No. 20 frog. For both cases, the time to first repair is the largest component, averaging 50 million gross tons (MGT) for the standard frog and 101 MGT for the high-integrity frog. This doubling effect is also evident in the first and subsequent weld repair averages: 20 MGT and 11 MGT for the standard frog and 39 MGT and 21 MGT for the high-integrity frog respectively.

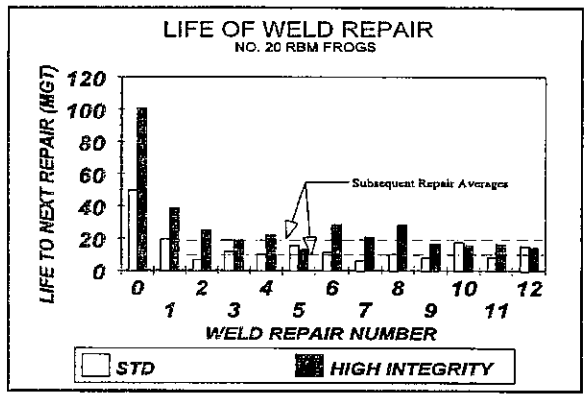

Exhibit 1. Components of Frog Service Life

It is worth noting that numerous factors influence frog repair life, including:

- quality of the frog casting,
- quality of the frog components and fabrication,
- turnout location,
- turnout track geometry,
- train operating practices,
- frog maintenance,
- welding materials, and
- welding procedure.

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. Maintenance procedures along this line are considered to be among the best in the industry.

Exhibits 2 and 3 show the location of the leading edge of each repair for the No. 20 standard and high-integrity frogs as measured from the nose tip or frog point. Negative values are toward the frog toe and positive values are toward the frog heel. Because of the operating pattern on this line, weld repairs occurred almost exclusively on the frog nose and main wing.

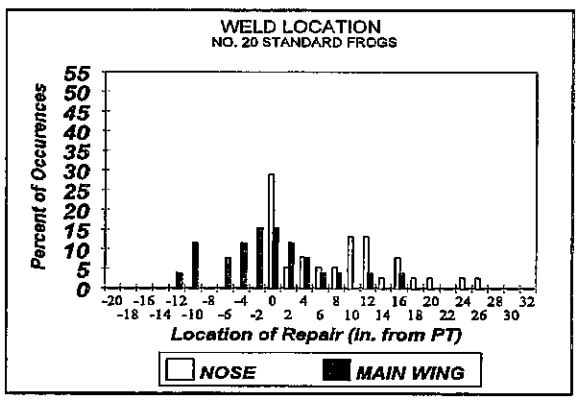

Exhibit 2. Location of Weld Repairs for Standard Frogs

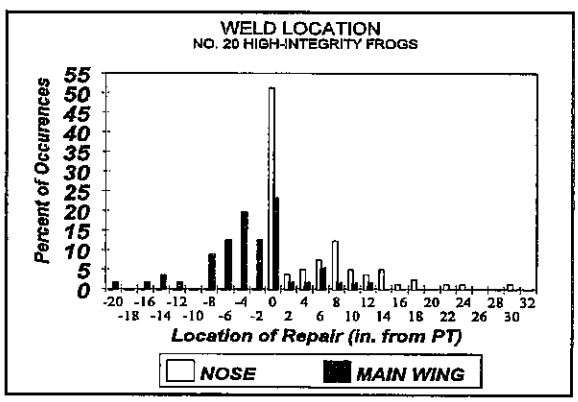

Exhibit 3. Location of Weld Repairs for High-Integrity Frogs

Loaded trains rarely make diverging moves through these turnouts. Included in this study are repair records for 64 No. 20 standard frogs and 138 No. 20 high-integrity frogs. Of the 64 standard frog repairs, 38 (59.4 percent) occurred at the nose and 26 (40.6 percent) occurred on the main wing. Of the 138 repairs made to the high-integrity frogs, 82 (59.4 percent) occurred at the nose while 56 (40.6 percent) occurred at the main wing. Hence, the repair distribution between the nose and the main wing was identical for both the No. 20 standard and high-integrity frogs.

The range of repair locations for both the nose and the main wing varied, with the No. 20 high integrity frogs exhibiting a more normal distribution. Standard frog repairs for the main wing ranged from -12 to +16 inches with nose repairs ranging from 0 to +26 inches. The high-integrity frog has a range of main wing repairs of -20 to +12 inches and 0 to +30 inches for the nose.

For the high-integrity frogs, the majority of the frog nose repairs were conducted at the point, whereas for the standard frog, the majority of the repairs on the nose occurred at two places: the point, and in the vicinity of 8 to 12 inches. The majority of the wing repairs on the high-integrity frogs occurred at the point or on the toe (negative values), whereas repairs for the standard frog occurred equally on both sides of the point.

Average weld repair dimensions for No. 20 standard and high-integrity frogs are displayed in Exhibit 4. Note that some repairs extend through the full thickness of the casting.

Exhibits 5 and 6 illustrate the repair life distributions of the nose and main wing for both frog types. The histograms indicate that approximately two-thirds of the nose and main wing repair data is huddled around 15 MGT for the standard frog and 20 MGT for the high integrity frog. The average nose and main wing repair lives for the standard frog are 17 and 18 MGT respectively. Likewise, the average nose and main wing repair lives for the high-integrity frog are 28 and 26 MGT. The high-integrity

graph exhibits more of a "tail," indicating that a small percentage of the repairs will last a long time. Further work is needed to identify the common characteristics of these superior performers.

Exhibit 4. Approximate Dimensions of Frog Weld Repairs

Parameter	Standard Frog		High Integrity Frog	
	Nose	Main Wing	Nose	Main Wing
Dist from nose tip (in)	7.7	-1.1	4.6	-3.3
Length (in)	13.4	17.9	17.0	20.8
Width (in)	.6	1.4	.6	1.3
Depth (in)	1.0	1.0	.9	.8
Volume (in^3)	8.1	23.0	9.1	21.9
Weight (lbs)*	2.3	6.6	2.6	6.3

* Based on an assumed weld specific weight of 0.286 lb/in^3

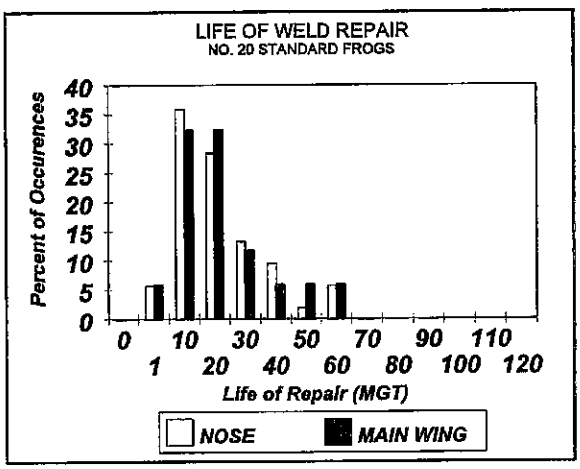

Exhibit 5. Life of Weld Repairs for Standard Frogs

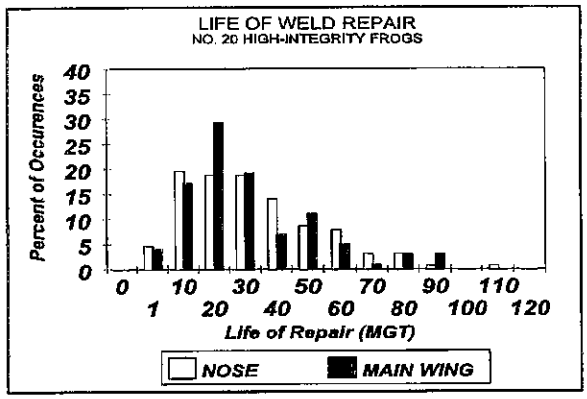

Exhibit 6. Life of Weld Repairs for High-Integrity Frogs

Comparison of the locations of consecutive repairs on the nose and main wing showed that repaired areas almost always overlap. For the No. 20 high-integrity frog, repairs to the nose and main wing overlapped previous repairs 90.6 and 71.7 percent of the time respectively. For the No. 20 standard frogs, repairs to the nose and main wing overlapped previous repairs 83.3 and 62.3 percent of the time. These differences might be related to the longer weld lengths of the high-integrity frogs.

ACKNOWLEDGMENT

The authors would like to acknowledge the assistance and cooperation of the Union Pacific Railroad. This report would not have been possible without the excellent records provided by Mike Larson, Manager of Track Maintenance and the coordination and support provided by Jack Mullen, Senior Project Manager, and David Connell, Senior Manager of Engineering Research.

__Note:__ Contact David Davis at (719) 584-0754 or Peter Rogers at (719) 584-0757 with questions or comments about this document.