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## Implementation Demonstration of Wayside Based TOR Friction Control Union Pacific Railroad – Walong, CA

By Richard Reiff,\* Tony Makowsky,\*\* and Marty Gearhart\*\*\*

### Summary

The results from monitoring six wayside-based top of rail (TOR) systems along a Union Pacific service line suggests significant reductions in curving forces and low rail wear rates. Data collected indicates curving force performance is influenced significantly by train operations. Trains operating upgrade achieved reduction in curving forces of 31 to 58 percent with TOR systems activated. Trains operating downhill with sustained air braking, however, experienced far less (0 to 18 percent) reductions under the same TOR conditions.

Rail wear measured over a 120 MGT period indicated that top of low rail wear rates were reduced by an average of 58 percent, while results from high rail of curves (gauge face and top of rail) were mixed. Curves near areas where inspections confirmed adequate gauge face lubrication had been maintained showed little or no change in wear rates, while curves where gauge face lubrication was occasionally determined to be marginal showed an increased wear rate with TOR systems. Although gauge face lubrication was improved during this period, it was not uniform and some curves were not well protected. For this area, the effect of TOR or long-term gauge face wear rates was not determined.

No indications of rail surface fatigue or spalling were noted during the 120 MGT period. The applicators were spaced over 5-miles apart in a severe mountain territory of 2-percent grades and continuous curves of up to 10 degrees. Trains traveling upgrade used sanding and trains traveling downgrade used air brakes. The configuration of sidings was such that some trains could bypass gauge and TOR application systems, contributing to the variable results. A follow-on evaluation is planned to monitor rail wear rates after gauge face and TOR applicators have been installed in all sidings to maintain proper lubrication on all trains passing the site. Comprehensive rail wear information is needed to confirm the cost benefit case for wayside based TOR in territories where rail life is a major concern.

Railroads intending to install wayside-based TOR systems should evaluate spacing and location of applicators to ensure they are installed on single track segments. Where significant amounts of double track or extended sidings are encountered, dual applicators (one for each track) should be used.

\*TTCI

\*\*Kelsan Technologies

\*\*\*Union Pacific



## BACKGROUND AND OBJECTIVES

Benefits from controlling top of rail (TOR) friction have been demonstrated in numerous trials using wayside, hi-rail, and locomotive-based applicator systems.<sup>1-6</sup> Primary benefits provided by TOR systems have included:

- Reduced Curving Forces
- Reduced Rail Wear Rates

To date, most revenue service demonstrations of TOR application systems have only been conducted during short timeframes, evaluating field performance issues of prototypes. This report summarizes results from implementing these systems for over a year. Key parameters, included:

- System Reliability
- Effectiveness under a Range of Traffic
- Interaction with Gage Face Lubrication
- Influence on Curving Forces
- Influence on Rail Wear

## TEST SITE

The test site, near Walong, California, is on a mountain railroad with 2 percent grades and numerous 10-degree curves. Rail life in the curves is generally less than 3-5 years (200-400 MGT). The site was near previous wayside TOR applicator trials. The initial trials conducted in 2002 and 2003 utilized prototype equipment to determine if the applicators would interfere with normal train operations and to obtain preliminary carry distance and applicator spacing information.

Figure 1 shows the track layout between MP 349.5 and MP 355, which was the distance of the demonstrations. It also shows locations where 4 of 7 improved solar-electric wayside gage-face applicators were installed. During this project, numerous inoperative, older hydraulic gage face applicators were replaced with improved units.

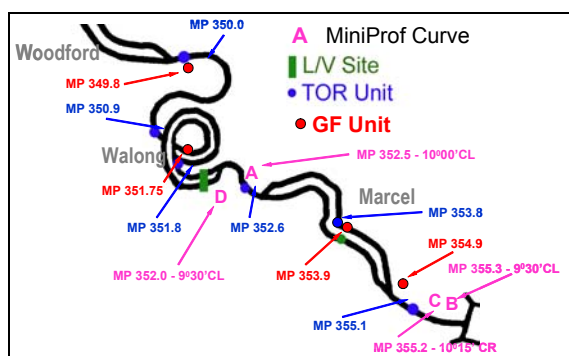


Figure 1: Site Layout showing Curves and Positions of Wayside TOR and Gage Applicators

Northbound traffic at this location is downgrade and operates in decreasing mileage, while southbound trains operate upgrade in an increasing mileage direction.

This was the first time multiple wayside TOR units were installed in such a territory. The trial was broken down into a number of periods to allow TOR applicator deployment and output rates to be optimized. This permitted accurate evaluation of TOR effects on curving forces and rail wear.

## KEY MILESTONES AND OBSERVATIONS

- 12/03:** Install lateral force detector
- 3/04:** Initial baseline gage face only data using standard LI + graphite track grease
- 4/04:** Start 5-month period of wayside TOR mixed with standard gage face, adjusting TOR applicator rates

Results suggested:

- Inconsistent curving forces (range -30 to +23 percent). Likely due to:
  - Initial baseline (gage face only) period too short
  - Grease contamination from gage face lubricators
  - Locomotive sanding
- 9/04:** Decision made to re-baseline gage face only performance. Installed upgraded gage face equipment, new lubricant

Summary of gage face matrix revisions:

### Before 9/04:

- Two applicators per mile
  - Mechanical/hydraulic
  - Few working
  - Periodic hi-rail application

### After 9/04

- Seven improved Portec Protector IV units with long blades installed (4 per site)
  - Soy-based grease
  - Hi-rail application terminated

**11/04:** After improving gage face lubricators, gage face only data collected:

- 1/05:** Reactivated Wayside TOR
- 5/05:** Final rail wear measurements

**KEY RESULTS**

**Curving forces**

Curving forces were collected for every axle for every train, and then sorted by direction and axle load. For purposes of this study, lead axle loaded car data (> 25 kip wheel load) was used because these cars/axles produce the highest forces and impart the most damage to track.

Figure 2 shows average curving forces generated by lead axles/loaded cars for southbound (uphill) trains during the gage face only baseline period (with Soy grease) and the following gage face+TOR period. Likewise, Figure 3 shows average curving forces for the same two periods for all northbound (downgrade) trains.

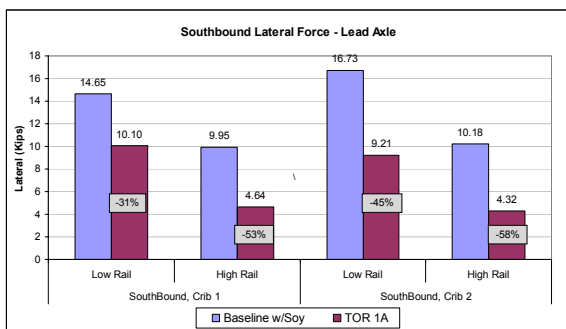


Figure 2. Curving Performance, SB Trains

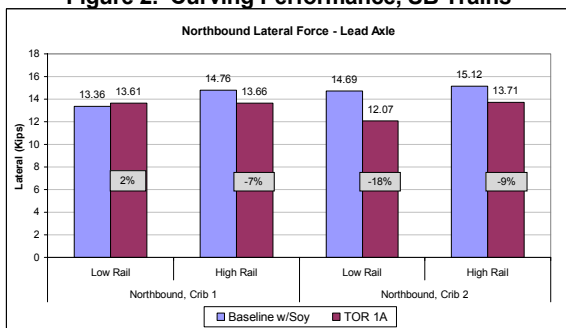


Figure 3. Curving Performance, NB trains

Results suggest that when the wayside TOR units were activated, curving forces produced by loaded cars for southbound trains were reduced by 31 to 58 percent. The effect on northbound trains was not as beneficial, with reductions of 0 to 18 percent.

**Rail Wear**

Rail wear data was collected on a periodic basis during the demonstration using MiniProf™ measurements. At each site, subsequent profiles were compared to the initial data for each curve to compute wear rates for each of the four performance periods. With the level of rail wear expected at this site, at least 25-30 MGT per condition was allocated to generate measurement differences between performance periods:

1. Initial baseline: (gage face only)
2. TOR optimization (gage face + TOR)

3. Second baseline (gage face w/Soy grease)
4. Final gage face + TOR period (w/Soy grease)

Low rail performance provided the most uniform data. Figure 4 shows average wear rates for top of the low rail for each of the four curves during the four periods. Figure 5 shows dimension changes to the gage face of the high rails for the same curves and periods. Note that the gage face wear performance appears as two distinctive groups, one for curves A and C, the other for curves B and D. Curves B and D are the closest to the load station and nearest to the area where a dry gage face was noted during some inspections. The average gage face wear rates of paired performance for A and C compared to B and D are shown in Figure 6.

Similar performance was obtained for high rail top (vertical) wear.

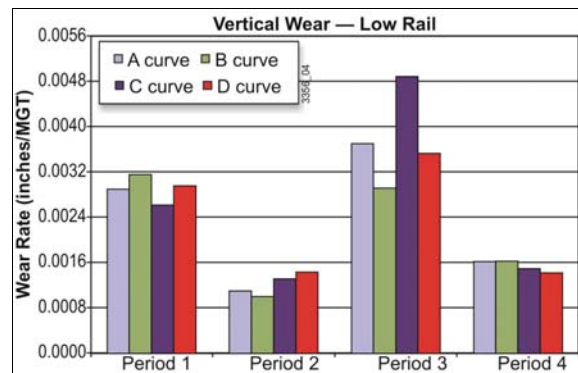


Figure 4. Low Rail Wear Data by Performance Period

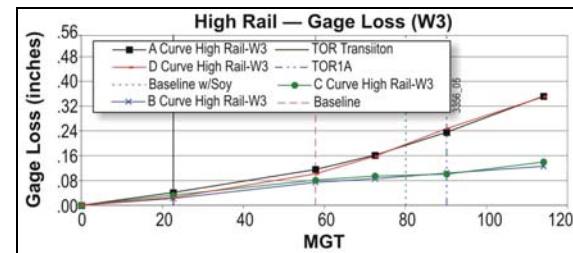


Figure 5. Gage Face Wear Data by Performance Period

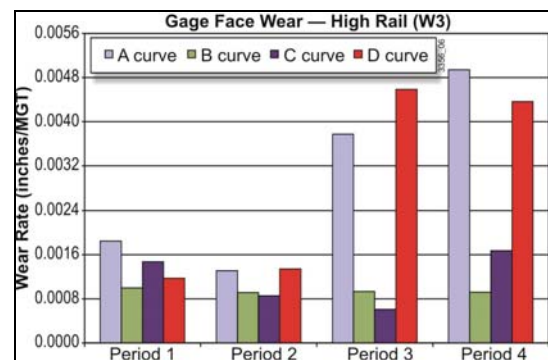


Figure 6. Gage Wear by Performance Period and Rail Curves (A-D)

## SUMMARY AND DISCUSSION

The site produced measurable results in both curving force behavior and rail wear when TOR systems were activated. Top of low rails exhibited approximately 58 percent less wear during both gage face + TOR periods than during the two gage face only baseline periods. This suggests that low rail wear life was significantly improved with TOR. During the same periods, however, high rail gage face wear and top of rail wear rates were mixed. Curves at the extreme south end of the site exhibited about the same wear rate during all periods; however, the curves near the middle of the site (A & D) experienced significant increased gage face wear during the second baseline gage face only and second gage face + TOR periods.

Curving forces were reduced by at least 30 percent for almost all southbound trains, while northbound trains produced reductions of  $\leq 18$  percent, with many northbound trains demonstrating little or no reduction.

This disparity in performance is attributed to a number of site and train operating conditions. Most northbound trains require the use of airbrakes to control speed. This creates hot wheels from brake shoes rubbing on wheel treads, which also removes some TOR material. Contributing to variability of results is the site configuration which results in many trains passing each other at Marcel and Woodford sidings, neither of which is equipped with gage face or TOR applicators. Trains operating through these sidings receive less gage face lubricant and TOR materials, contributing to variable gage face lubrication within the zone. This produces variable results for northbound and southbound trains while also making it difficult to determine effectiveness of TOR in reducing rail side (gage) wear.

### Rail Fatigue

Rail surface conditions were closely monitored during all field inspections utilizing visual and dye penetrant methods. No rolling contact fatigue or other defects were noted at, near, or adjacent to wayside TOR applicators.

### Reliability and Maintenance

Older gage face lubricators did not produce adequate lubrication and were replaced. Additional improvements were made to gage face applicator bars to further enhance product distribution. No significant TOR bar operating problems were experienced.

### FUTURE PLANS/RECOMMENDATIONS

The results suggest that additional wayside applicators (both TOR and gage face) be installed in sidings to ensure all trains receive adequate friction control materials and lubrication. Because so many trains operate over sidings, and applicator placement on single

track segments is limited, this will ensure that regardless of train routing adequate materials are being applied. This layout will improve coverage to ensure adequate materials are being applied regardless of train routing.

A measurement period to monitor rail wear after installation of a revised layout with applicators on sidings is being considered. By comparing these results to nearby similar curves, with gage face only, the effectiveness of TOR in reducing wear rates of the gage face as well as top of rail can be obtained.

## ACKNOWLEDGMENTS

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## REFERENCES

1. Reiff, Richard and Scott Gage. "Evaluation of Three Top of Rail Lubrication Systems," Research Report R-936, Association of American Railroads, Transportation Technology Center, Inc., November 1999.
2. Toma, Elton, Scott Cummings and Richard Reiff. "A NUCARSTM Study on the Effects of Top of Rail Lubrication on the Performance of Freight Cars," Research Report R-957, Association of American Railroads, Transportation Technology Center, Inc., July 2002.
3. Reiff, Richard P. and Scott Gage. "Demonstration of the Viability of Top-of-Rail Lubrication for Freight Railroads," *Technology Digest* 99-016, Association of American Railroads, Transportation Technology Center, Inc., May 1999.
4. Otter, Duane and Brian Doe. "Bridge Capital Spending on Three Heavy Axle Load Routes," *Technology Digest* 03-017, Association of American Railroads, Transportation Technology Center, Inc., August 2003.
5. Reiff, Richard and Kevin Conn. "Implementation Issues Affecting Locomotive-Based, Top-of-Rail Friction Control System Effectiveness," *Technology Digest* 03-019, Association of American Railroads, Transportation Technology Center, Inc., September 2003.
6. Reiff, Richard and Thomas Brueske. "Preliminary Implementation Issues for Wayside-Based Top of Rail Friction Control Application Systems," *Technology Digest* 03-020, Association of American Railroads, Transportation Technology Center, Inc., September 2003.

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