Effect of Top of Rail Friction Control on Rail Performance

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Presentation Overview

- Project background and objectives.
- Site description.
- Monitoring efforts.
- Significant results.
- Issues and concerns.
- Questions/Discussion.

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LBFoster Friction Management

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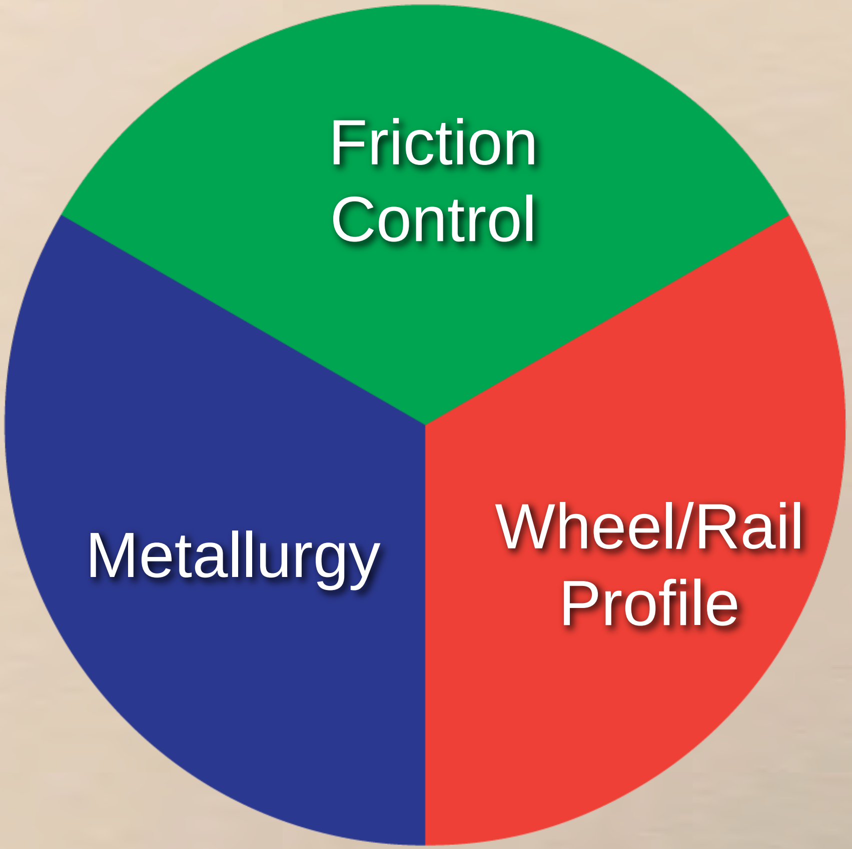
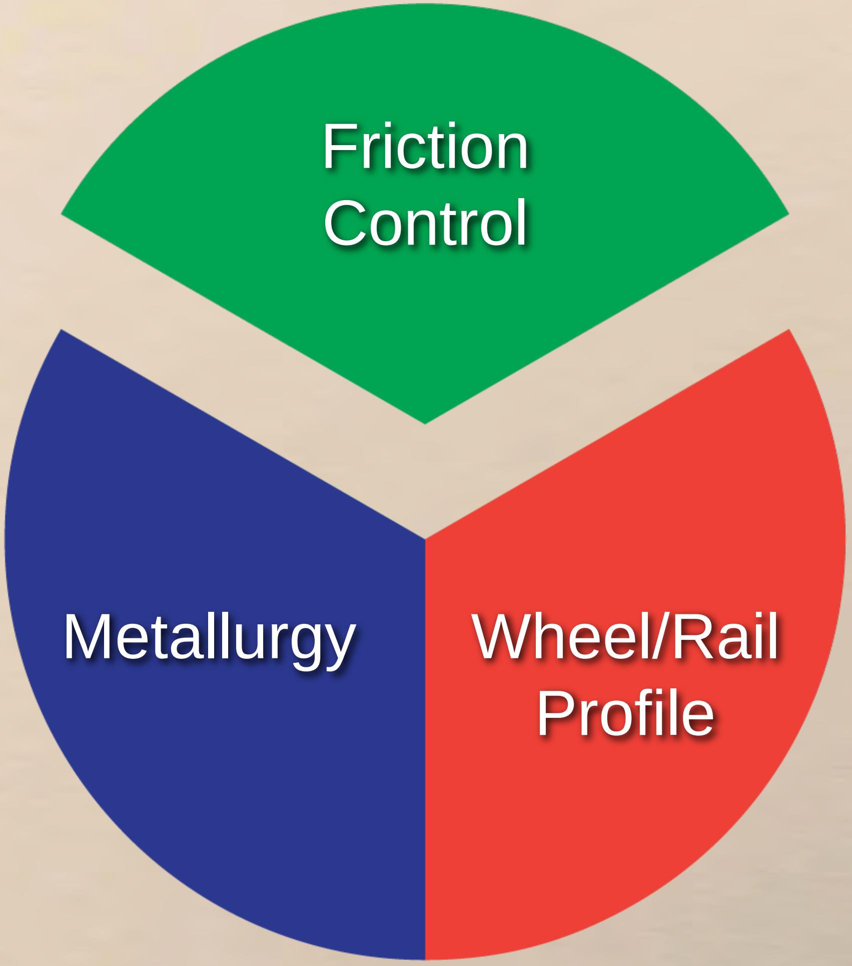
Wheel/Rail Interface Management
Extending Rail/Wheel Life



Implementing Top of Rail Friction Control Benefits, Implementation Issues



Project Overview and Justification

- Previous AAR and member railroad demonstrations of TOR
  - Carefully controlled implementation, maintenance, inspection.
  - Limited curvatures (e.g. UP site only 10° curves).
  - Insufficient controls – traffic, rail age, rail types.
  - Results encouraging.
    - Suggest rail wear savings > 40%.
- Need for "real world" results.
  - Everyday conditions of maintenance and inspection.
  - Range of curvatures.

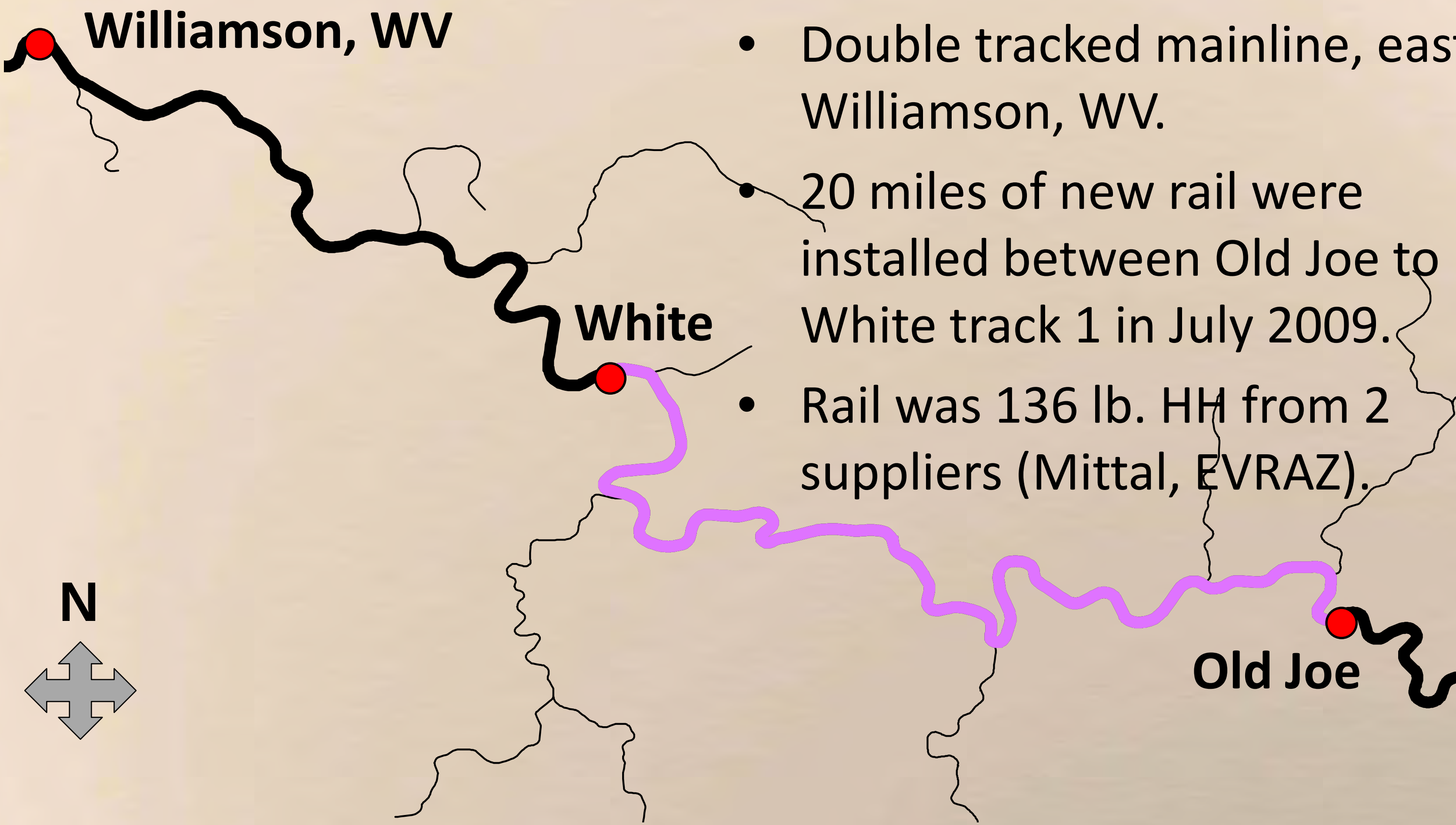
Previous AAR Demonstrations on NS

- Locomotive-based TOR
  - Captina Secondary (Powhatan Point, OH)
    - Equipment logistics issues.
- Wayside-based TOR
  - Captina Secondary (Powhatan Point, OH)
    - Concentrated on curving force performance.
    - Insufficient time/traffic density for rail wear study.
  - Eastern Megasite (Bluefield, WV)
    - Demonstrated reduced curving forces.
    - Rail wear comparison compromised by traffic density (i.e. location), rail metallurgy and age.

New Opportunity - Old Joe to White

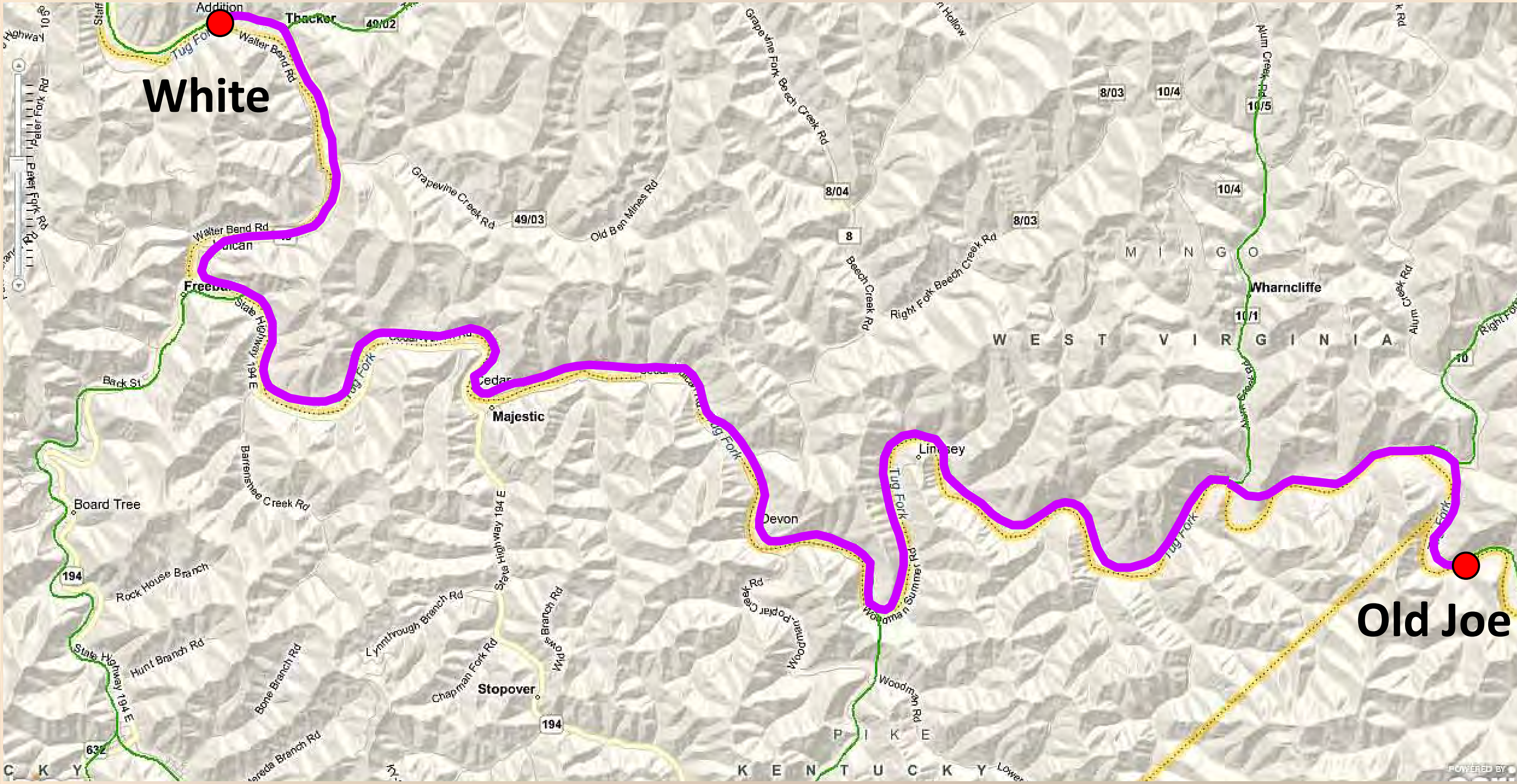
- 20 miles of new rail (dual) installed in July 2009.
- Desire to build test on controls similar to long term demonstrations, such as UP Tehachapi site.
- To do this (i.e. compare TOR rail performance to non-TOR rail performance) requires:
  - Same rail metallurgy, age and train traffic.
  - Limit variables of location (use same line segment).
  - Range of curvatures.
  - Loaded coal trains (HAL) with mixed freight.

Test Site Characteristics



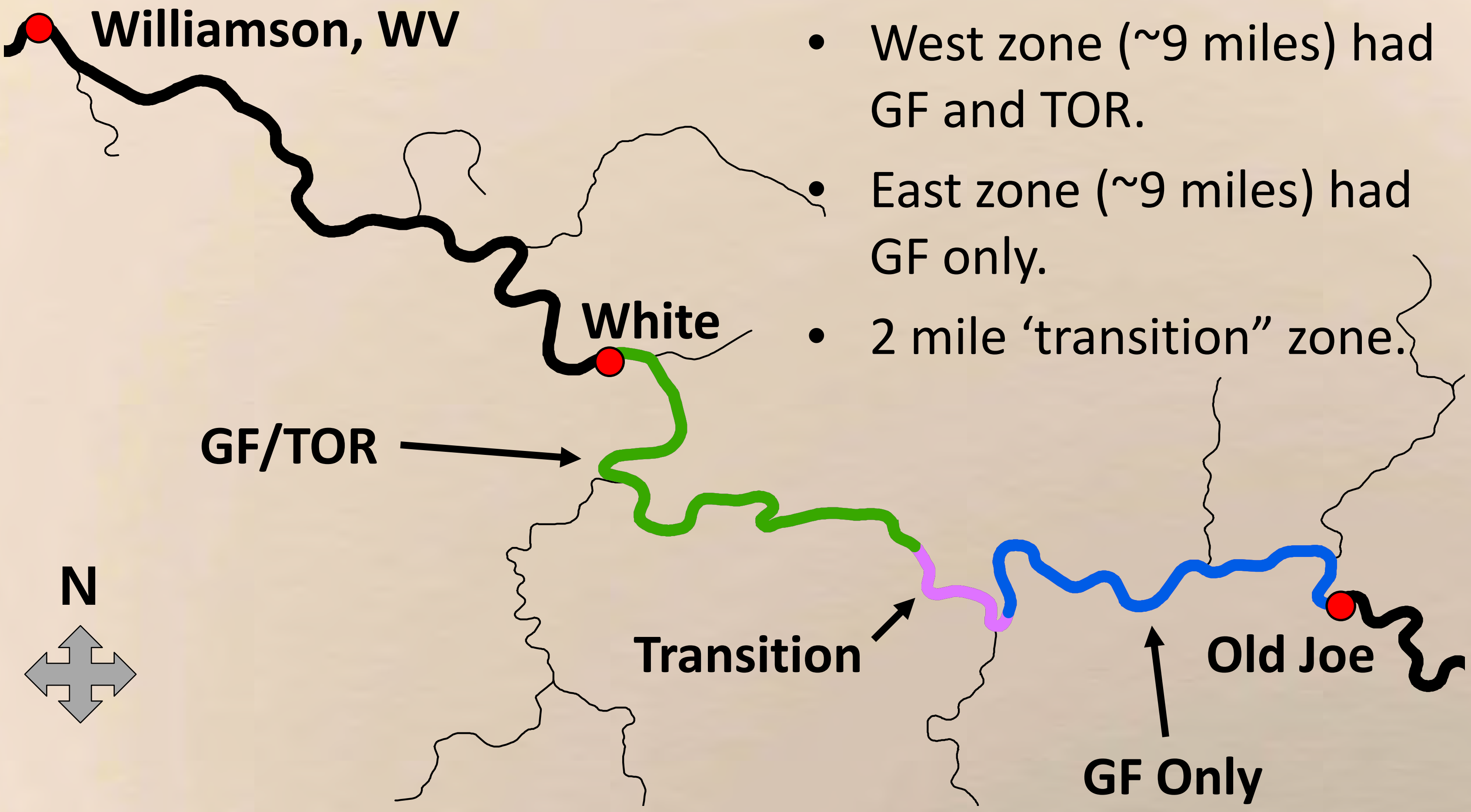
- Double tracked mainline, east of Williamson, WV.
- 20 miles of new rail were installed between Old Joe to White track 1 in July 2009.
- Rail was 136 lb. HH from 2 suppliers (Mittal, EVRAZ).

Test Site Characteristics



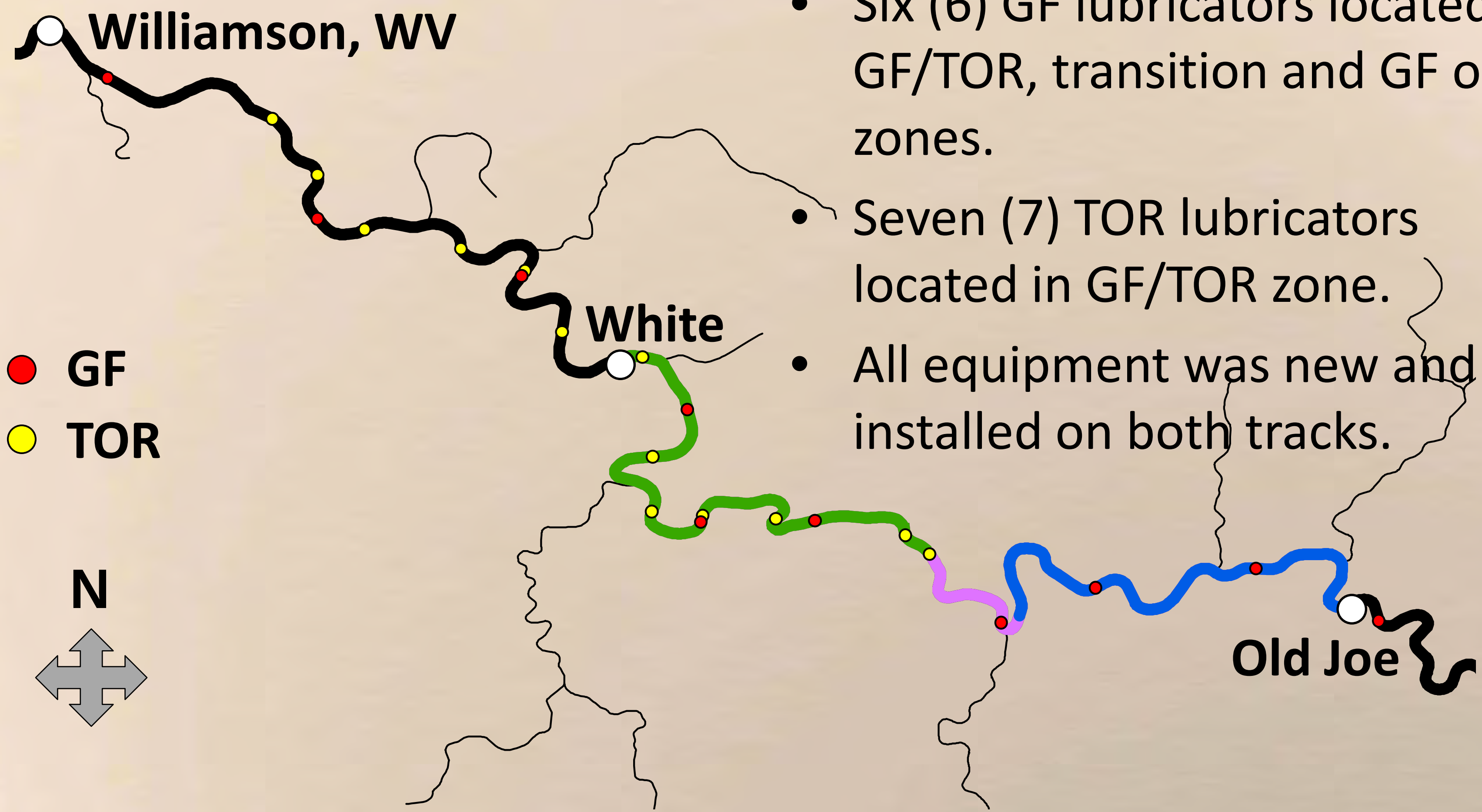
- 3°-12° curves, simple and compound, level grade.

Test Zones – GF/TOR & GF Only



- West zone (~9 miles) had GF and TOR.
- East zone (~9 miles) had GF only.
- 2 mile 'transition" zone.

GF and TOR Equipment Locations



- Six (6) GF lubricators located in GF/TOR, transition and GF only zones.
- Seven (7) TOR lubricators located in GF/TOR zone.
- All equipment was new and installed on both tracks.

GF and TOR Equipment

Gage Face
(2) 55” bars/rail, 48 ports/bar.

Top of Rail
(1) 55” bar/rail, 3 ports/bar.

Train Traffic (Heartland Corridor)

- Primarily loaded coal.
  - 286,000 lb. cars.
  - Head-end power.
  - 35 mph track speed.
- Also subjected to
  - Empty coal.
  - Mixed freight, grain, double stacks.
  - Bi-directional mine pick-ups and setoffs.
  - Variable train speeds.

NS Old Joe Monitoring Efforts

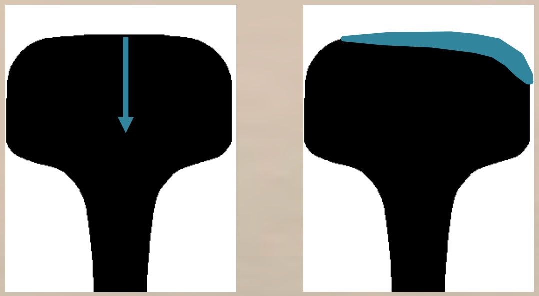
- Rail Wear
  - MiniProf ® used to take rail profiles.
  - 18 curves (9 GF/TOR zone, 9 GF only zone).
  - 12 measurements total per curve in full body, six on the high rail and six on the low rail.
  - Measurements made before and after grinding (~4 months).
- Rail Surface Performance
  - Dye penetrant inspections, 3 locations/curve.
- Equipment performance (RPM), maintenance, repair history.
- Rail grinding history.
- Accumulated tonnage determined for each curve.

Measuring Railwear - MiniProf®

Determined Metrics

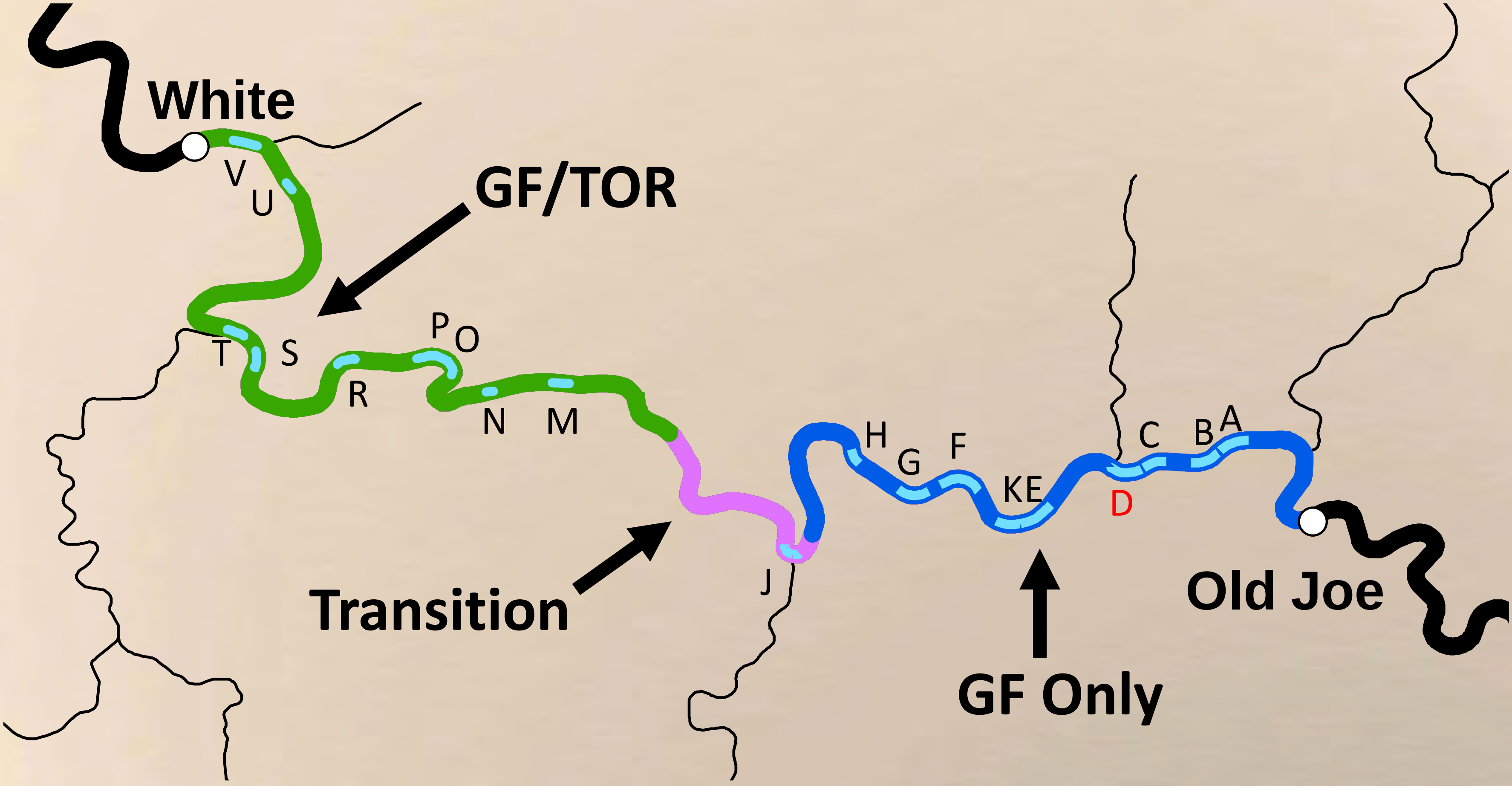
$$\text{Wear Rate} = \frac{\text{Metal Wear}^{1}}{\text{Traffic Density}^{2}}$$

Railhead Surface Cracking (Qualitative)

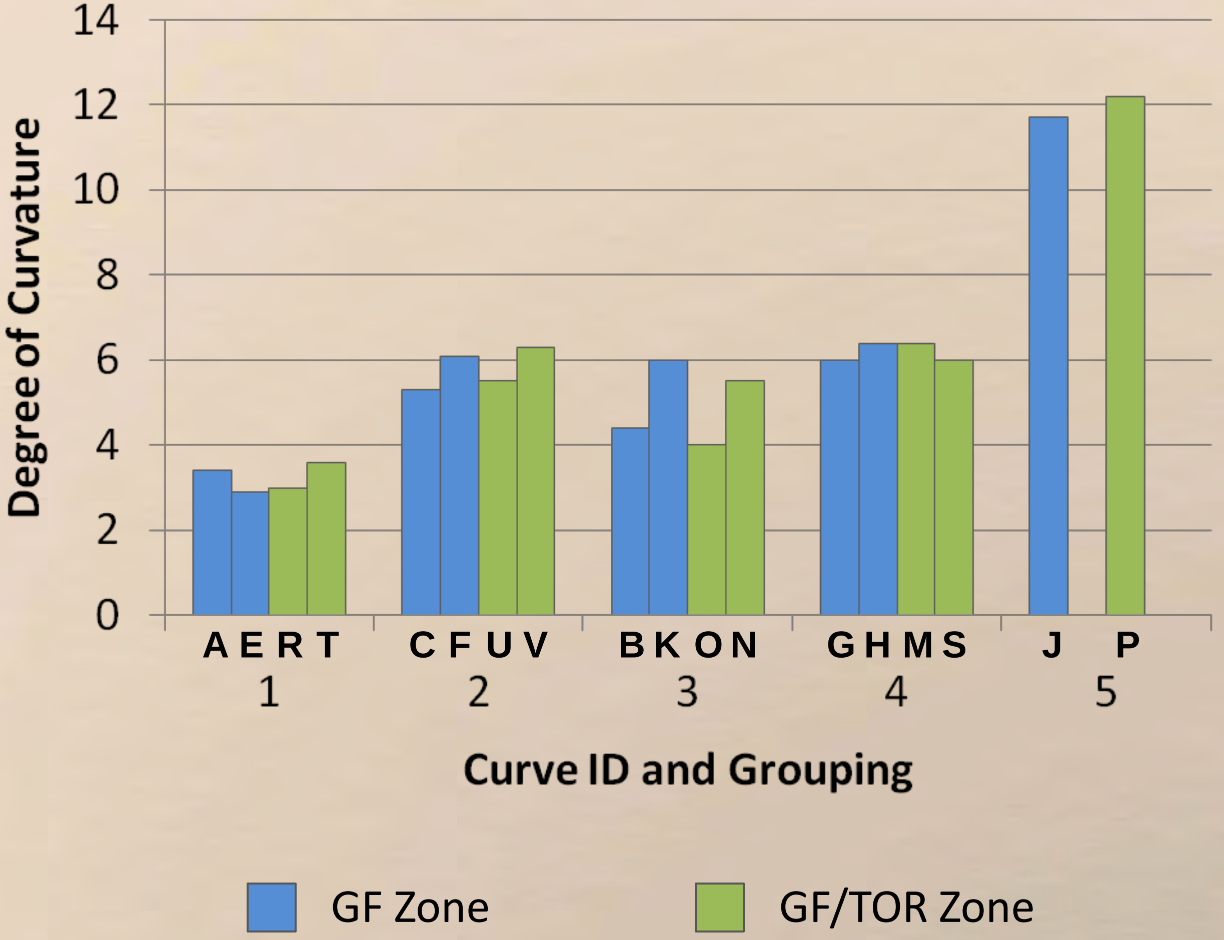


[1] *vertical height, area*
[2] *million-gross-tons (MGT)*

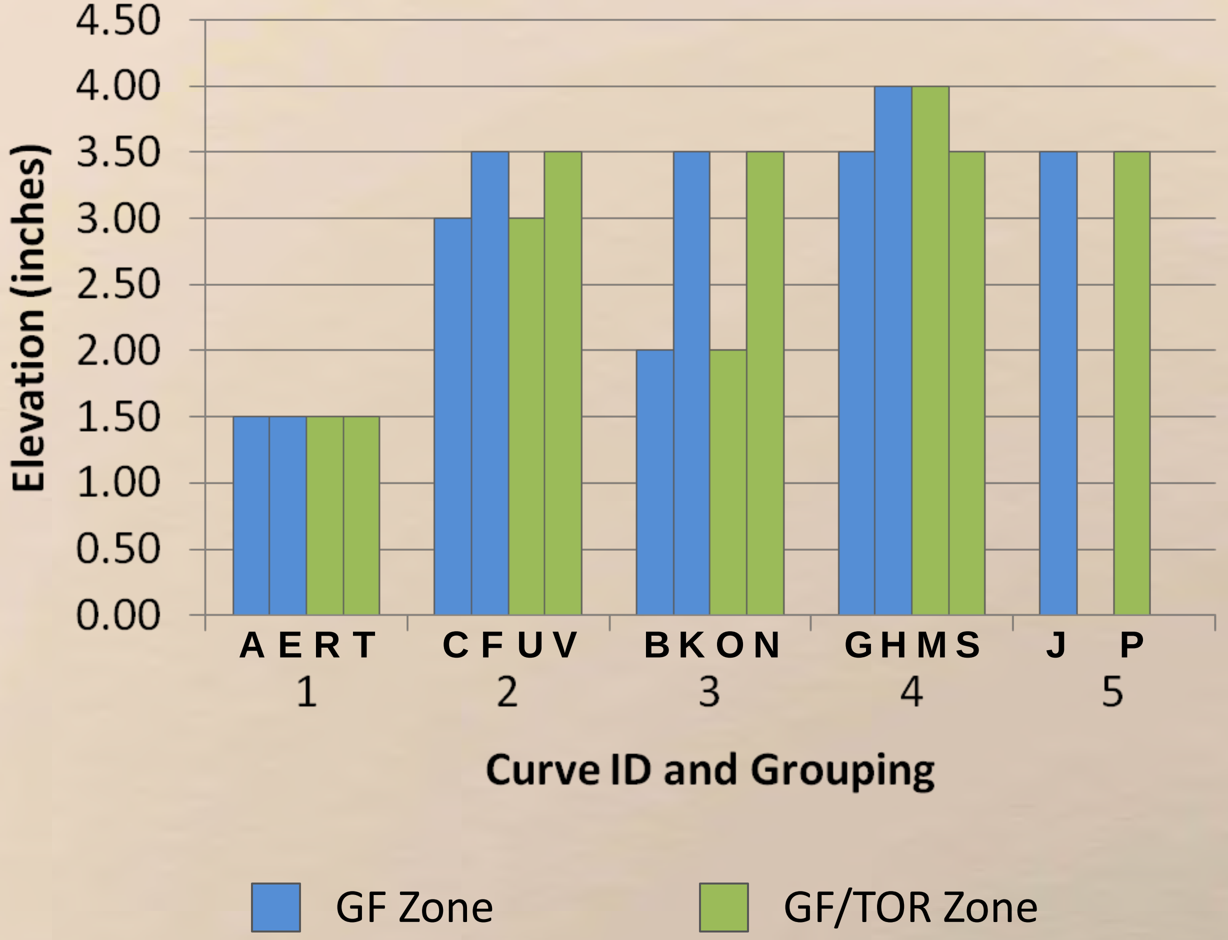
Rail Wear Test Curves



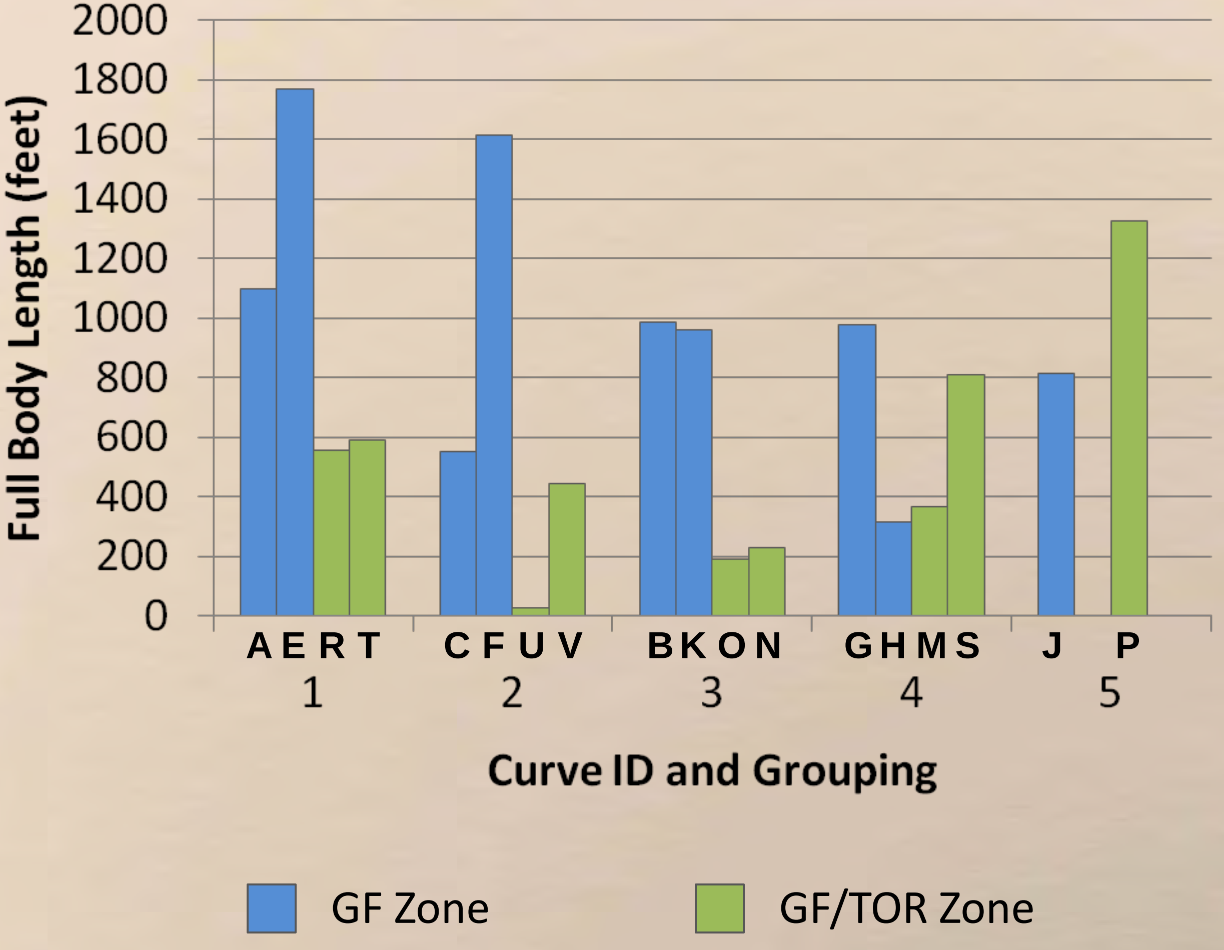
Curve Characteristics - Curvature



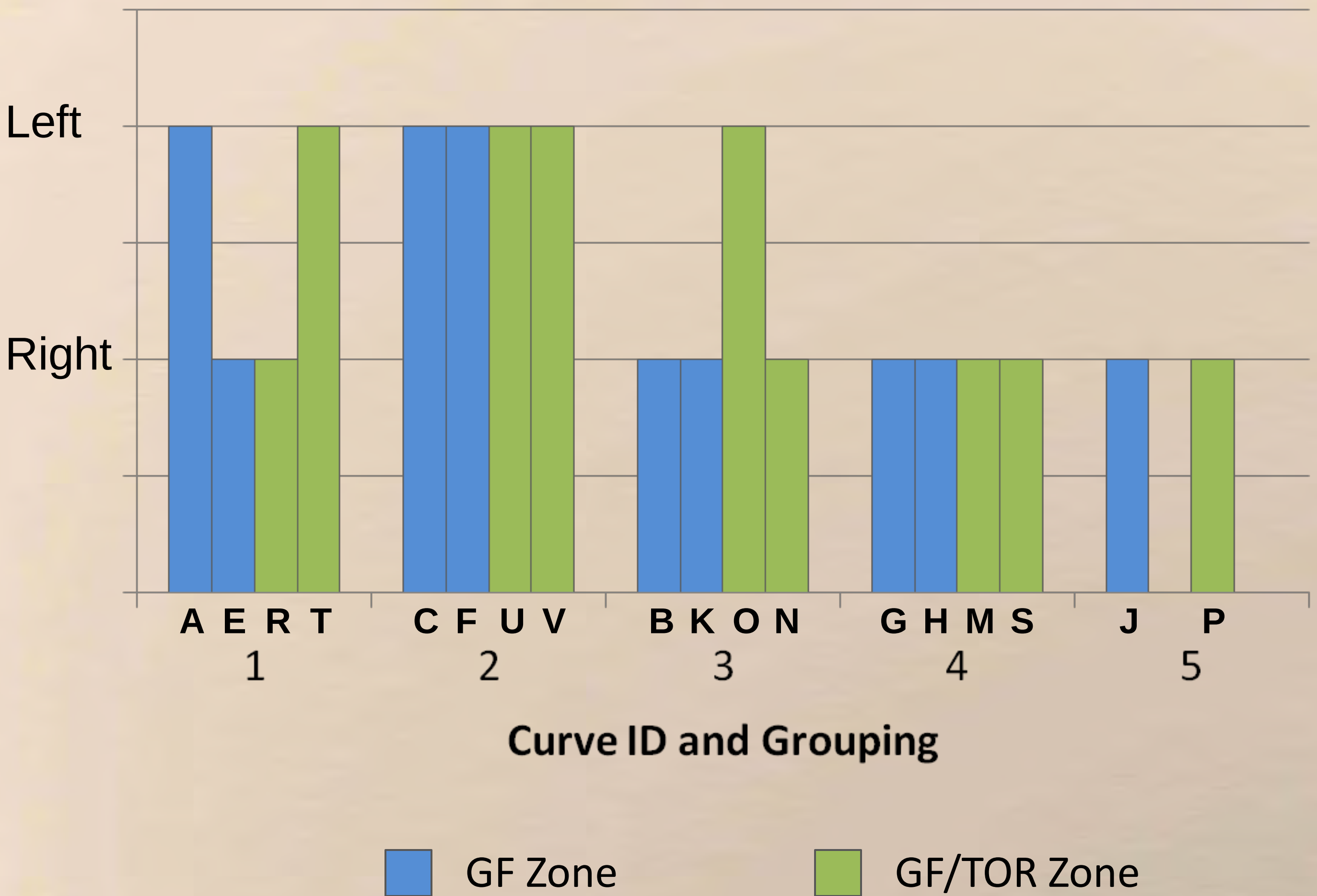
Curve Characteristics - Elevation



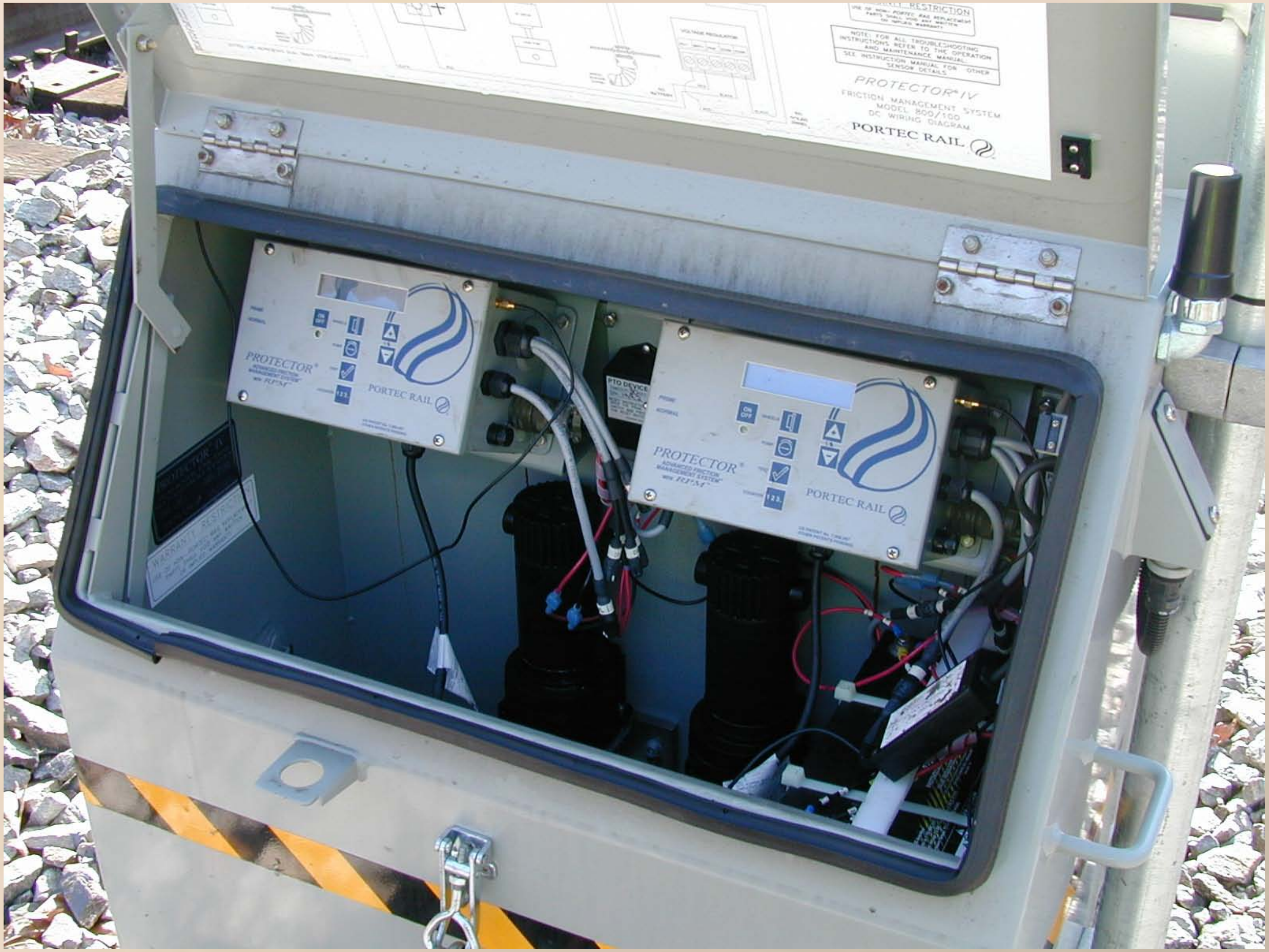
Curve Characteristics - Length



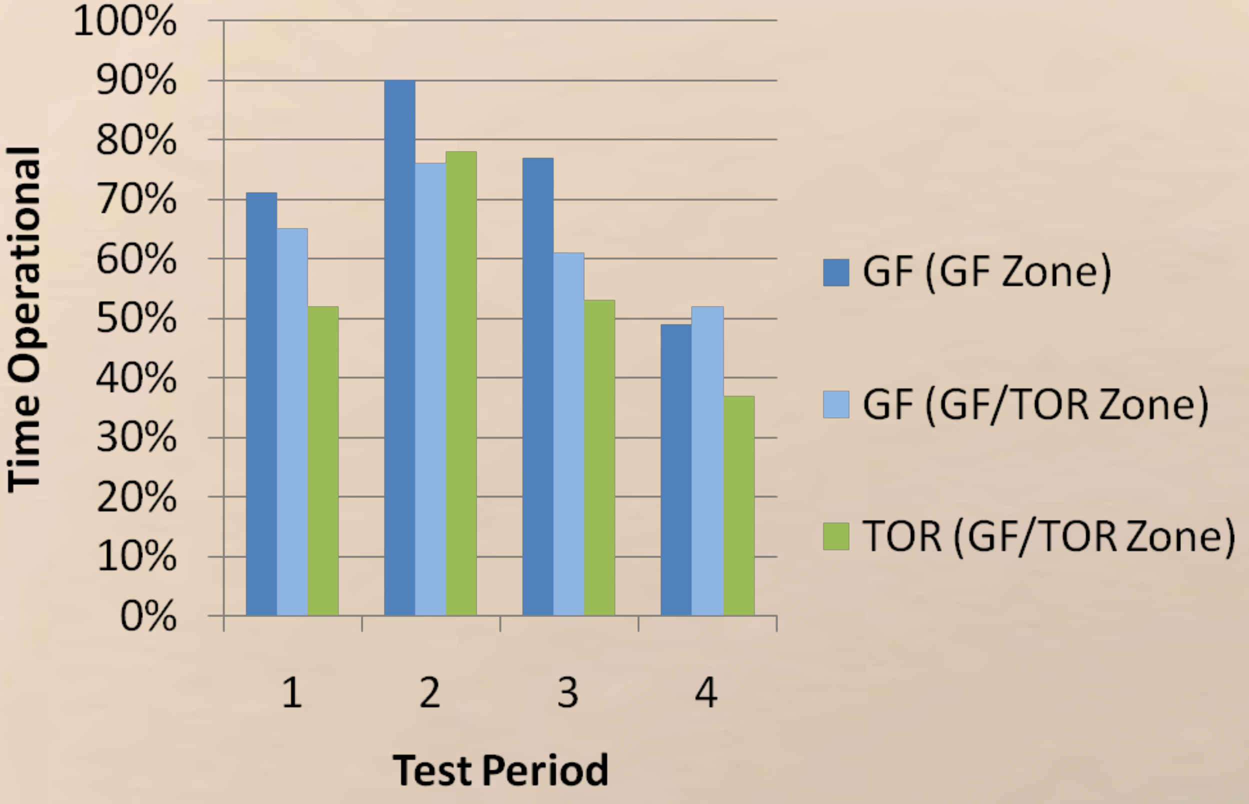
Curve Characteristics - Direction



Monitoring GF & TOR Performance



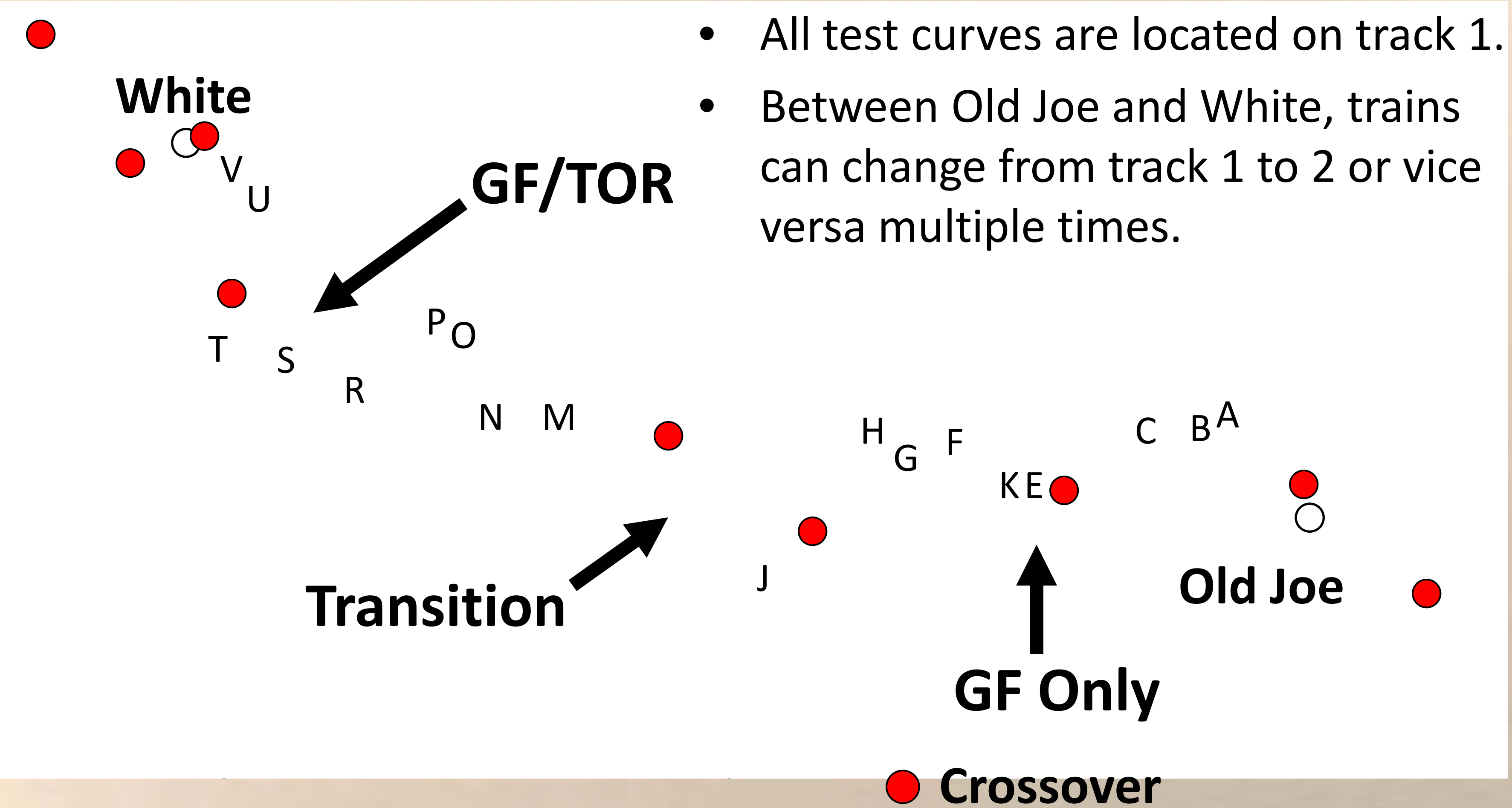
GF & TOR Equipment Status



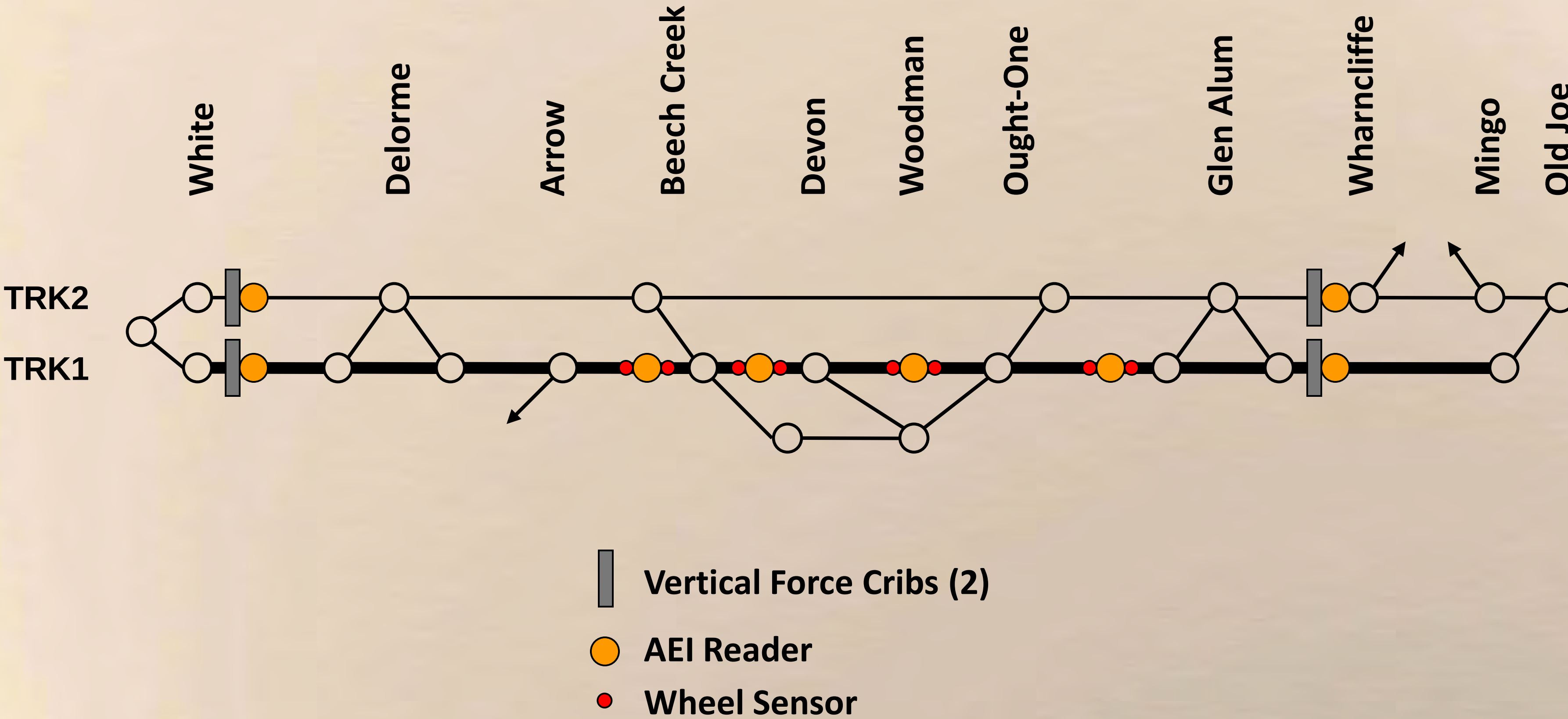
MGT – Crossovers & Branch Lines

Location of Test Curves & Crossovers

- Area between Old Joe and White is double-tracked.
- All test curves are located on track 1.
- Between Old Joe and White, trains can change from track 1 to 2 or vice versa multiple times.

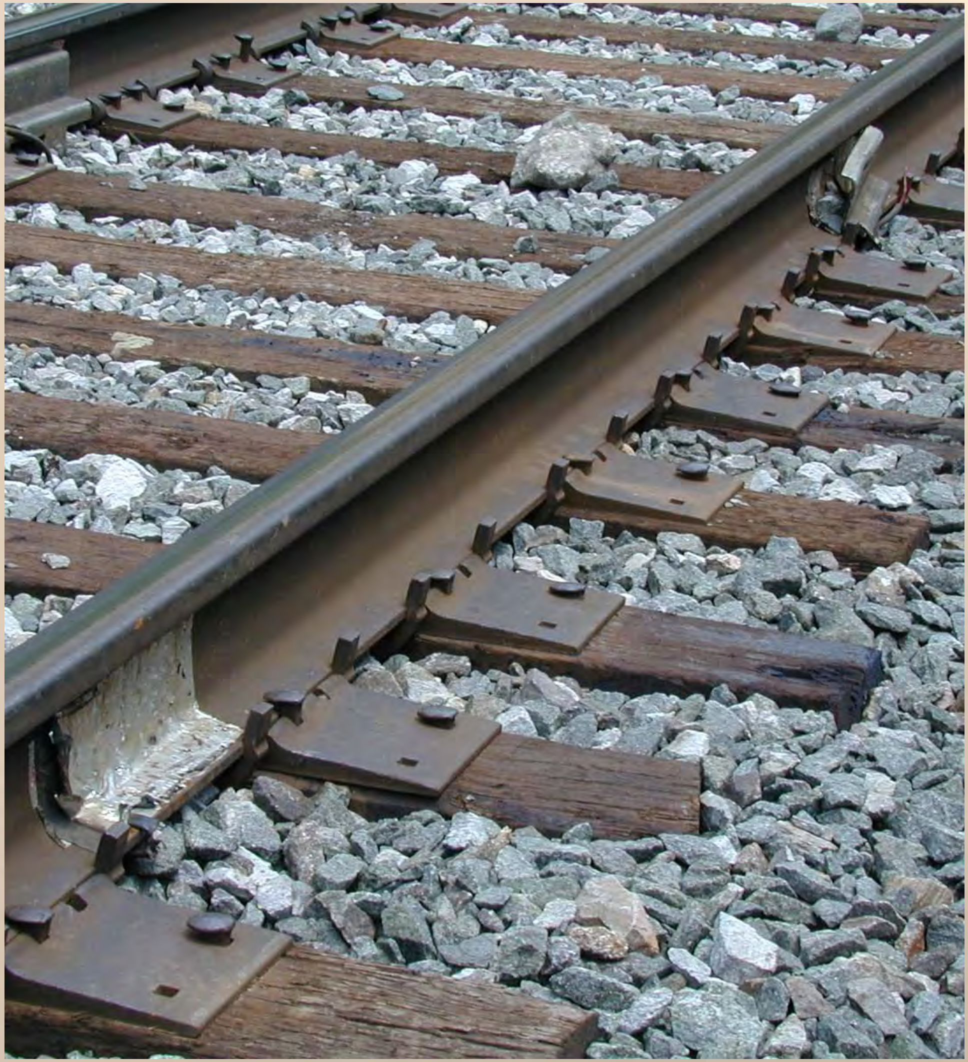


Approach 1 - Train Tracking & MGT



Approach 1 - Train Tracking & MGT

Approach 1 - Train Tracking & MGT

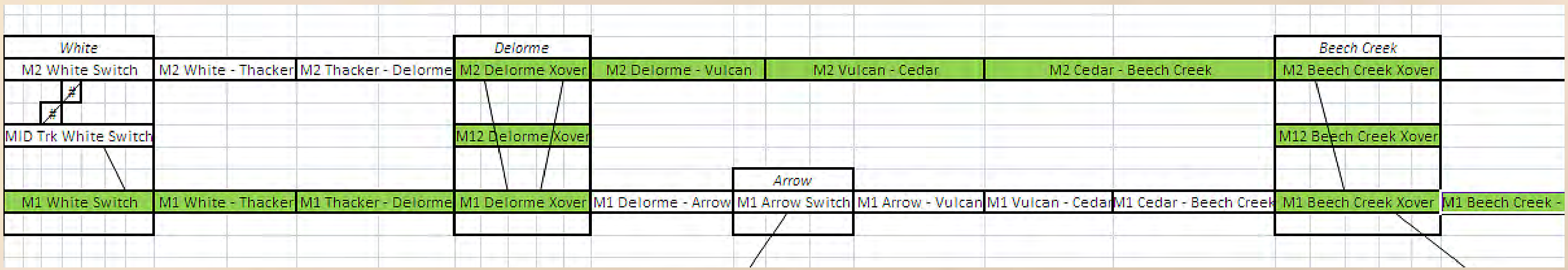


Approach 2 - Train Tracking & MGT

- Route history for every train tracked from Dispatcher's display.

Approach 2 - Train Tracking & MGT

Train Route History



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Train Tonnage Reports

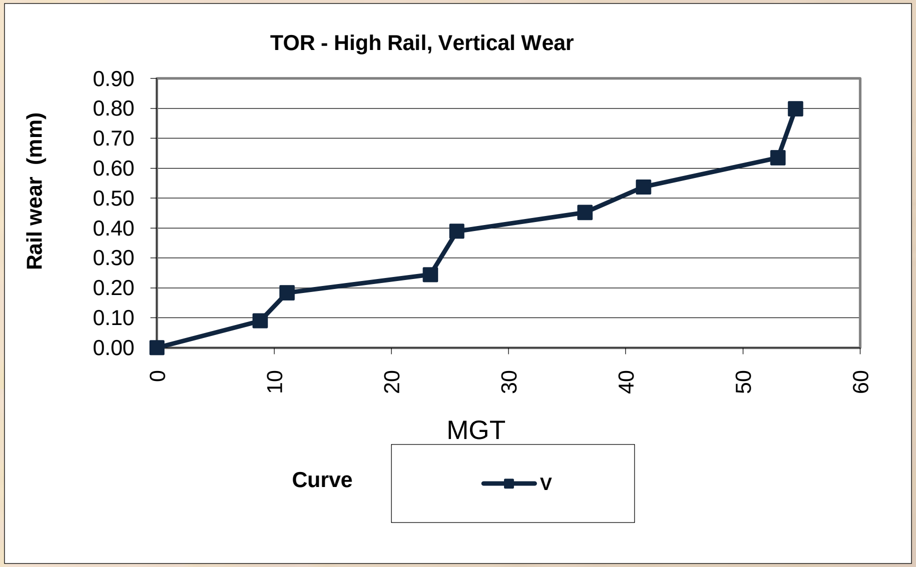
= Accumulated MGT per curve

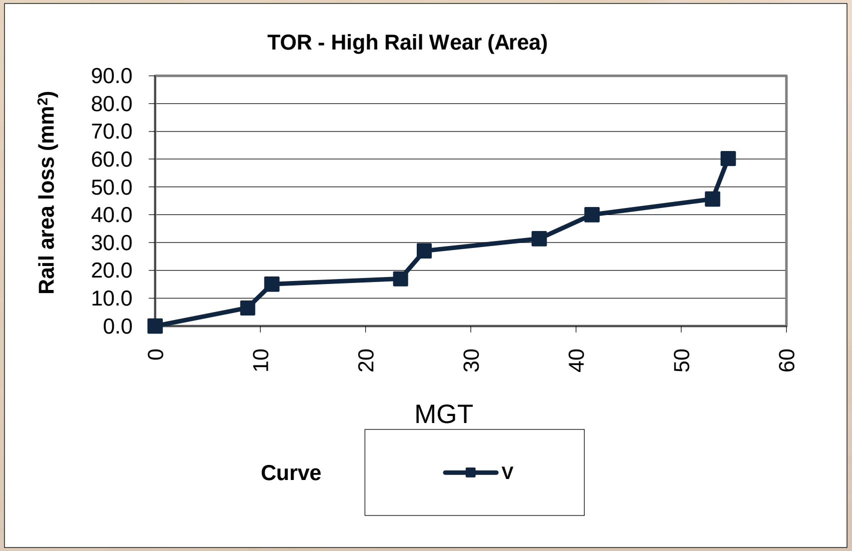
Rail Wear Test Curves and ID Codes

Limited groupings used for this presentation

Curvature range	TOR + GF	GF Only
3°	R, T	A, E
5°-6°	M, N, O, S, U, V	B,C,F, G, H
12°	P	J

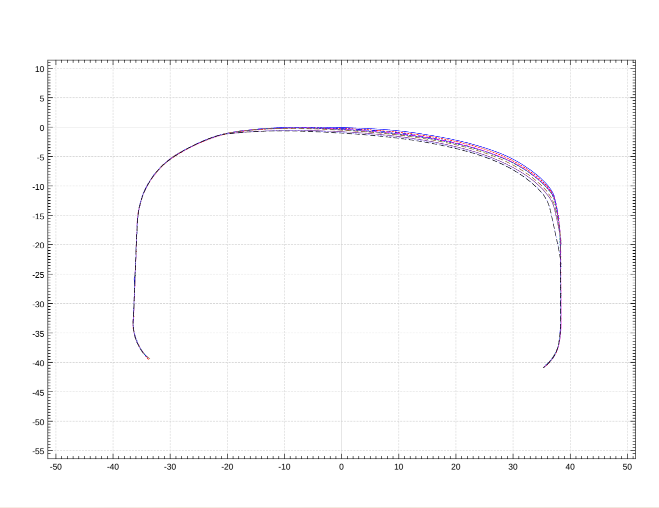
Typical Time/MGT Wear Plot Curve V
Data collected at Pre- and Post-Grinding

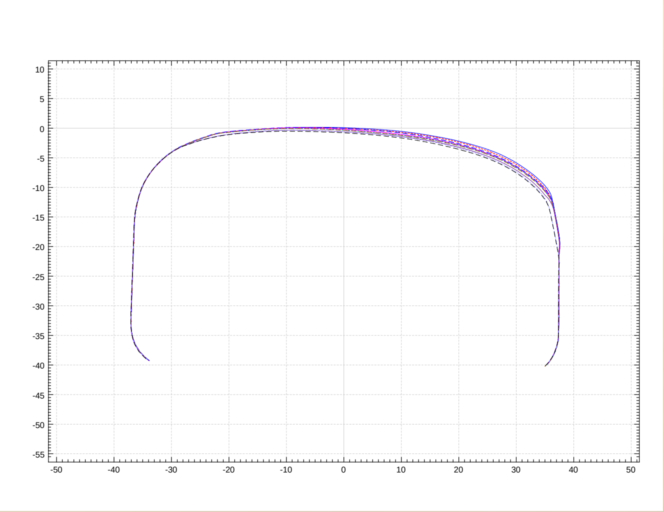


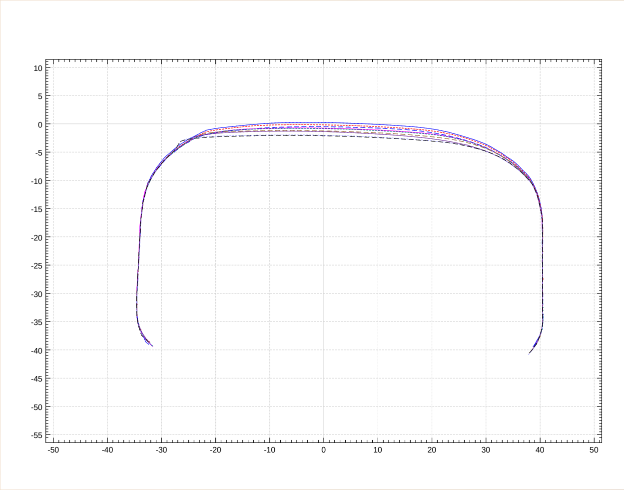


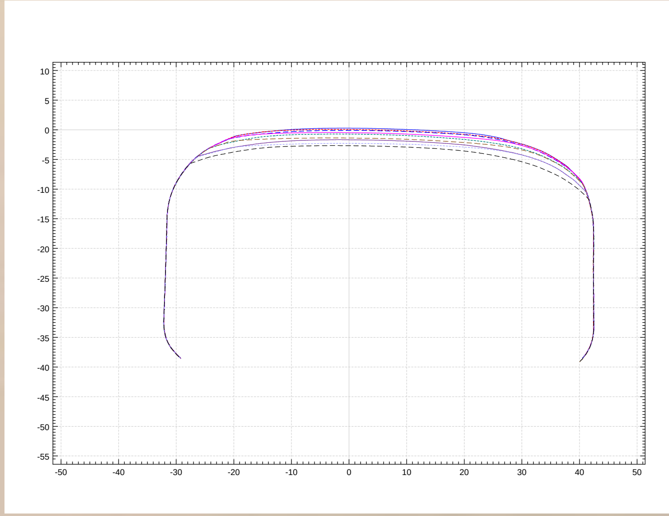
Profile Changes after 70 MGT

GF/TOR left 12 °curves GF only right



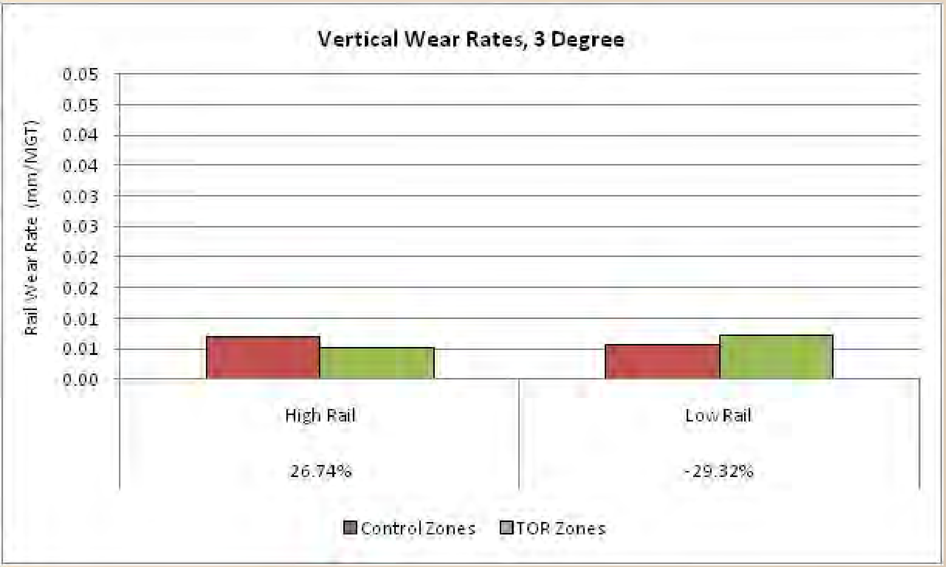


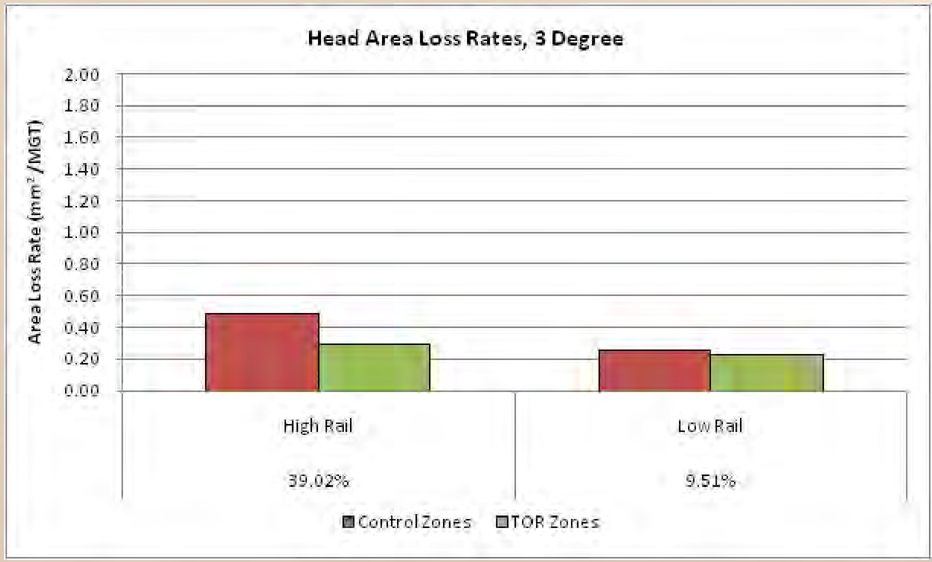




Rail Performance - Wear

Curves ~ 3° After 60 MGT, 18 months





- Mixed reduction in GF/TOR vs. GF only zones.
- Low rail shows slightly higher vertical wear rate in GF/TOR zone.
- Wear rate values still very low

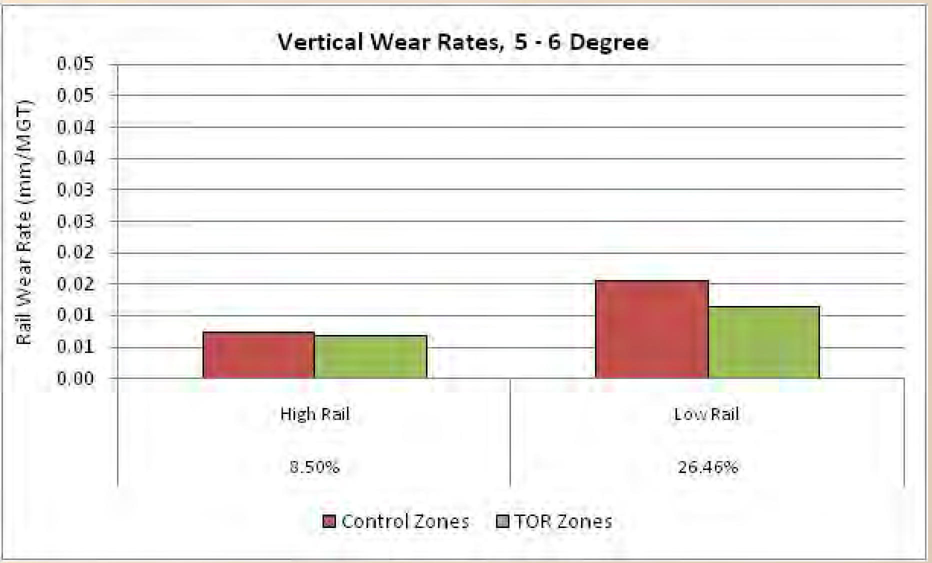
Rail Performance - Surface Fatigue/Cracking

Curves ~ 3° After ~ 60 MGT, 12 months

- Left view – typical high rail with GF lubrication and TOR applied (curve R).
- Right view – typical high rail GF lubrication only (curve E).

Rail Performance - Wear

Curves ~ 5°- 6° After 60 MGT, 18 months



- Vertical wear rate, area loss show lower rates from GF/TOR compared to GF only.

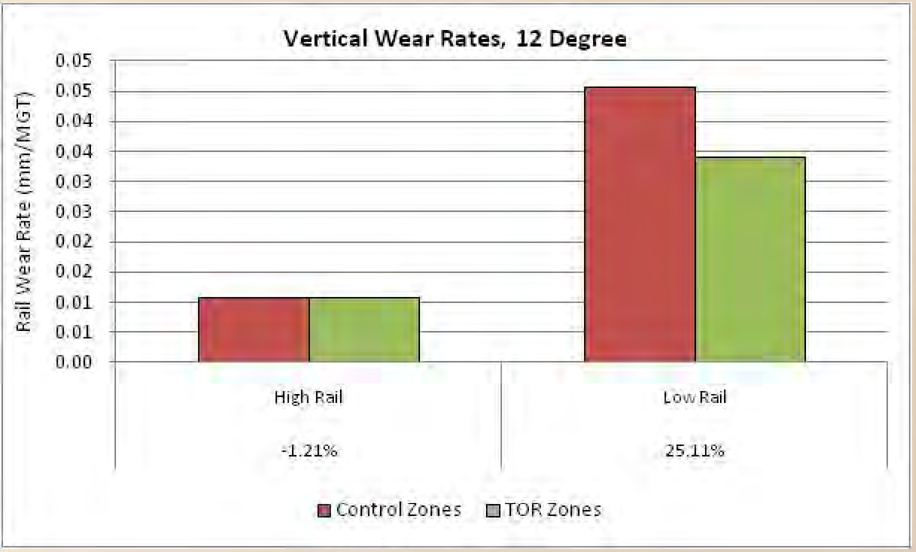
Rail Performance - Surface Fatigue/Cracking

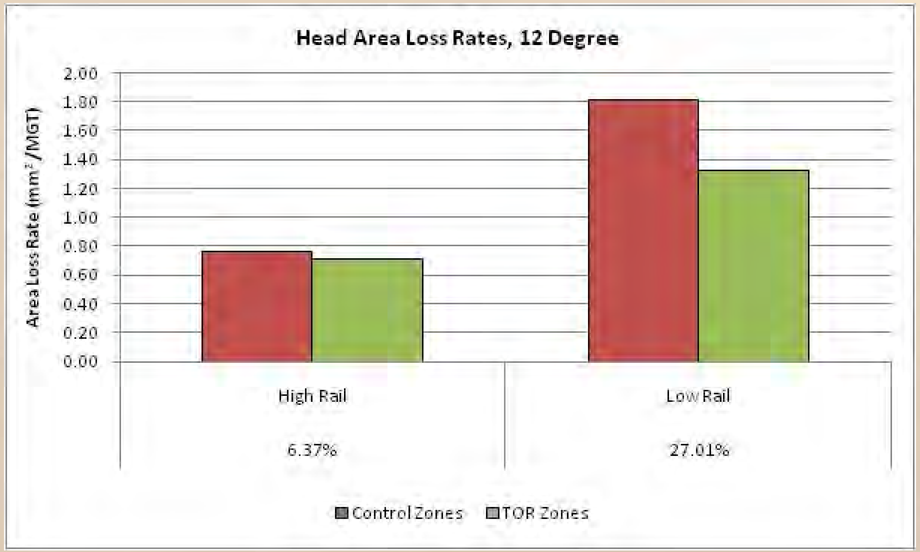
Curves ~ 5° - 6° After 60 MGT, 18 months

- Left view – typical high rail with GF lubrication and TOR applied (Curve O).
- Right view – typical low rail GF lubrication only (Curve C).

Rail Performance - Wear

Curves ~12° After ~ 60 MGT, 18 months

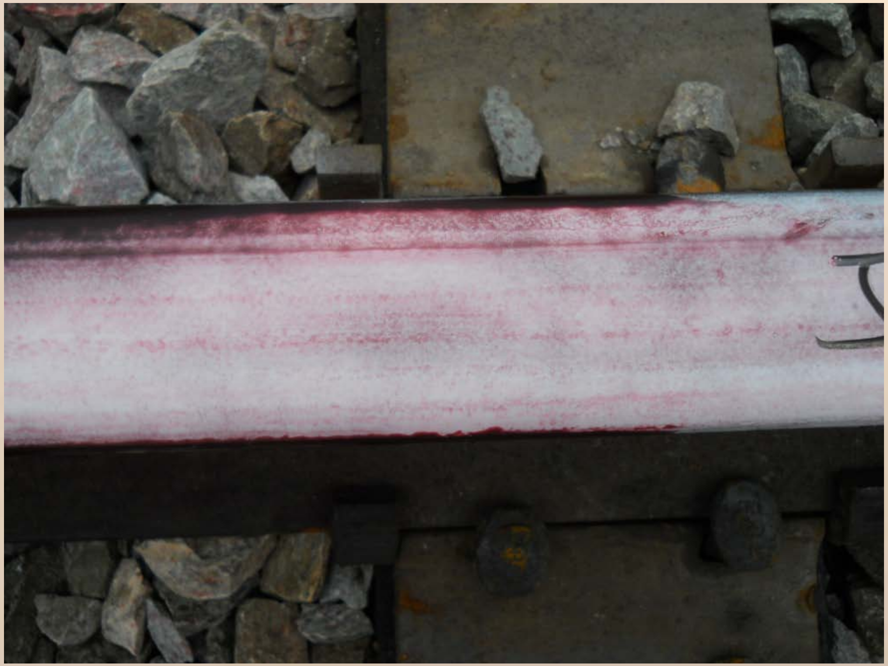




- No benefit on low rail vertical wear rate, area loss shows both rails benefit from GF/TOR compared to GF only.

Rail Performance - Surface Fatigue/Cracking

Curves ~ 12° After 60 MGT, 12 months



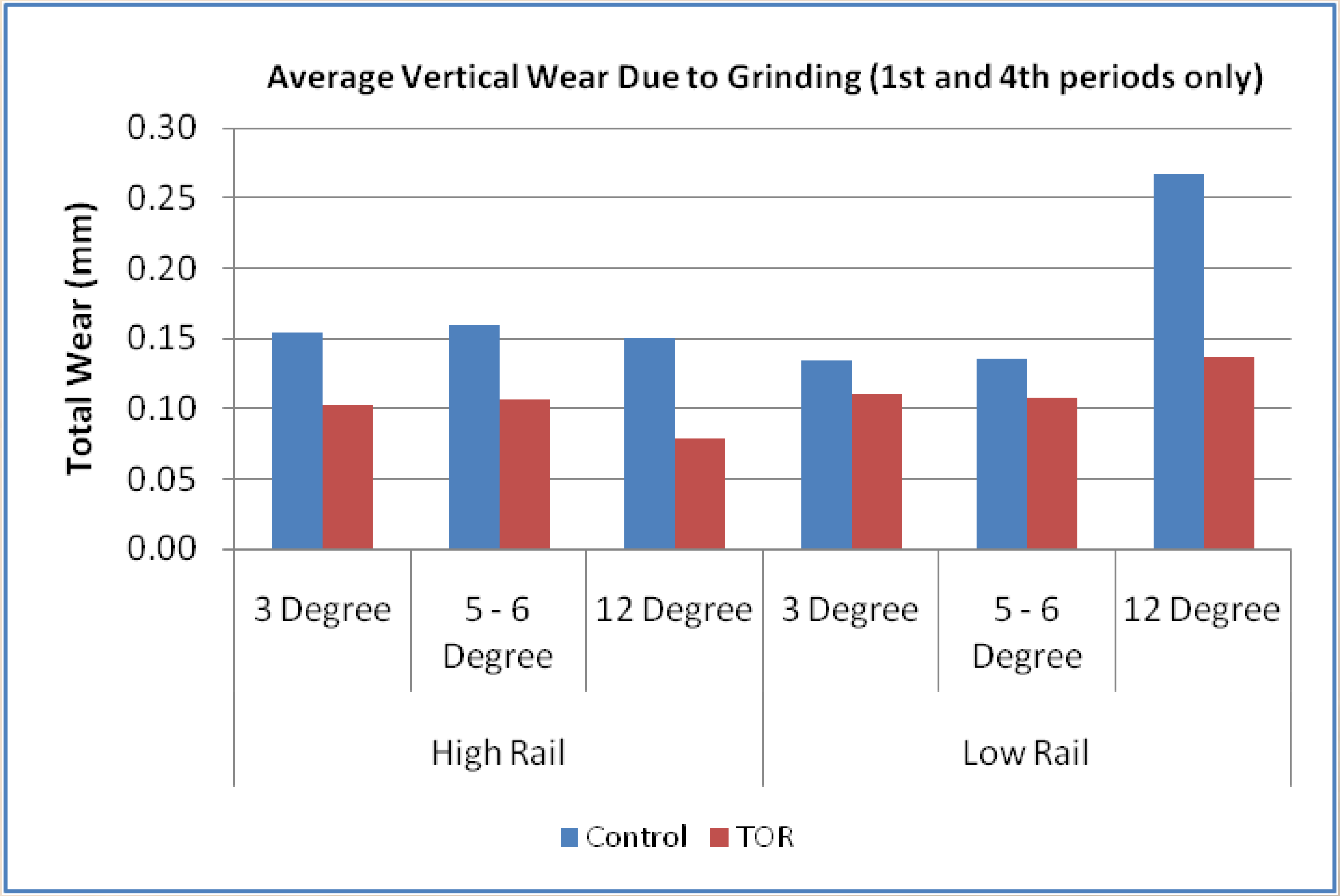
- Left view – typical high rail with GF lubrication and TOR applied (Curve P).
- Right view – typical low rail GF only (Curve J) .

Vertical wear and Area Loss show significant benefits from TOR

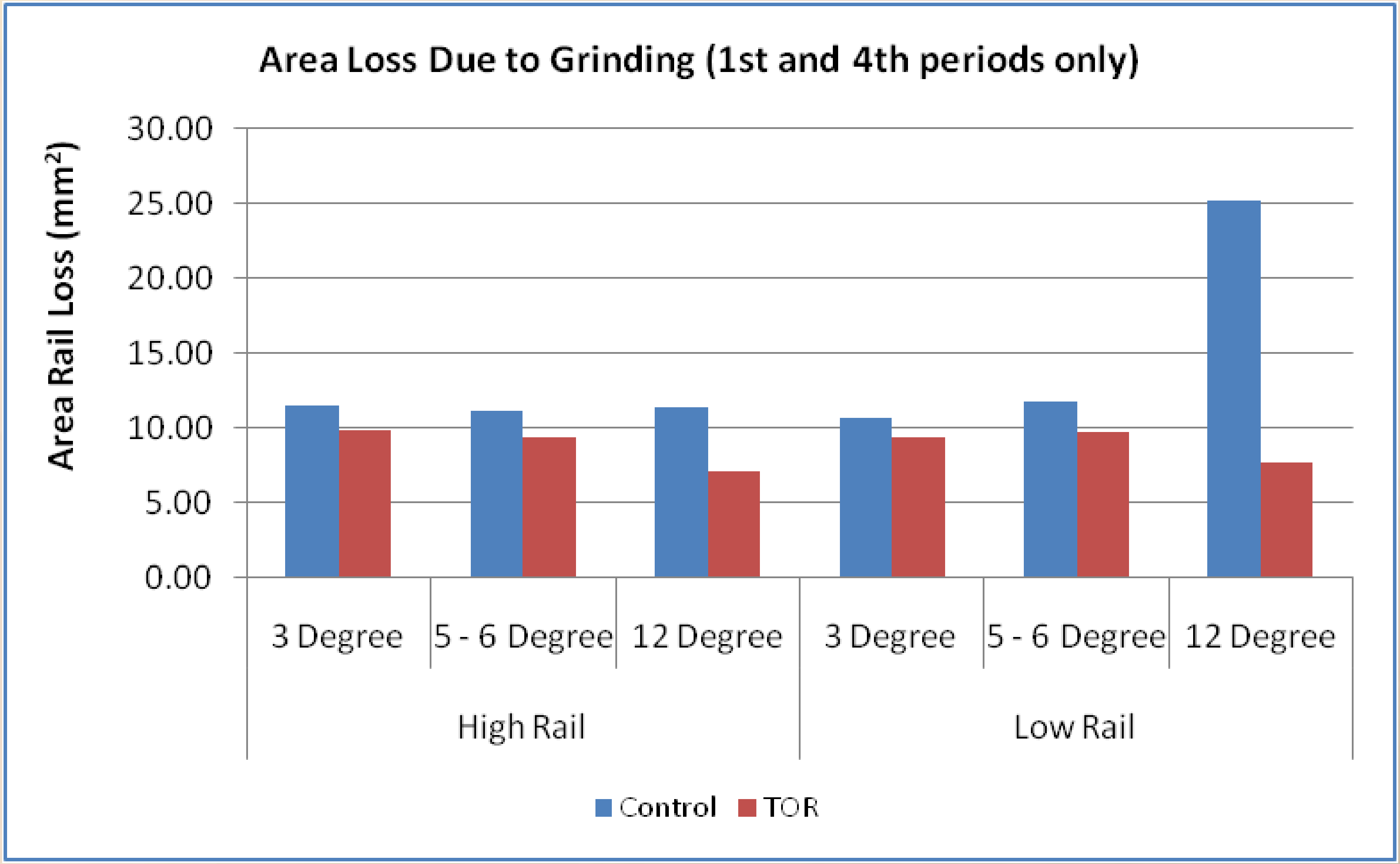
- Less metal removed during grinding operations in GF+TOR zones compared to GF
- Potential benefits
  - Less metal removed during programmed grinding
  - Extended time between grinding periods

Reduced Rail Grinding in TOR Zone

Vertical wear/grinding at center of rail (not rate)

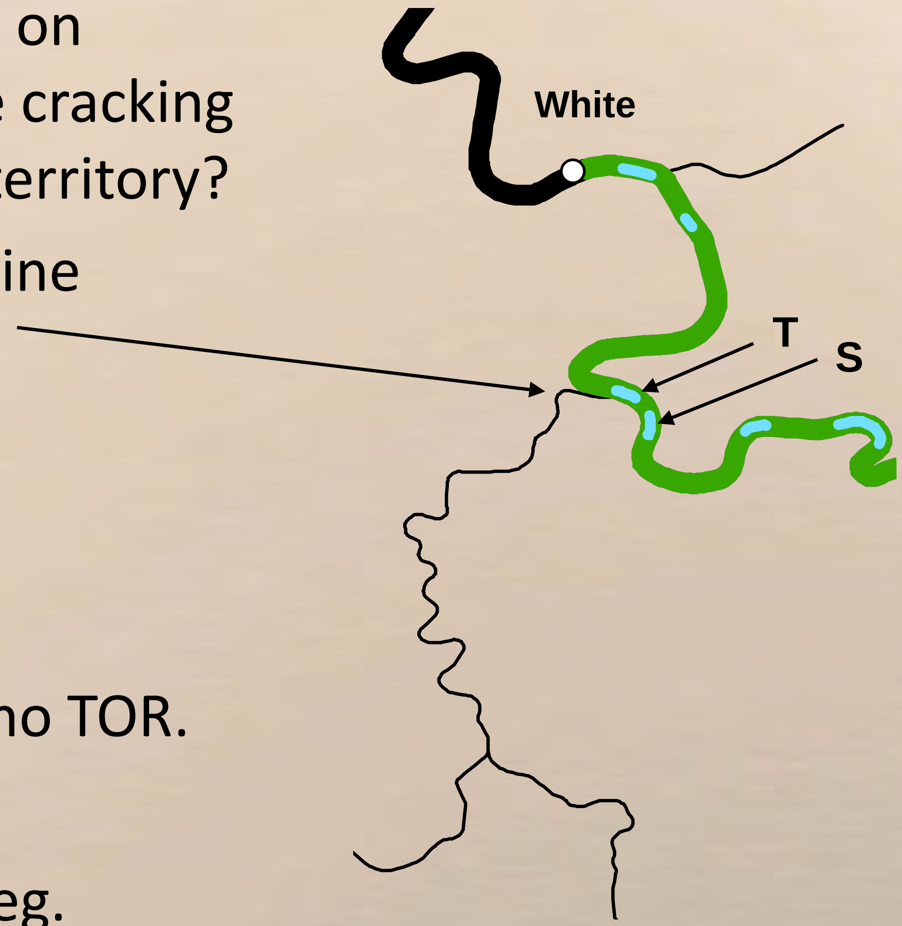


Reduced Rail Grinding in TOR Zone
Head area removed (not rate)



Some things did not go as planned

- Why did RCF performance on Curves S and T show more cracking than other curves in TOR territory?
- Location at major branch line junction.
- Frequent
  - Train braking.
  - Backup moves.
  - Trains off branch with no TOR.
- Potential solution
  - Install TOR on branch leg.



4665_01Map.cdr

Implementation Issues
Day to Day Real World Events

- Maintenance of applicators
  - Repairs, adjustments
  - Filling
  - Additional inspections – how to tell if it is working?
- Logistics during major trackwork (tie, surfacing, etc)
  - Remove, reinstall applicator bars
- Vandalism
  - Does everyone in the county now have a 12 volt battery?

Deployment Experiences for Wayside TOR

- Manpower to maintain systems is key.
  - TOR spacing > GF spacing which increases manpower requirements.
- Must understand movement of ALL train traffic in area.
- Minimize number of systems to reduce manpower and material cost while still achieving benefits.
- Remote Performance Monitoring needs to be rethought in ‘remote’ areas so that real time reporting can be achieved.
- Training of personnel for ‘buy-in’ to potential benefits.
- Need a ‘quantitative’ way to access surface cracking (i.e. depth) and integrate into grinding rail for profile.
- Robust way to determine tonnage in an area (e.g. tie plate).

Summary: Implementing an Improved Rail Friction Control Program

- Results suggest significant savings can be achieved
  - Less grinding per cycle OR extend time between grinding.
  - Rail wear starting to show lower rates in TOR zones.
  - Needs consistent, reliable application.
- Improve Gauge Face lubrication first
  - Acquire improved applicators, premium grease/lubricant .
  - Ensure spacing, operation provides uniform lubricant
- Site audit to determine location for TOR applicators.
  - Mix with existing GF units.
  - Avoid too close together.
- Personnel training
  - Need buy in.
  - Education on differences between TOR and GF.
    - Products, applicators and inspection
- Monitoring equipment
  - Not yet user friendly and low cost.
- Enforcement
  - Management buy in

Thank you