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August 26-28,  
2025

**WRI2025RT** SEATTLE, WA





# Wheel/Rail Maintenance Planning and Operations

**SAHAYA**  
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PRINCIPLES COURSE



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# Outline

- Reasons to perform maintenance
- Rail Maintenance
  - Understanding work windows
  - Effective Planning
  - Logistics and Execution
  - QA/QC
- Wheel Maintenance
- Friction Management

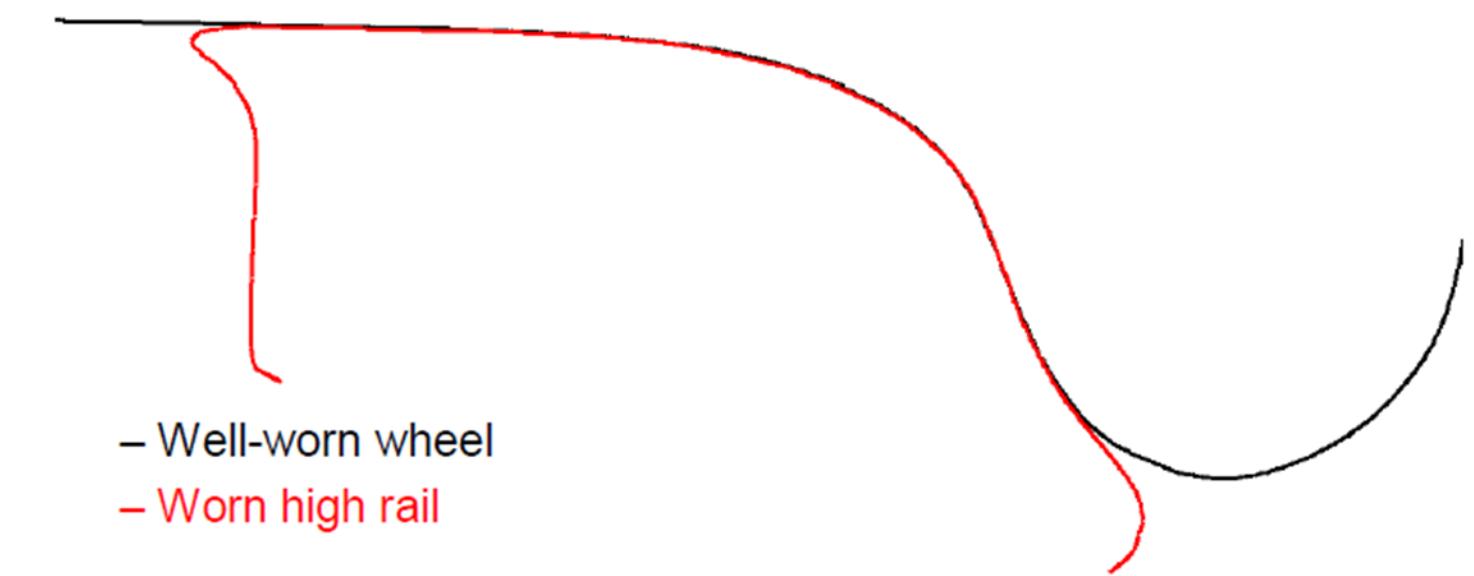




# *Reasons to Perform Maintenance*

Maintaining the wheel/rail interface supports:

- Safety
- Wear and tear
- Noise and vibration
- Asset life
- Energy consumption



Typical reasons for undertaking maintenance include:

- Install or restore wheel/rail profiles
- Remove defects
- Mill scale removal

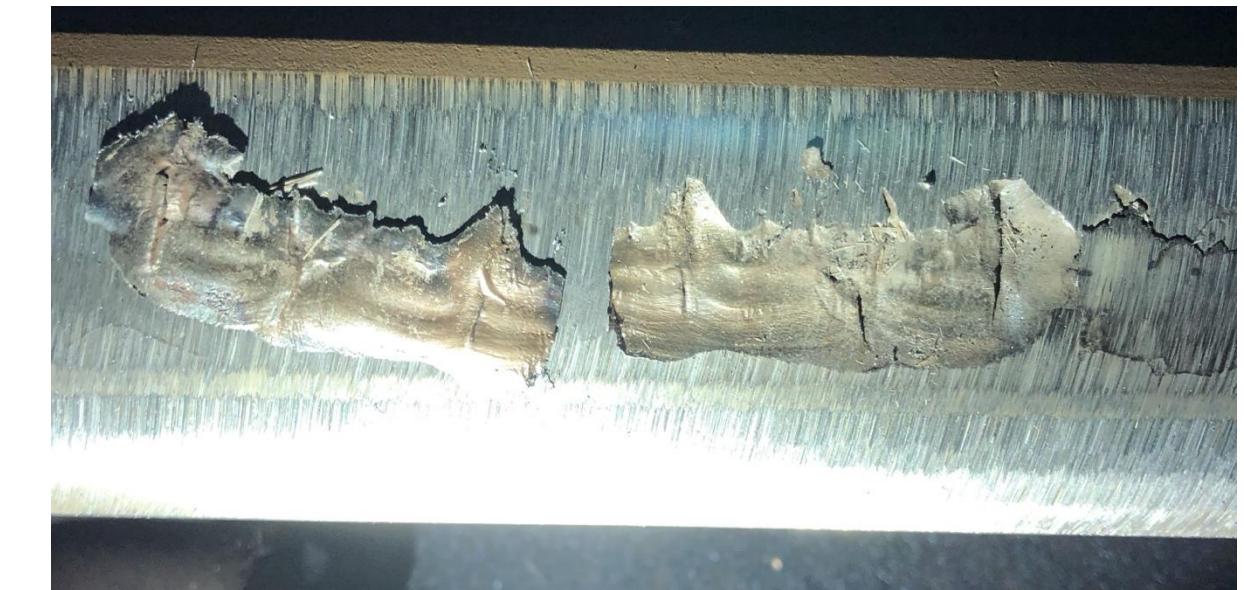


# Rail Condition Examples



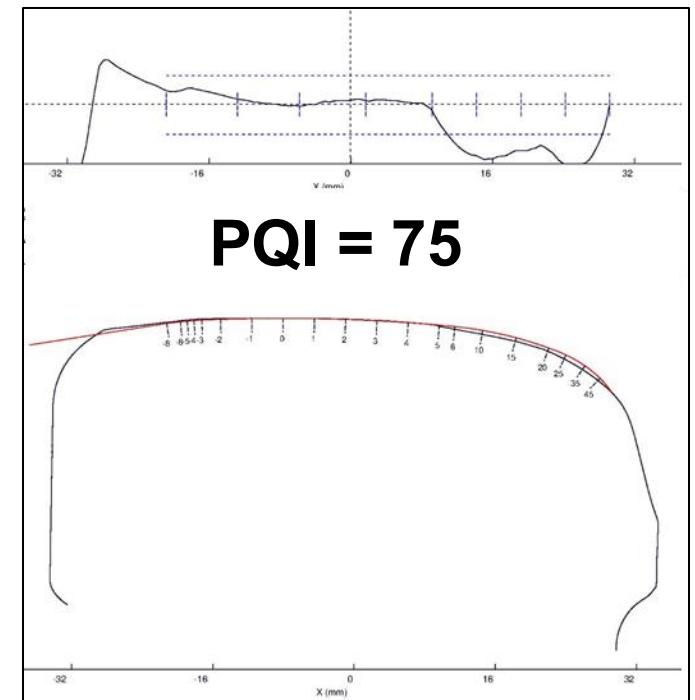
# *Types of Rail Maintenance Programs*

1. Corrective Work (Grind, Mill, or Replace)
  - Heavy profile work required and moderate to severe defects
2. Preventive Work (Grind or Mill)
  - Minor profile and surface defects
3. Acoustic Objectives
  - Noise/vibration sensitive areas, harder rail, community complaints

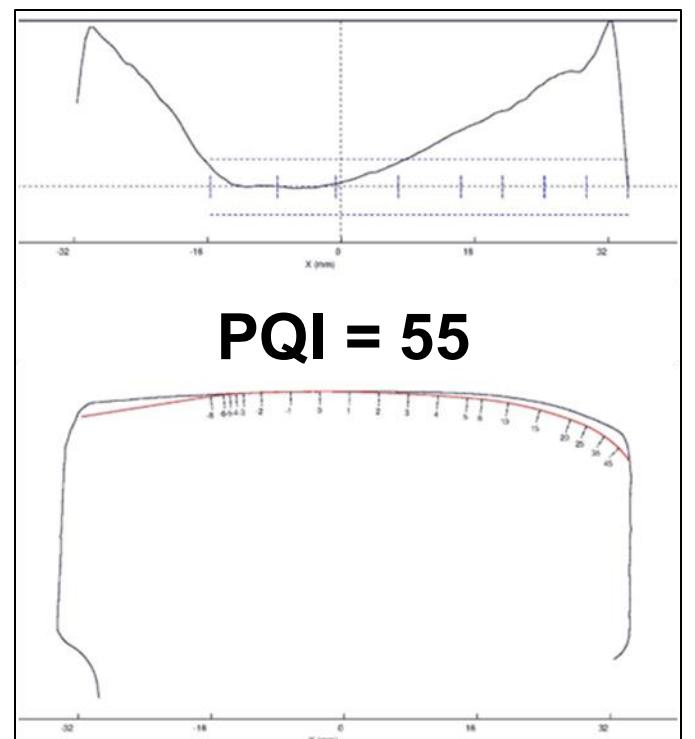


# Considerations for Rail Programs

Characterize the rail system to understand rail profile conditions and surface damage severity



Rail Surface Defect	Monitor & Grind	Monitor, Schedule Milling, weld, repair or Replacement	Replace ASAP
<b>Wheel burns</b>	< 0.060", < 1"	0.060 - 0.125", 1-2"	> 2", > 1/8" deep, broken piece
<b>Squats</b>	<0.060", < 1 "	0.060 - 0.125"	> 2", > 1/8" deep, broken piece
<b>Gauge corner shells</b>	<0.1"	0.1 - 0.125"	> 2", > 1/8" deep, broken piece
<b>Head Checks</b>	<0.060"	0.060 - 0.125"	> 1", flaking, spalling severe, wet
<b>Corrugations</b>	<0.060"	0.060 - 0.125" deep	> 1/8" deep
<b>Dipped or low welds</b>	<0.030"	0.030 - 0.125"	> 1/8" deep
<b>Rail end batter</b>	<0.050"	0.050 - 0.125" deep	> 1/8 " deep



# *Staying on Top of Maintenance*

- Challenge to address
  - Limited track time and competing against other needs, specifically running trains and moving people
  - Limited wheel truing equipment, down time, and keeping vehicles in revenue service
- Objective
  - How to make the most out of your maintenance budgets, track time, and shop resources while achieving operational goals and running safely





# Rail Maintenance – Cost of Inaction

- Deferred maintenance will catch up with you...
  - Higher effort to return to State-of-Good-Repair
  - Reduced safety
  - Increased slow orders
  - Poor ride quality
  - Noise complaints
  - Derailment risks
  - Wheel and rail renewals/replacements
  - Reduced level of service



# *Rail Maintenance – Understanding Maintenance Windows*

- Engineering hours, non-revenue hours, maintenance windows/possessions, track occupancy, etc.
- Competing for track time with:
  - Routine inspections
  - Other corrective/preventive maintenance activities
  - Capital programs
  - Other departments
  - Train tests and sweeper trains



# *Effective Planning – Setting Programs up for success*



Working off good data

- Prioritize getting the necessary information, is it wear, RCF, or corrugation that is driving the program

Setting up objectives and specifications to adhere to

- Rail type, traffic/tonnage, noise requirements, new or custom profiles, wheel conditions

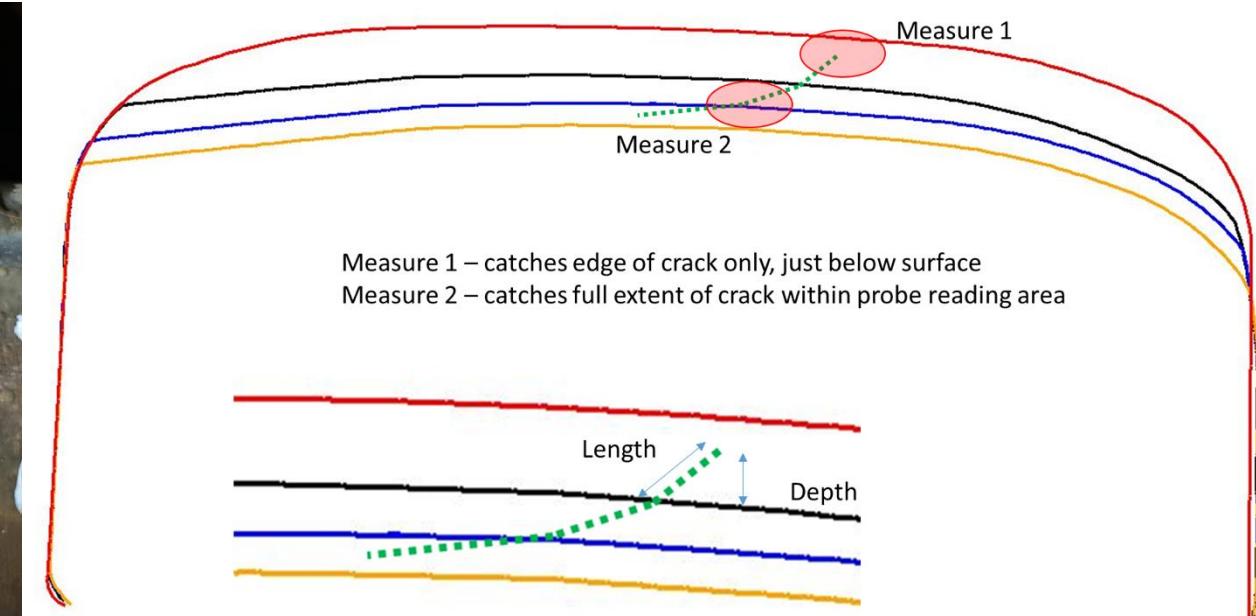
Strategic program development

- Multi-year programs, phased approaches, corrective/preventive/gradual preventive
- Budget and/or track constraints



# Effective Planning – Data Requirements

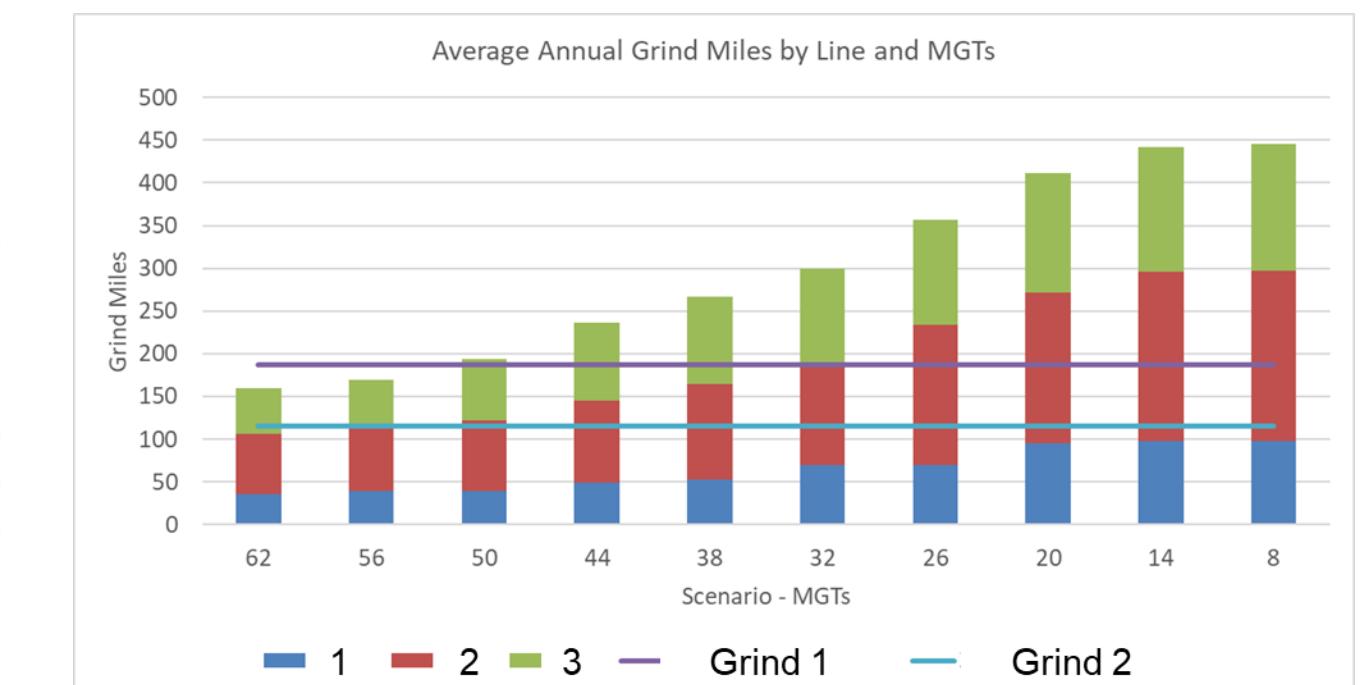
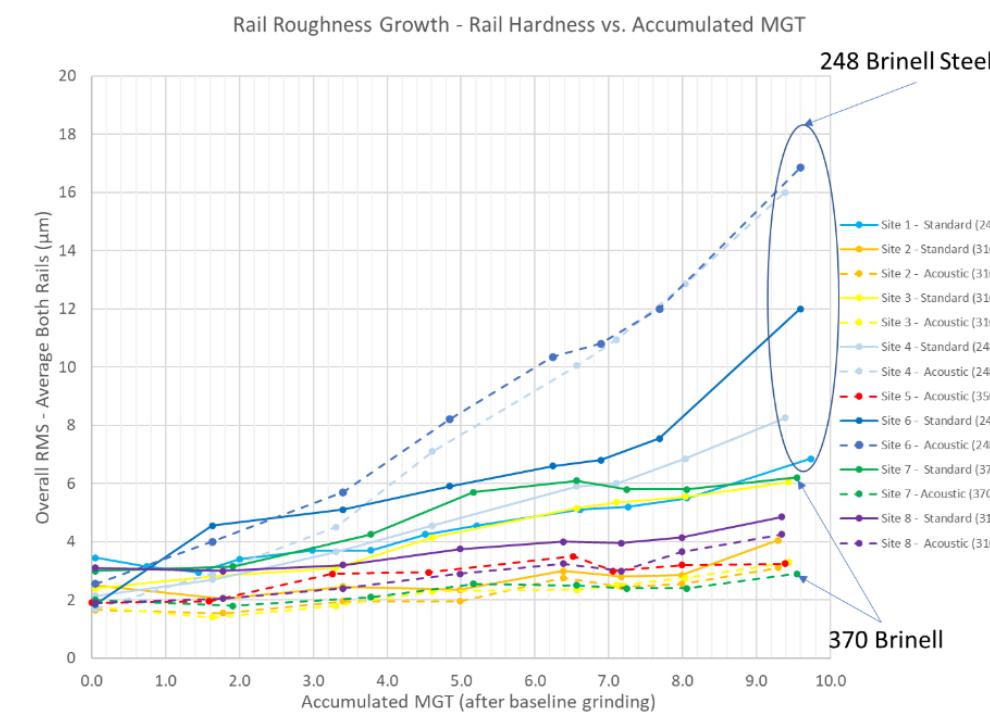
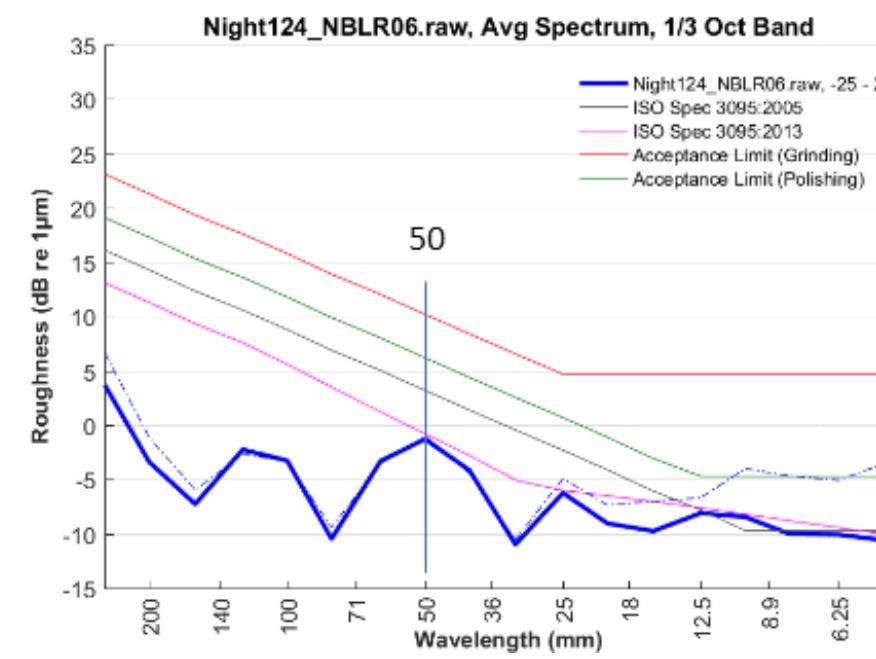
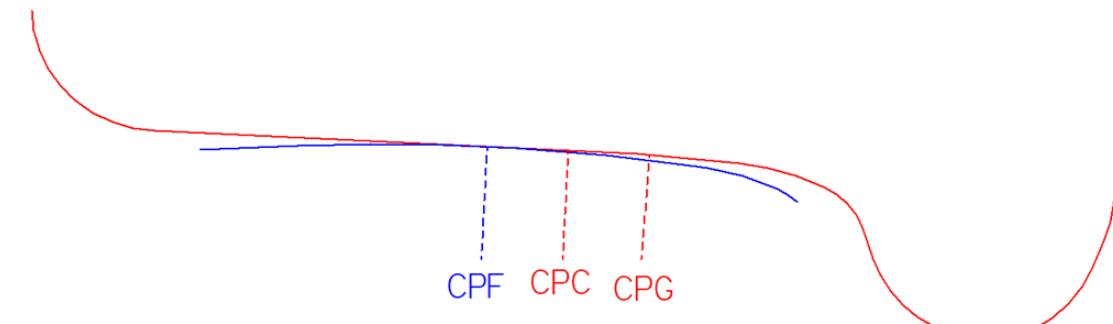
- Rail Wear
  - Remaining life
  - Profile adherence
  - Metal Removal
- RCF
  - Crack locations and depth
  - Discrete defects
- Corrugation
  - Depth
- Roughness
  - Might get louder... or different...





# Effective Planning – Specifications/Objectives

- Setting up objectives and specifications to adhere to
  - Rail type, traffic/tonnage, noise requirements, new or custom profiles, wheel conditions
  - AREMA, EN13231, ISO3095





# *Effective Planning*

Typical specifications have included

- Travel/work speeds
- Grind pattern control
- Motors and power
- Clearance and geometry
- Operator experience
- Dust/Fire control
- Bi-directional work
- Metal removal rates
- Facet width
- Lateral positioning
- GQI/PQI
- Surface roughness

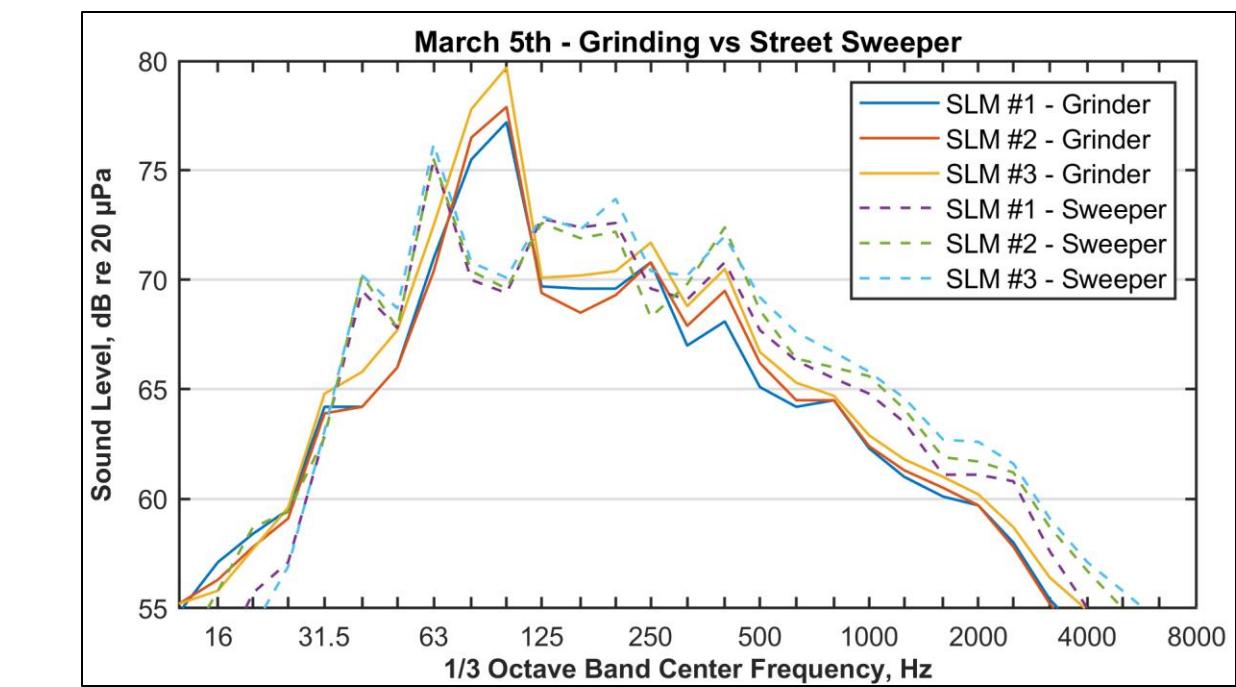
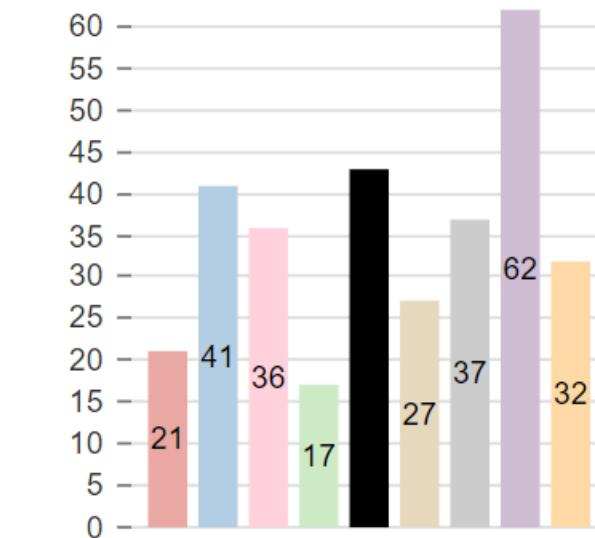




# Effective Planning - Influencing Factors

- Track utilization ratio – how much of your allocated time is being converted to actual work
- Operational schedules
- Regulatory requirements
- Public events
- Infrastructure limitations (stabling locations, travel times)
- Other work projects

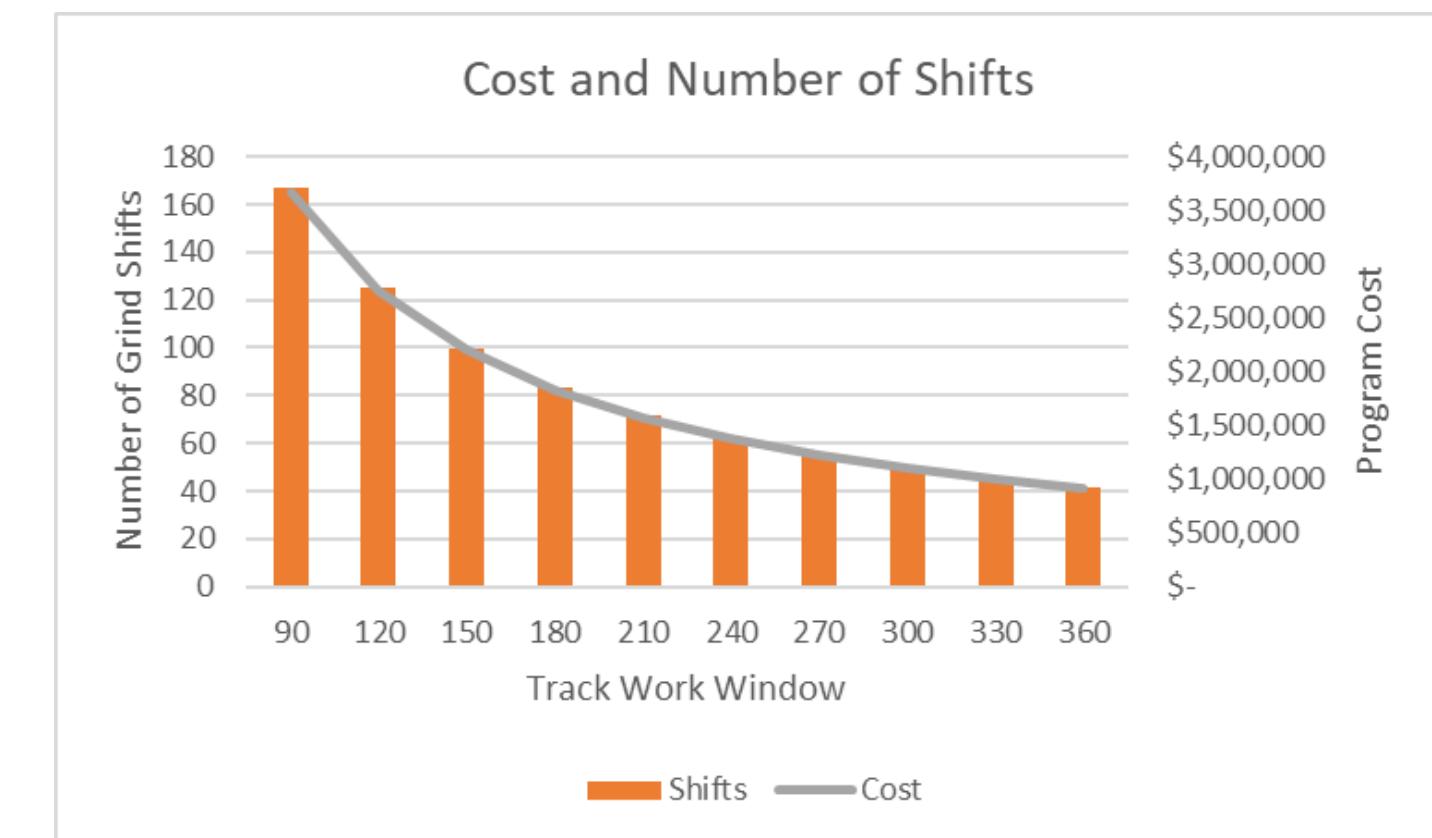
% Spark Minutes of Available Minutes





# *Effective Planning – Program Development*

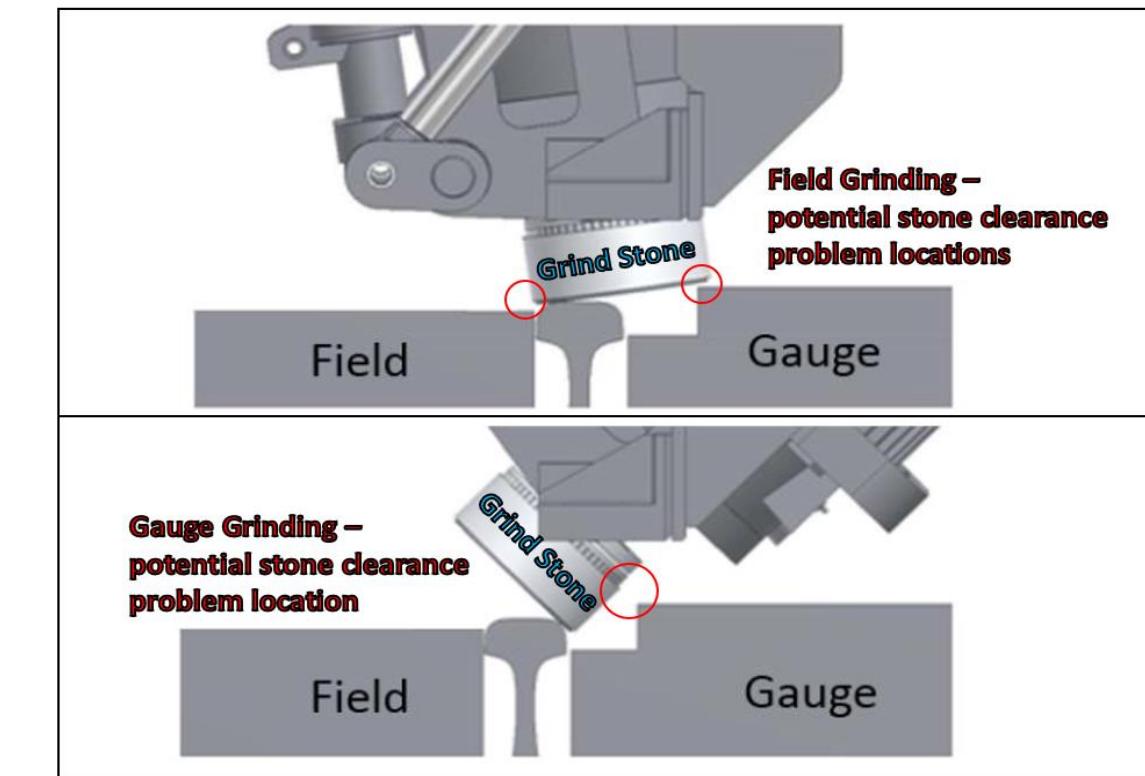
- Multi-year programs, phased approaches
  - Corrective/preventive/gradual preventive
- Budget and/or track constraints
  - Competing projects
  - Resources (staff and \$\$)
  - Engineering hours or Single Tracking





# *Effective Planning – Selecting Solutions*

- Grinding or Milling (or rail replacement)
  - Plus acoustic outcomes
- Equipment available in North America
  - Rail bound
  - Hi-Rail
- Stone Types
  - Track types
  - Finishes



Criteria	Rail Bound	Hi-Rail
# of Stones	8+	6 to 12
Stone Diameter (inch)	6 and 10	3 to 4
Operating Speed (mph)	3 - 6	1 - 3
Min. Curve Radius (ft)	100	60
Max. Grade (%)	6	7
Grind Angles across rail head <small>Note that achievable angles can be limited by track construction (embedded track limits stone tilt)</small>	75 gauge / 20 Field	75 gauge / 55 Field

# *Effective Planning – Selecting Solutions*



# *Effective Planning – Selecting Solutions*





# *Effective Planning – Selecting Solutions*

Grinding versus Milling example pro and con list (not exhaustive and technology is always changing)

Pros	Cons
Very good profile	Slower (0.25 mph vs 5mph)
Very good surface finish	Less flexibility on rail shape
Dust-free	Damage from mismatch rail
Spark-free	Higher costs per shift
Defect removal	Single direction operation

Hi-rail grinders typically operate slower and are less productive than railbound but have the benefit of better work windows (no rail travel to work area)

# *Effective Planning – Selecting Solutions*



Selecting the right equipment comes down to budget, operations, and objectives

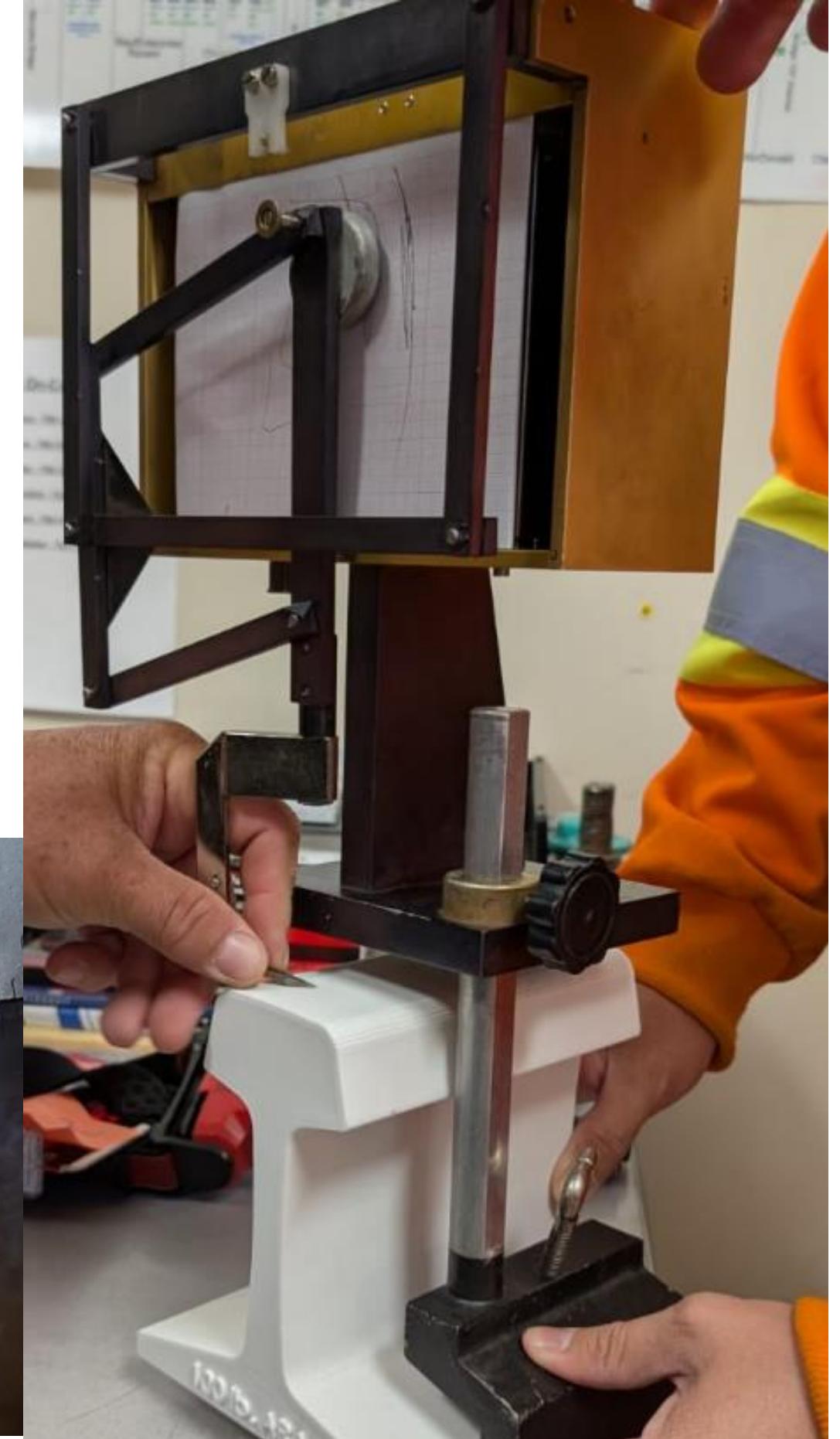
	Mild Case – Advisory	Moderate Case – S3	Heavy Case – S2	Severe Case – S2+ *
<b>Rolling Contact Fatigue (RCF)</b>	Advisory – Schedule 1 grinding cycle to remove	S3 – Schedule 1-2 grinding cycles to remove	S2 – Schedule milling or 3+ grinding cycle to remove, or grind to reduce severity	S2+ – Control with maintenance (milling or grinding) to reduce severity, but plan for replacement to remove defect.
<b>Gage Corner Cracking</b>	Advisory – Schedule 1 grinding cycle to remove	S3 – Schedule 1-2 grinding cycles to remove	S2 – Schedule milling or 3+ grinding cycle to remove, or grind to reduce severity	S2+ – Control with maintenance (milling or grinding) to reduce severity, but plan for replacement to remove defect.
<b>Rail Wheel Burns</b>	Advisory – Schedule 1 grinding cycle to remove	S3 – Schedule 1-2 grinding cycles to remove	S2 – Schedule milling or 3+ grinding cycle to remove, or grind to reduce severity	S2+ – Control with maintenance (milling or grinding) to reduce severity, but plan for replacement to remove defect.
<b>Corrugation</b>	Advisory – Schedule 1 grinding cycle to remove	S3 – Schedule 1-2 grinding cycles to remove	S2 – Schedule milling or 3+ grinding cycle to remove, or grind to reduce severity	S2+ – Control with maintenance (milling or grinding) to reduce severity, but plan for replacement to remove defect.





# *Effective Planning - Monitoring*

- Monitoring Methods
  - Visual checks
  - Manual measurements
  - Onboard monitoring



# *Logistics and Execution*

- Coordination
  - Communication and planning with all stakeholders
- Procurement support
  - Clear specifications for services and equipment
- Contingency planning
  - Potential delays from weather, equipment issues, and/or unexpected track conditions



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# *Logistics and Execution*

- Staging equipment and access to equipment
- Water and fuel
- Travel times from stabling locations
- Track Utilization Ratio
- Tunnels and ventilation
- Firewatch
- Lubricators
- Pilot vehicles and restrooms



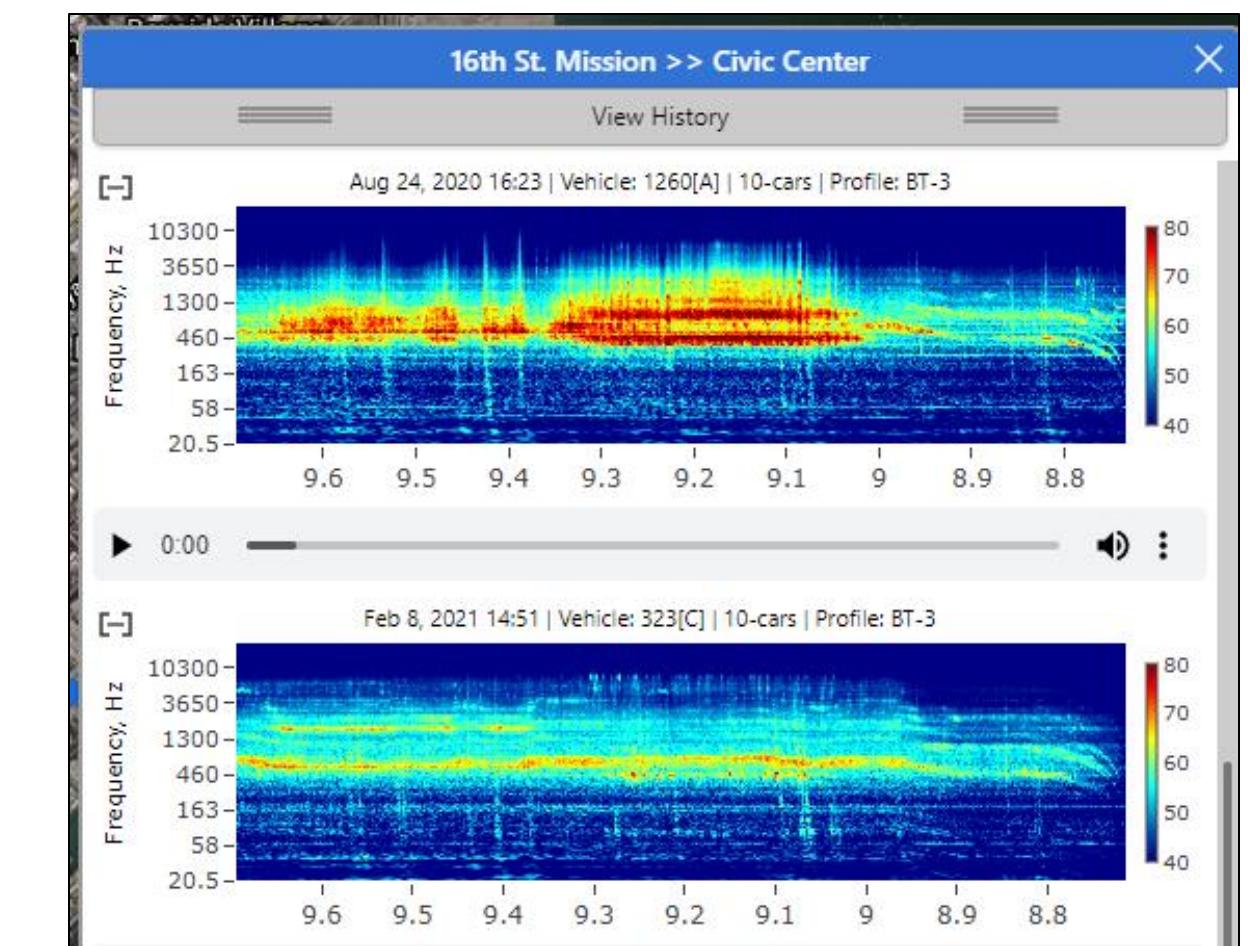
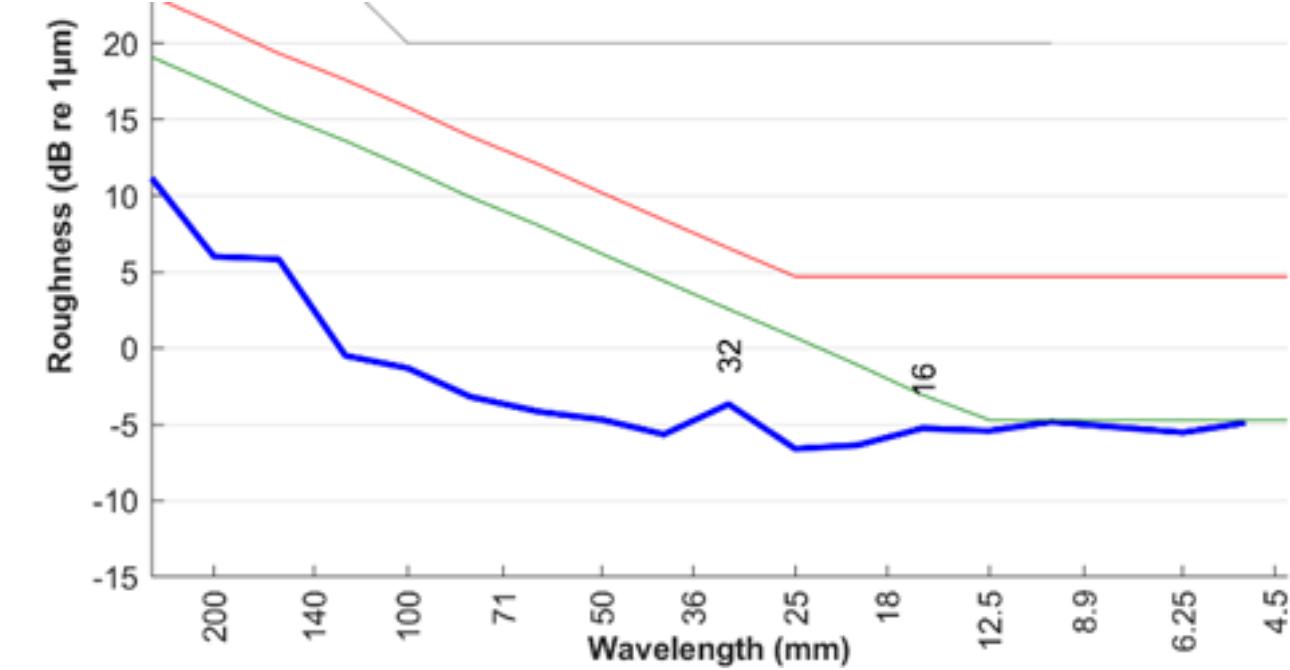
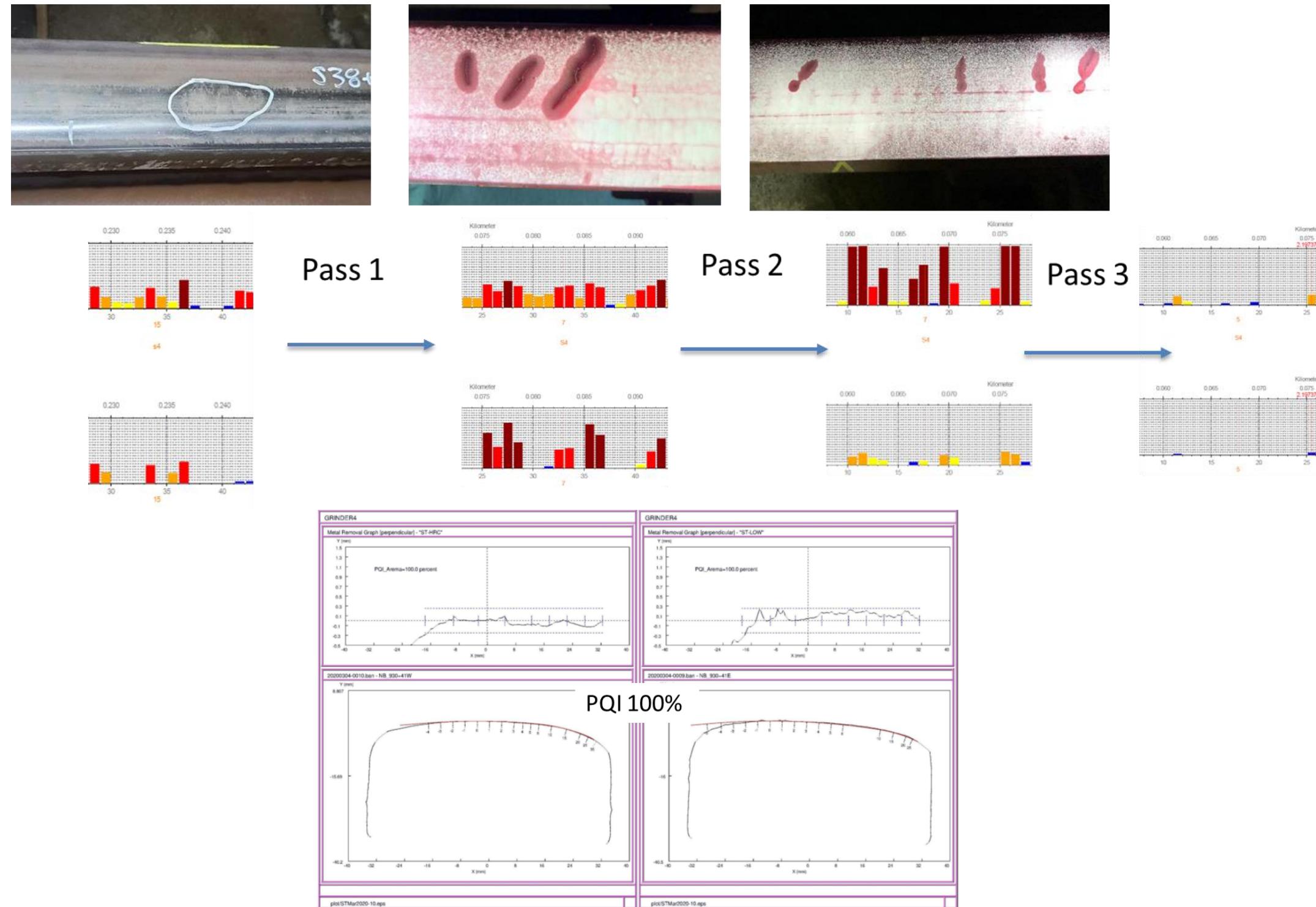


# *Checks and Balances*

- On-site QA/QC and daily reporting
  - Getting what you paid for – verifying outcomes
- Adaptive strategies
  - Managing real-time changes in conditions and productivity
  - Feedback loop



# Checks and Balances





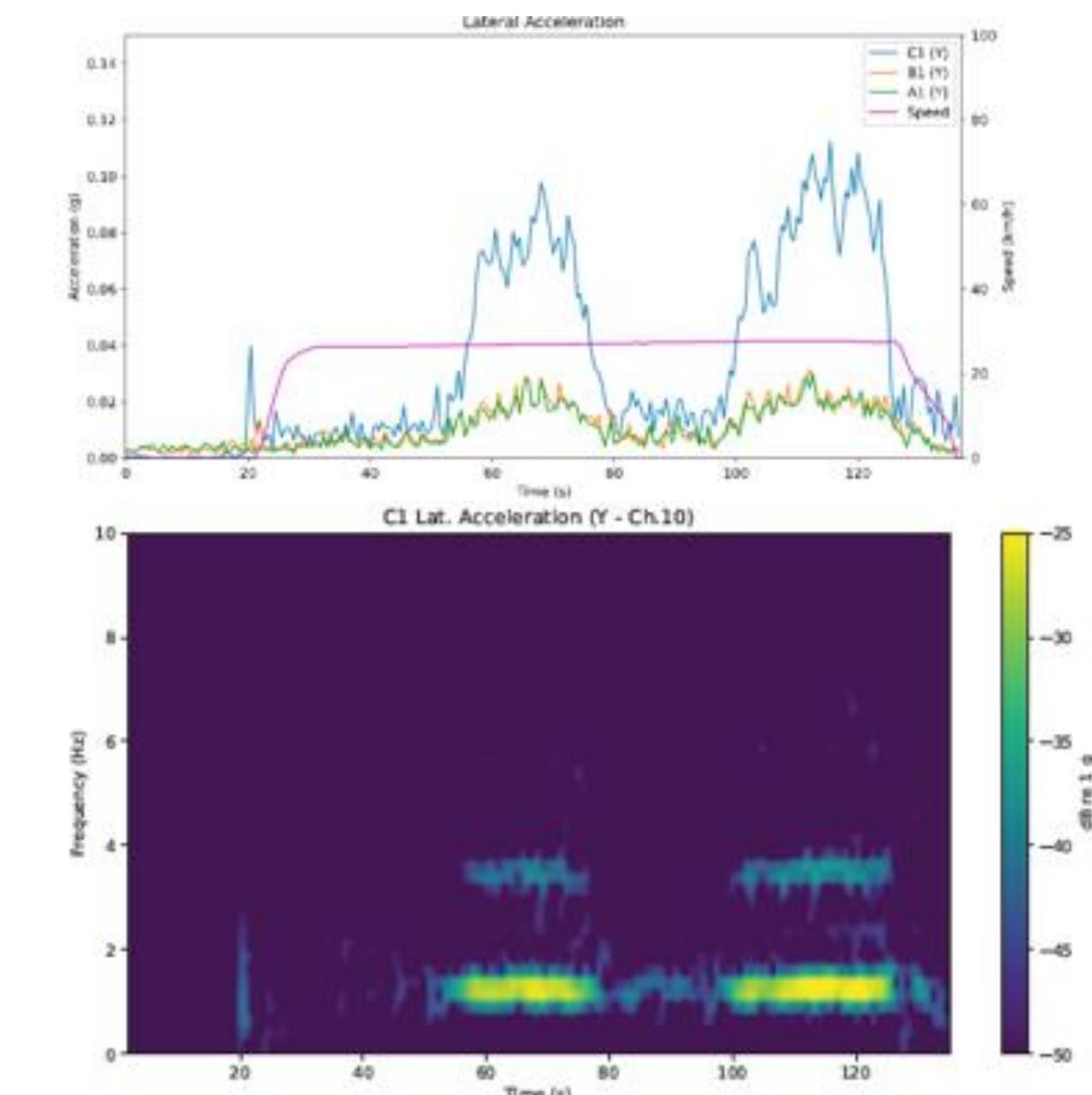
# *Wheel Maintenance*

- Can't forget about this side of the equation!
- APTA/TCRP standard with no set requirement (often established by the vehicle supplier/designer) BUT, key things are:
  - Flange height and width (special trackwork)
  - Hollow wheels (conformal contact, ride quality)
- Car balancing after cutting
  - By axle, by bogie, and by car (tolerance limits)
- How many miles should you get out of a wheel
- Other maintenance requirements (wheel flats, RCF)



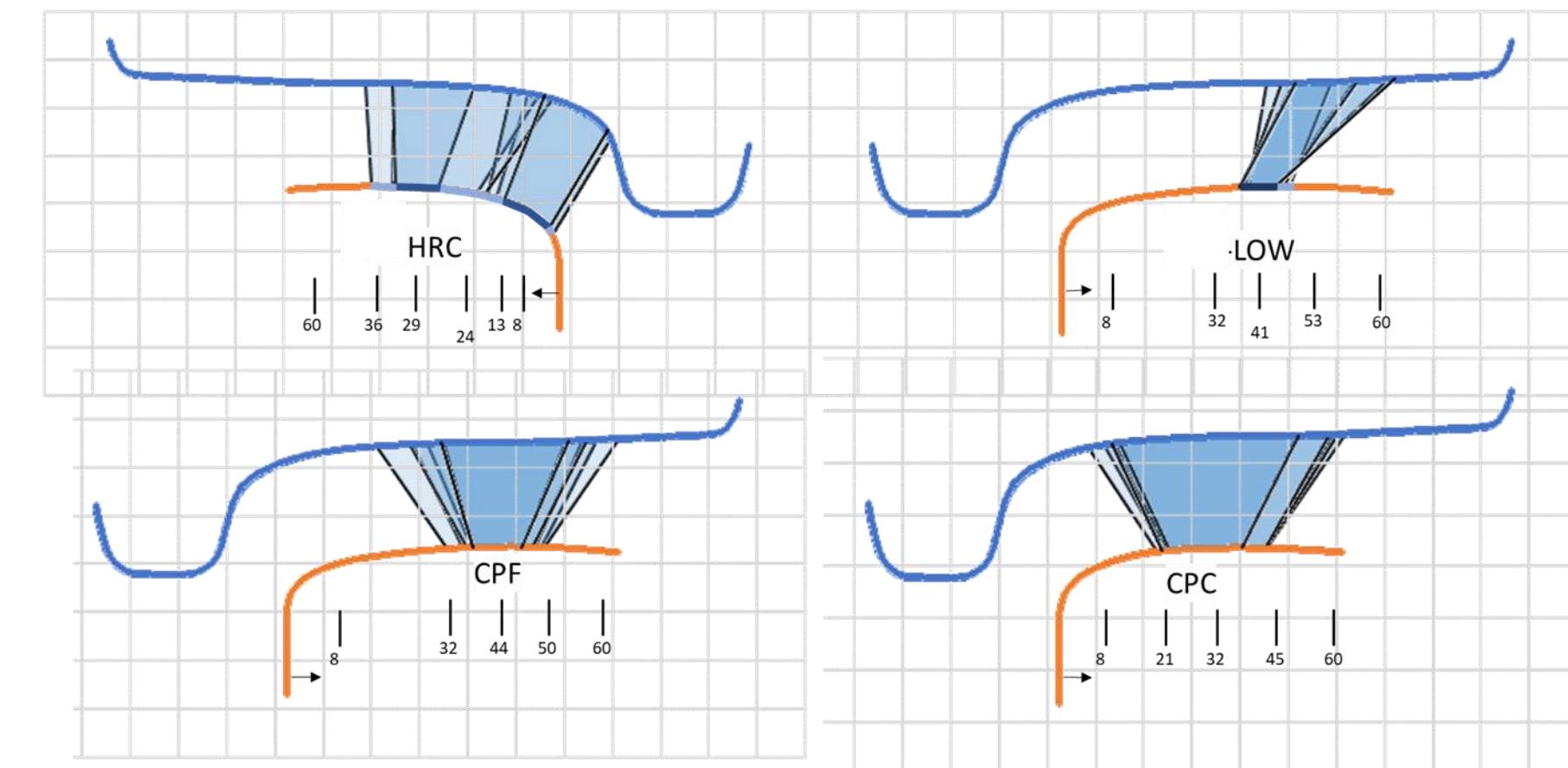
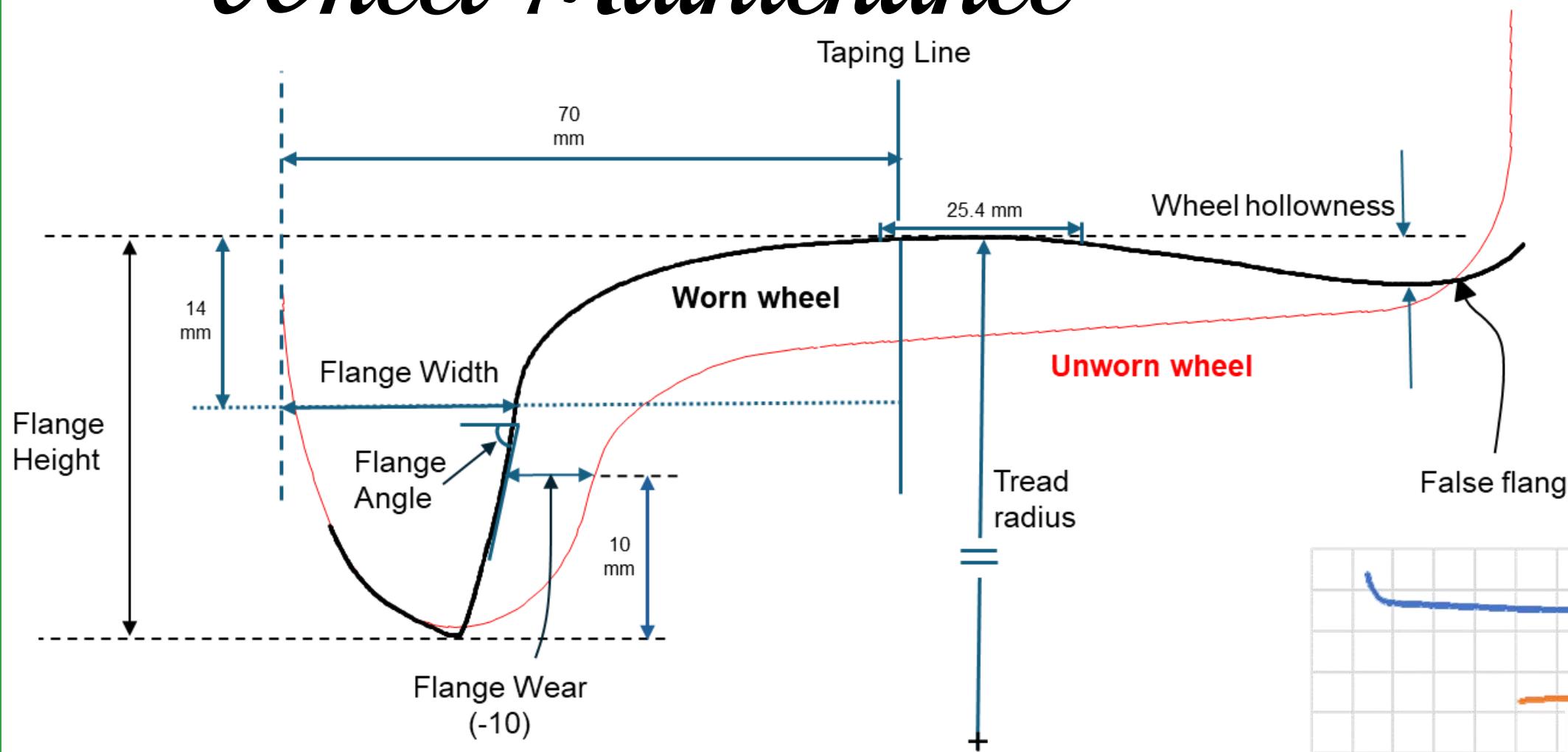
# Considerations for Wheel Programs

- Special trackwork
  - Flange height and width
- Safety
  - Flange angle
- Ride Quality
  - Hunting and curving
- Asset Life
  - W/R contact stress and wear
- Typically set by OEM
  - TCRP 65 – Wheel Profile Maintenance Guidelines





# Wheel Maintenance



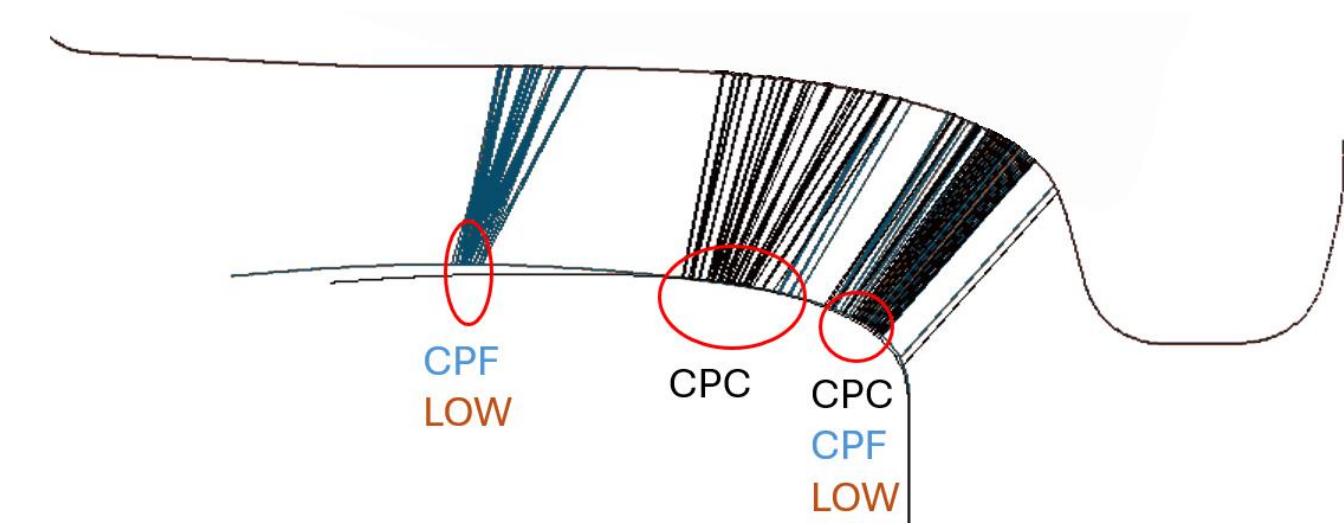


# Wheel Maintenance

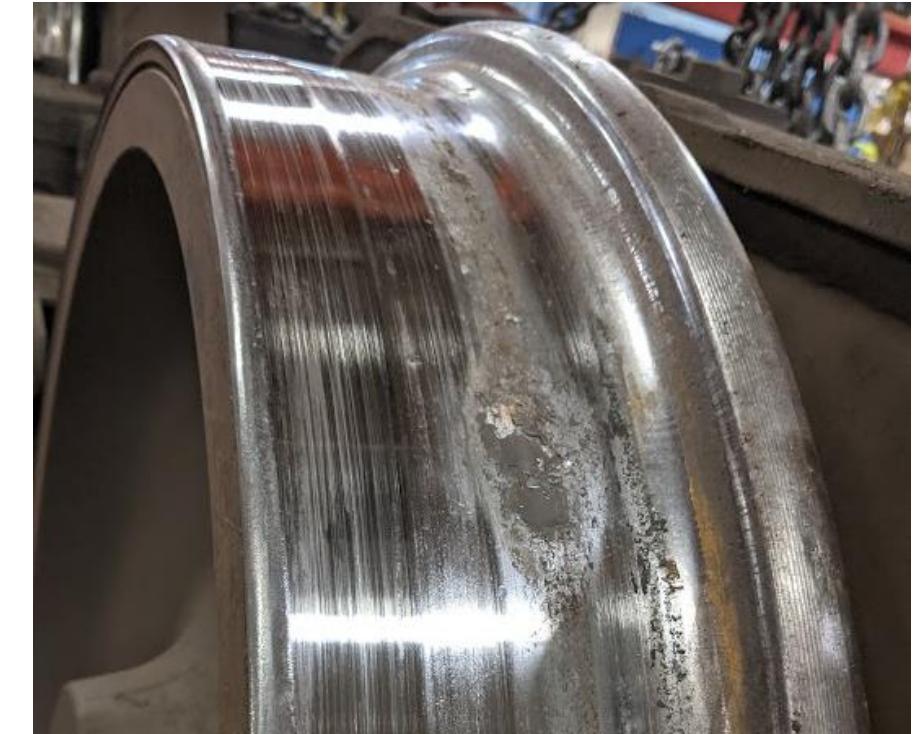
- Truing intervals vary
  - Speed, tonnage, track geometry, material hardness, friction management, environment conditions, maintenance practices
- Typical metrics used
  - Mileage/kilometrage limits, e.g., every 80,000 miles
  - Wear limits, e.g., 0.075" wear

Example curve distribution

Degree	Length	
0	2637	MILD 48%
1	26273	
2	7394	
3	11640	
4	12833	
5	4541	
6	1148	MOD 38%
7	555	
8	1795	
9	3360	
10	1024	
11	1448	
12	148	
13	419	
14	396	



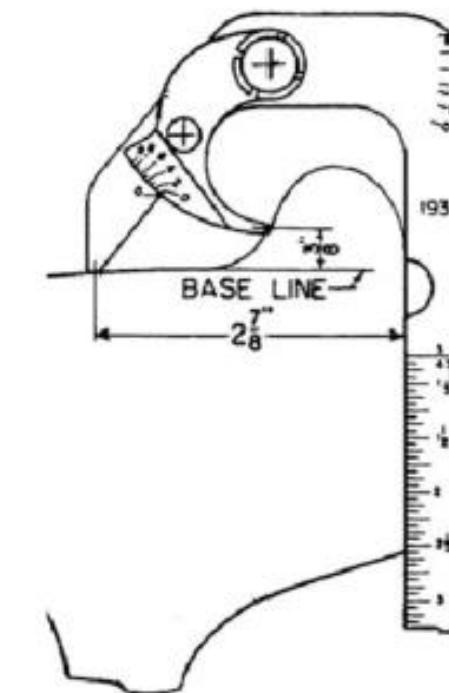
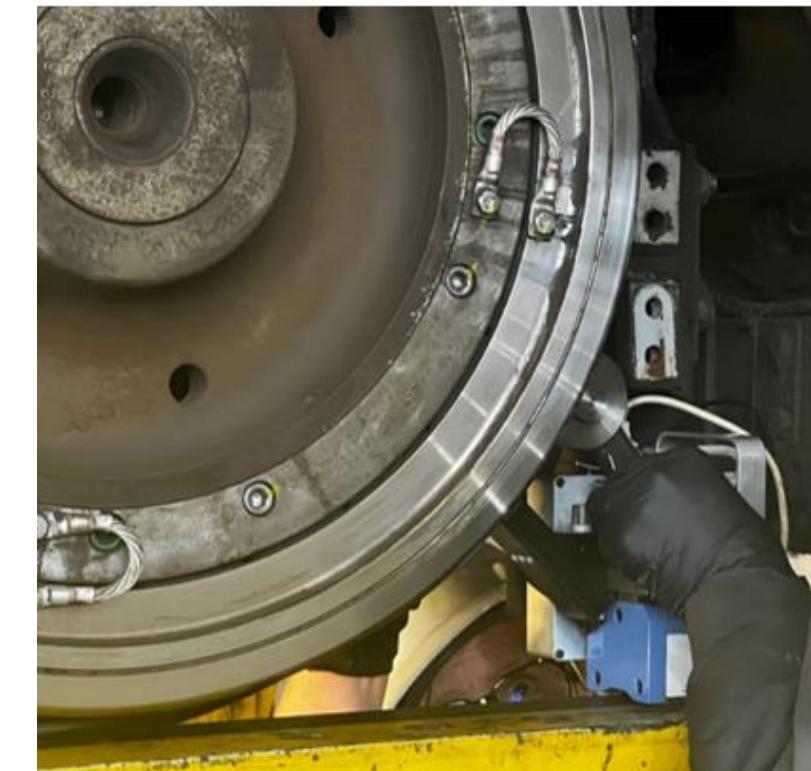
# *Wheel Condition Examples*





# Wheel Maintenance

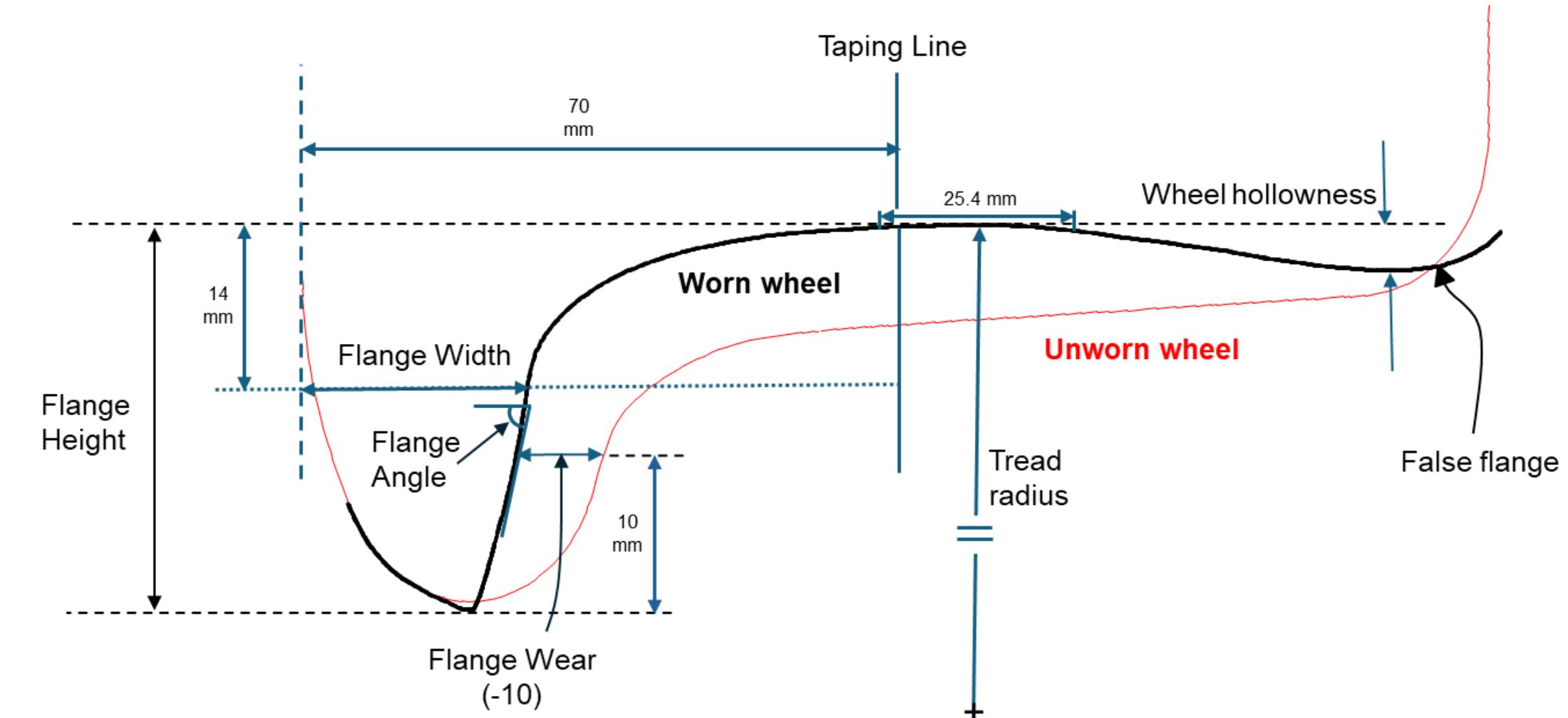
- Inspections used
  - Hand check
  - Wheel profilometer
  - Wheel scan system
  - Out-of-Roundness
  - Roughness





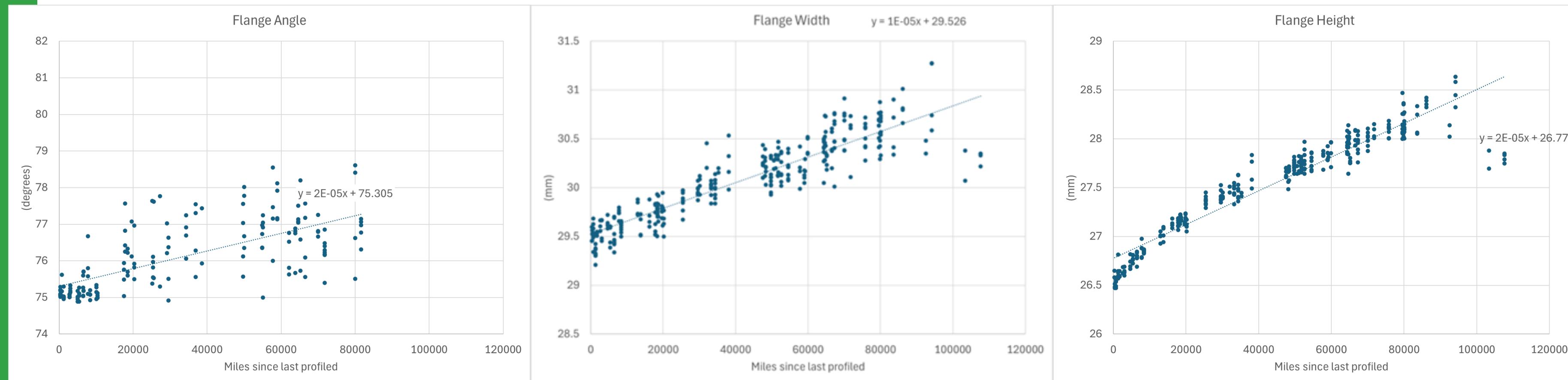
# Wheel Maintenance

- Metrics used
  - Flange width/height
  - Tread wear
  - Hollowness
  - False flanging
  - Flange angle



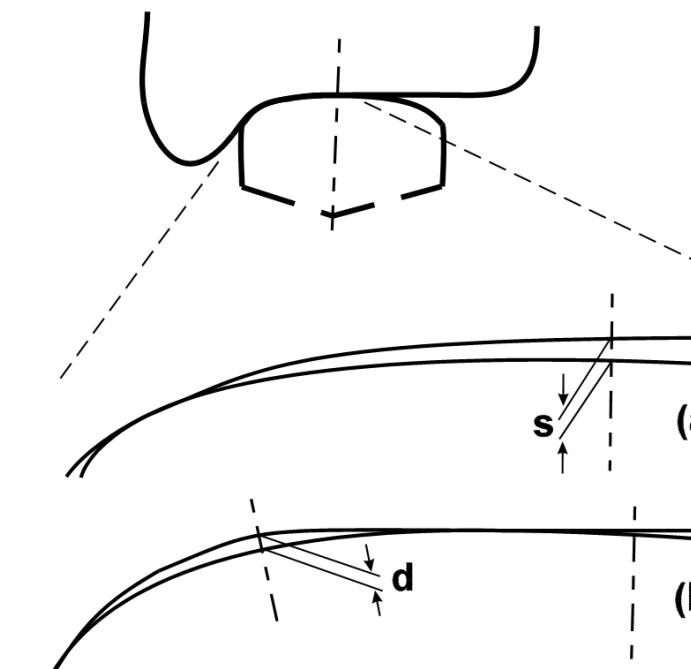
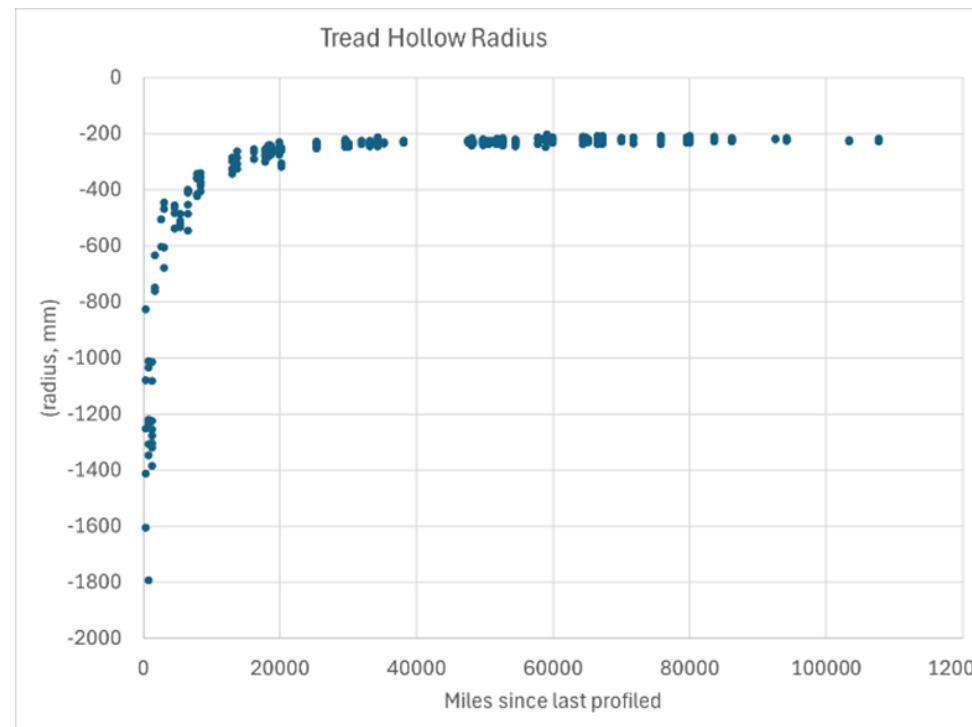
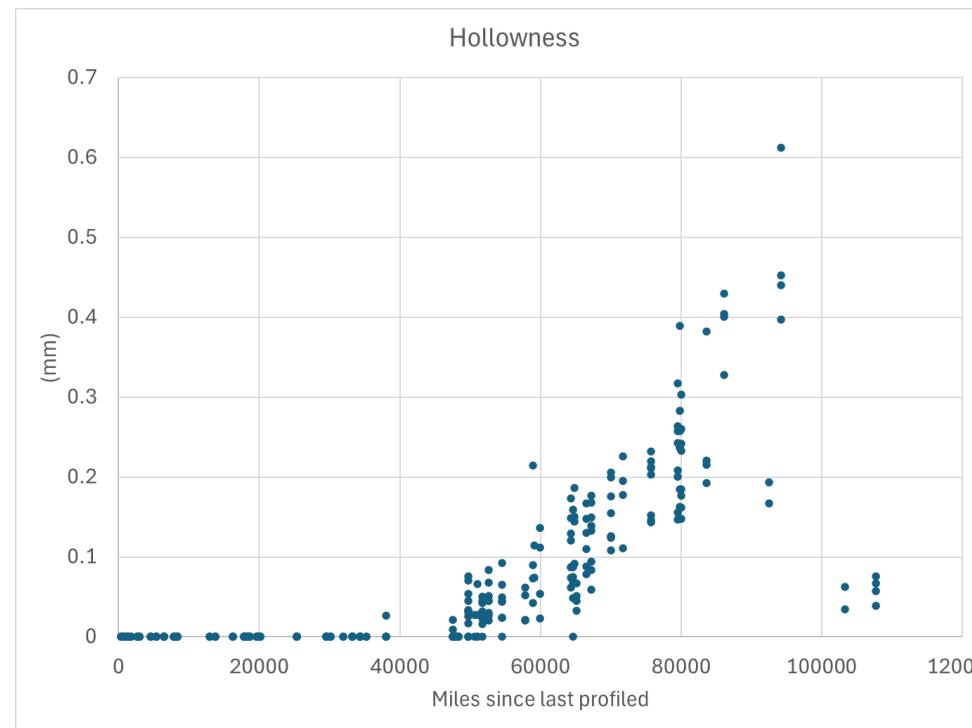
# Wheel Maintenance

- Measure and plot versus mileage since last cut



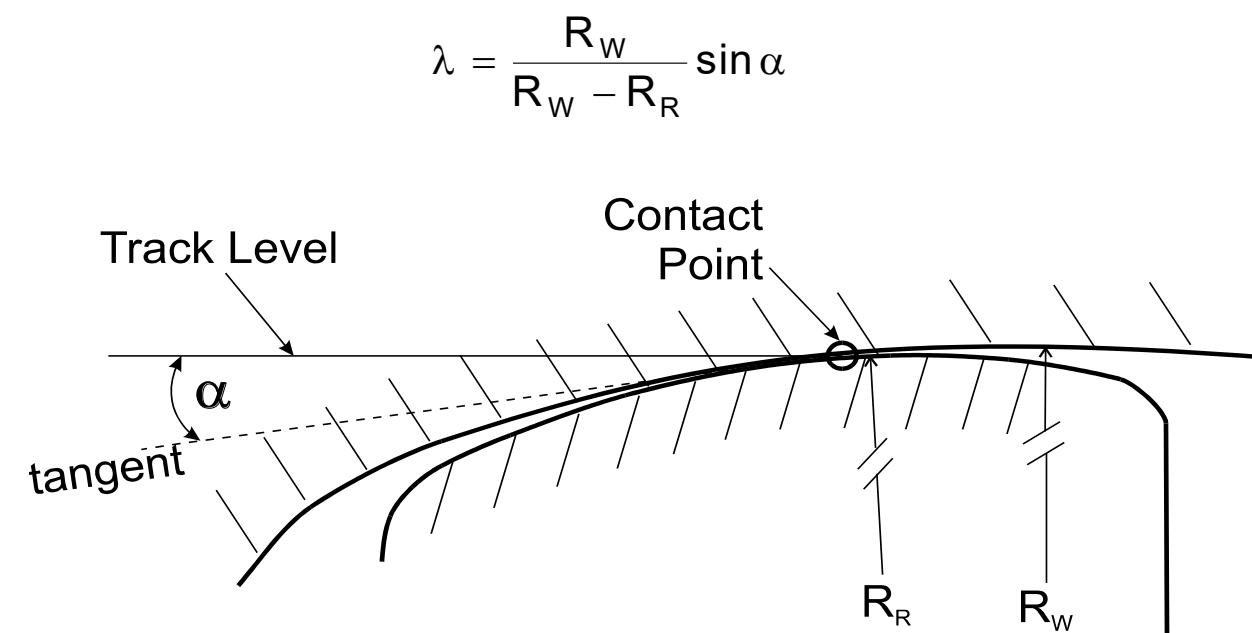


# Wheel Maintenance



closely conformal (as per hertzian spring)  
0.1 mm (0.004") or less

- conformal  
0.1 mm to 0.4mm  
(0.004" to 0.016")
- non-conformal  
0.4 mm (0.016") or larger



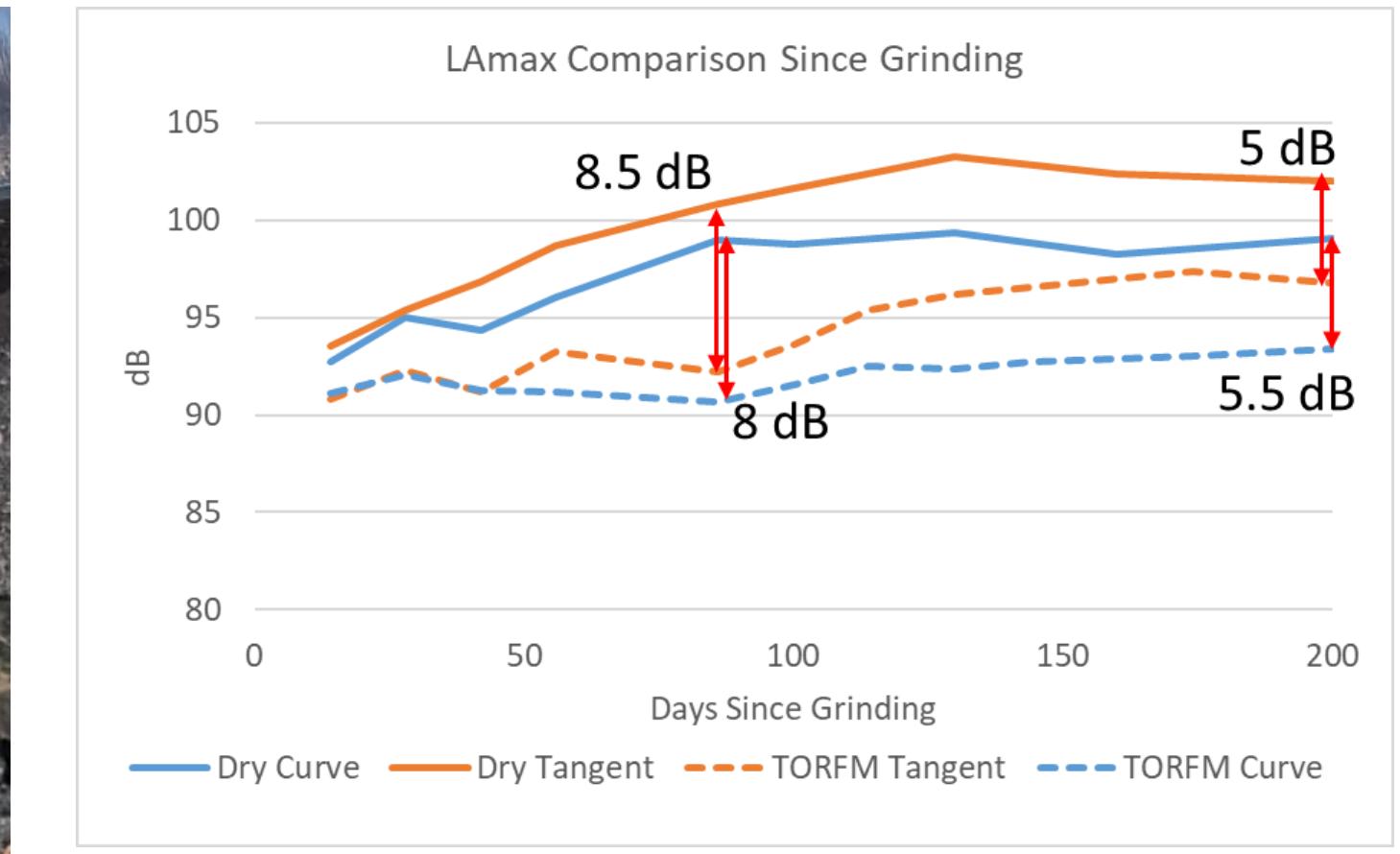
# *Wheel Truing Equipment*





# Friction Management

- Don't forget about this key component
  - Effective friction management goes a long way
  - Occasionally an afterthought at some agencies





Empty

Different Products



Separation





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# Friction Management



Overapplication  
(material on field side)



Clogged Ports



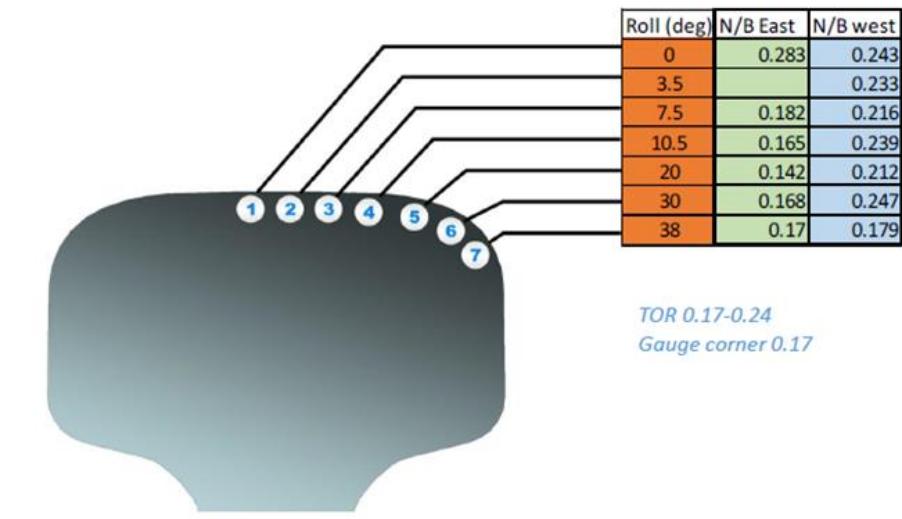
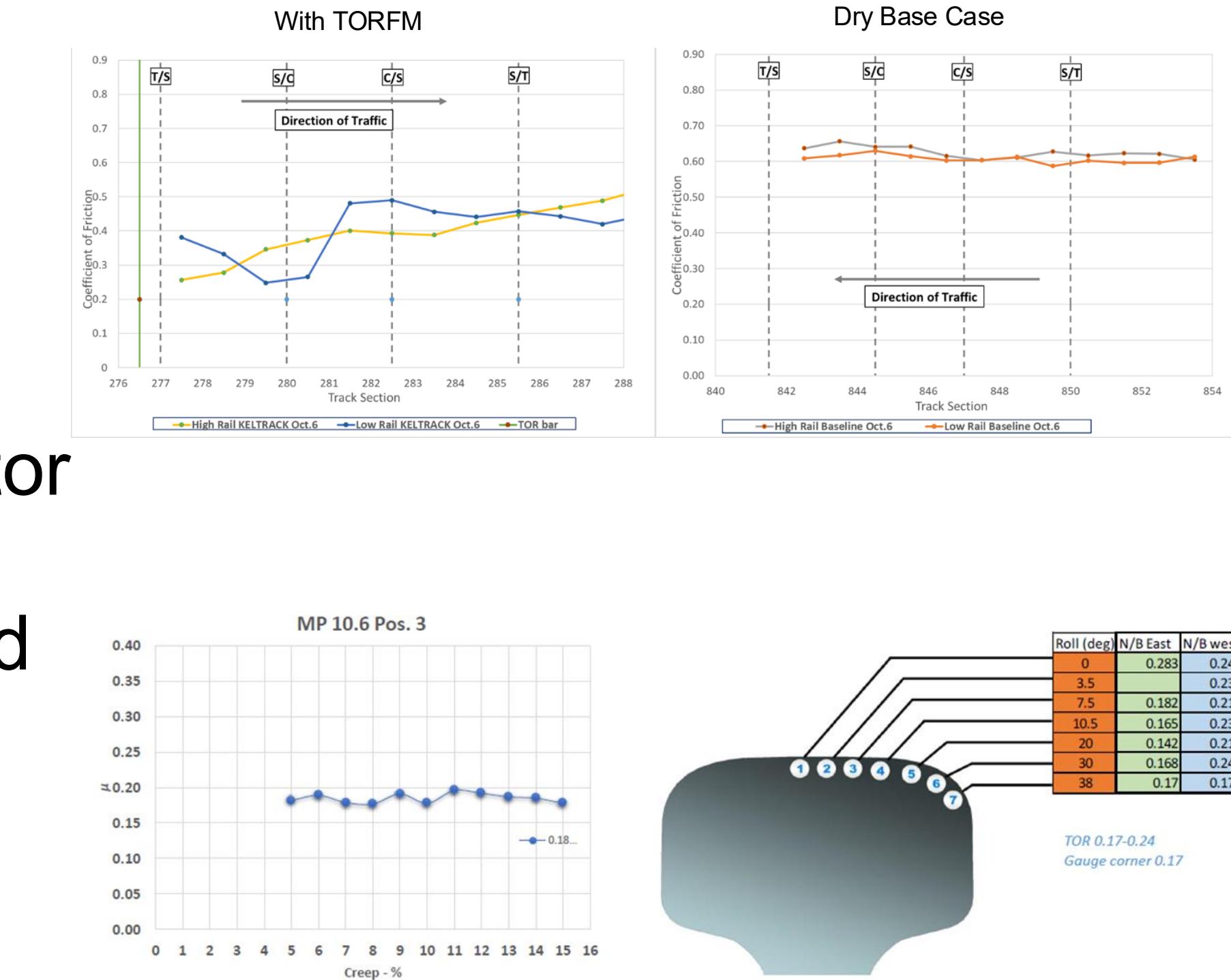
Insufficient Material





# Friction Management

- Clean and maintain equipment
- Refill tanks and replace sticks
- Check bar heights, applicator settings, pump, distributor
- Properties of materials used and equipment used
- Measure carry down and achieved friction levels





# *Questions and Discussions*



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