Planning and Executing an Effective Grinding Program: the North American Experience

WRI 2015: Rail Transit Seminar

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Outline

Why grind?

Pre-grind inspection

Developing a specification

Plan and execute the grind

Follow up

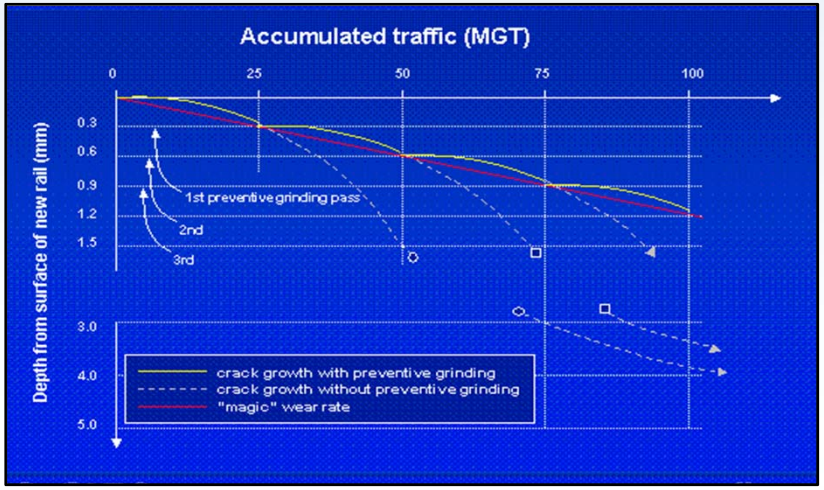
Why Grind Freight Railroads?

Rolling contact fatigue (RCF)

Rail life savings

-Magic wear rate

Reduce transverse defects



Gage Corner Checking

Severe Spalling

Why Grind Transit Systems?

Corrugation

Noise concerns

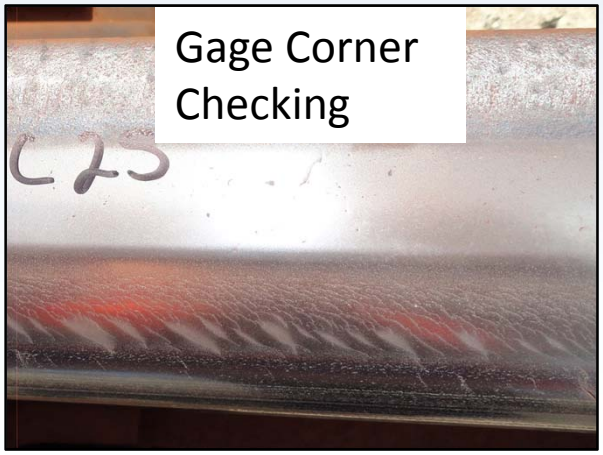
Ride quality

Mill scale

Ride quality

Rail wear

Wheel wear



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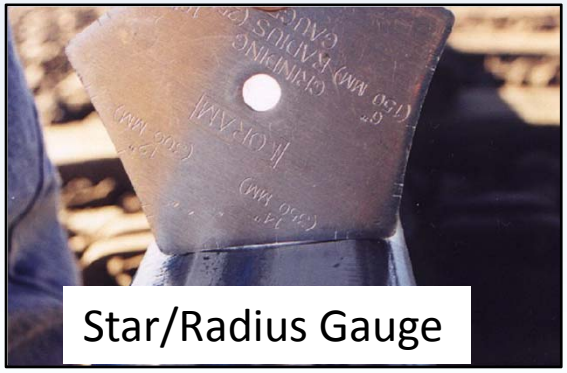
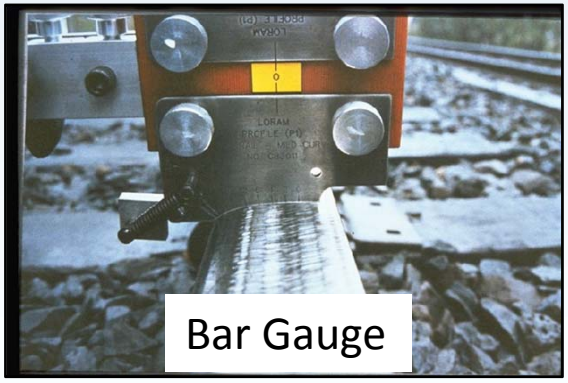
Pre-Grinding Inspection

Transverse profile shape (basic tools)

1. **Star/Radius gauge**
2. **Bar gauge**


Star/Radius Gauge


Bar Gauge

Pre-Grinding Inspection

Transverse profile shape (advanced tools)

Store a digital record to allow comparison between pre/post-grind and against a target template

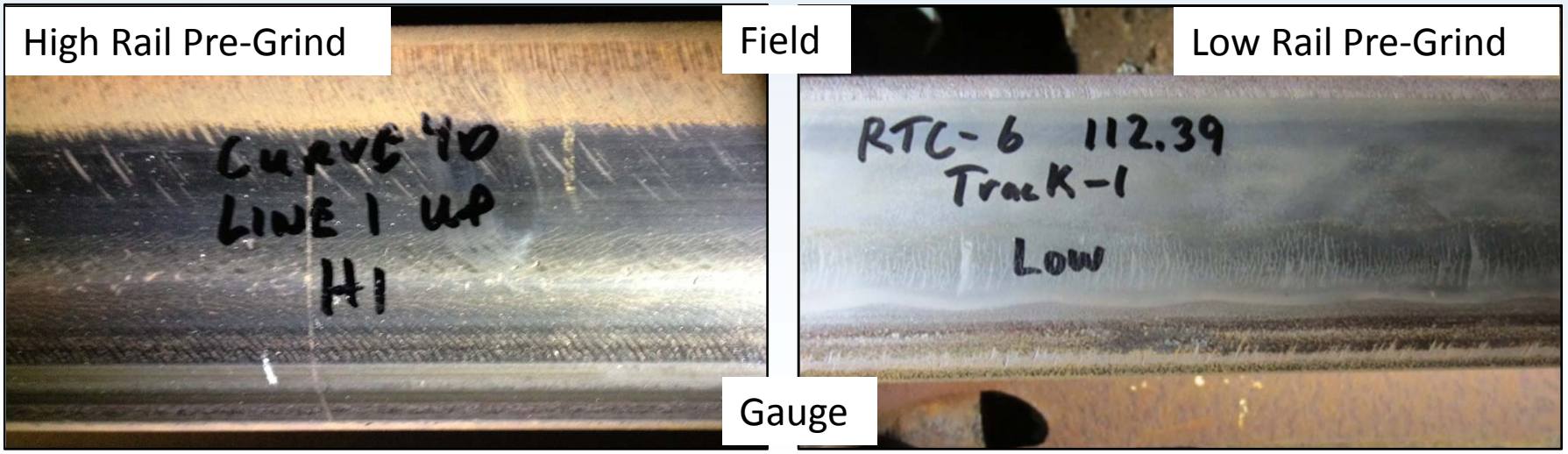
1. **Handheld device**

2. **Laser based equipment mounted profile measurement systems**

Pre-Grinding Inspection

Wheel/Rail interface (running band location)

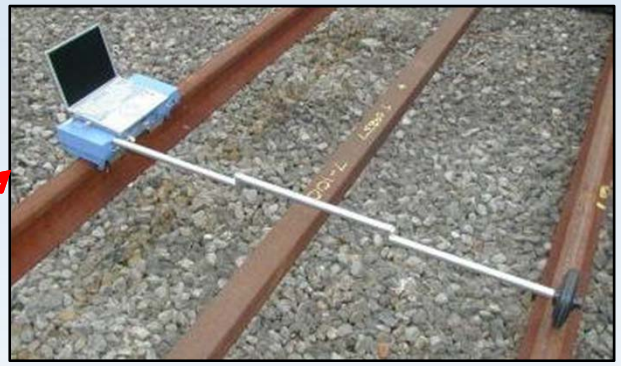
1. Visually determine where the wheels and rails interact
2. Rolling contact fatigue development

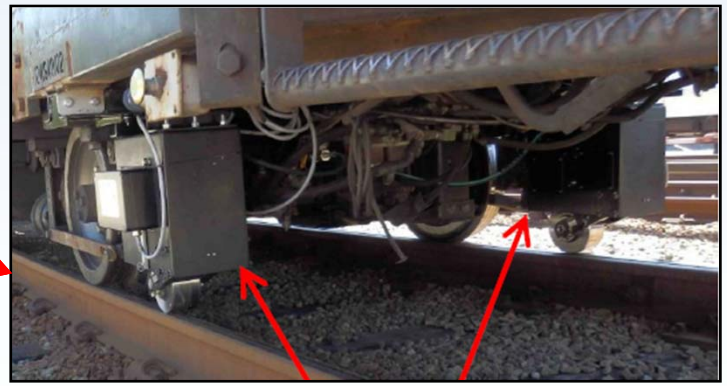


Pre-Grinding Inspection

Longitudinal profile (corrugation) measurements

1. **Ride quality**
2. **Straight edge**
3. **Noise study**
4. **Hand operated trolley**
5. **Hi-Rail or grinder mounted**

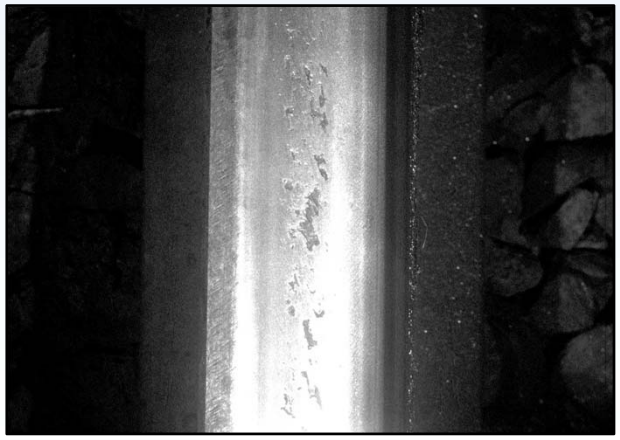


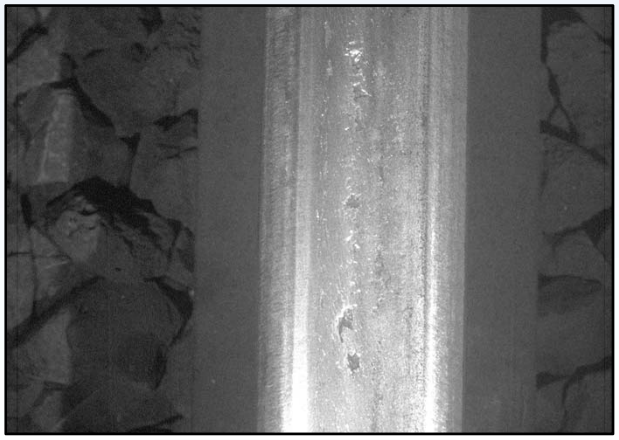


Pre-Grinding Inspection

Surface condition issues

1. **Manual inspection**
2. **Camera systems**





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Grinding Specification

Transverse profile templates

1. **Specify target template shape**
2. **Different templates for tangent, high or low rails**
3. **Specify which track sections require which templates, i.e., by track and curvature**

Transverse Profile - Templates

Options for designing templates

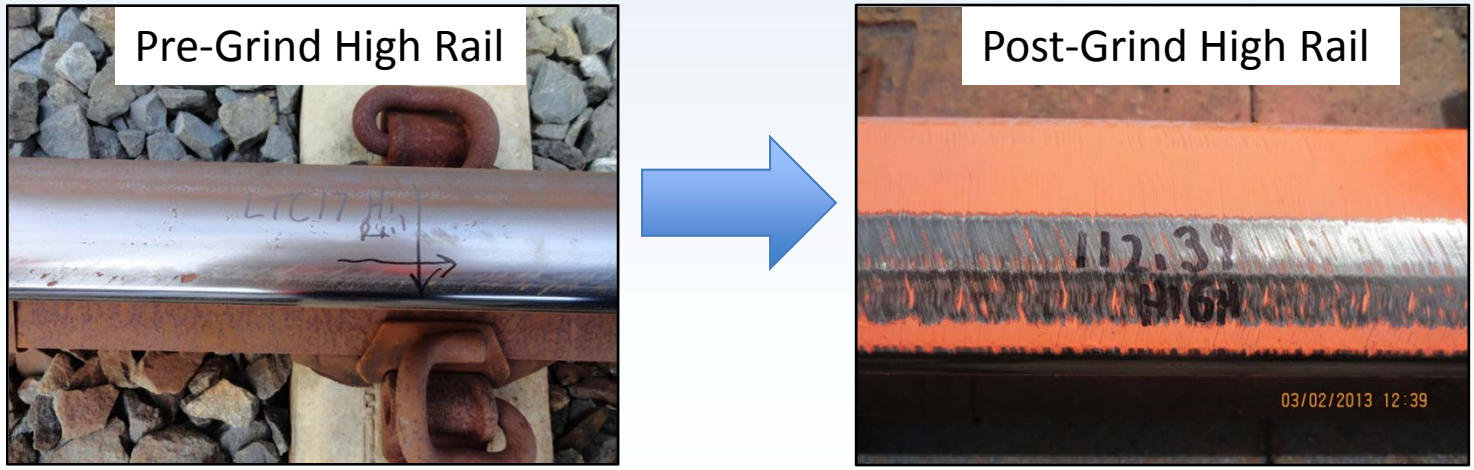
1. **New rail shape (i.e. 115 RE)**
2. **Defined rail head radius**
3. **Large scale wheel/rail interaction study**
4. **Practical implementation of appropriate running band**

<u>Note</u>: Important to monitor how templates affect rails and wheels once they are implemented

Transverse Profile - Templates

Transverse Profile Validation

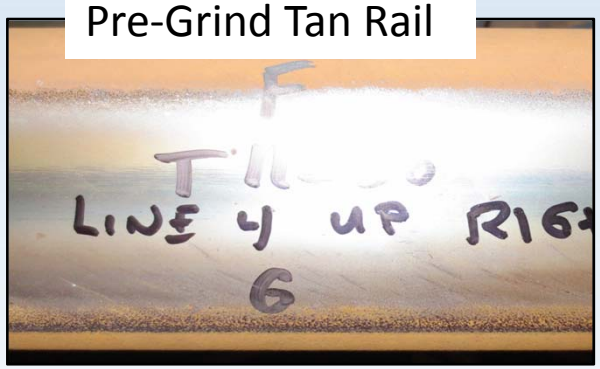
1. Determine if the position and size of resulting running band is as expected
2. Track over time to gauge effect on rail surface condition and wheel wear



Transverse Profile - Templates

Other examples

Pre-Grind Tan Rail



Post-Grind Tan Rail

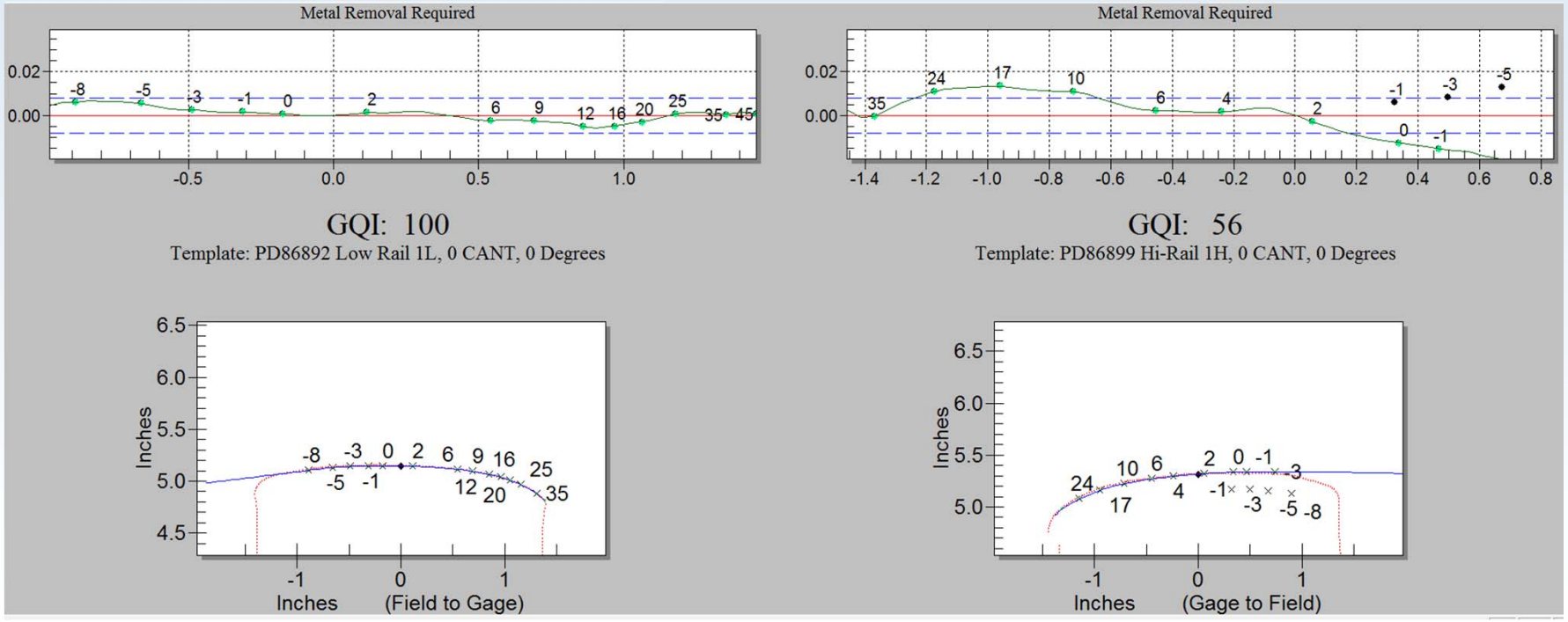
Pre-Grind Low Rail

Post-Grind Low Rail

Grinding Specification

Transverse profile tolerances

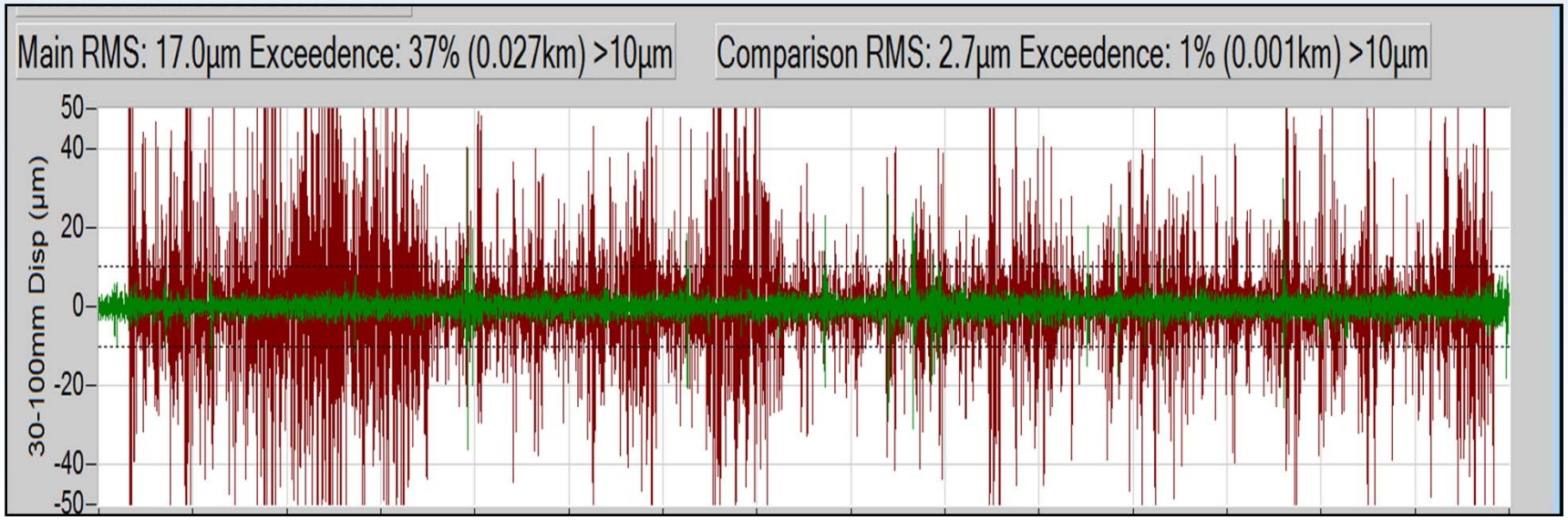
1. +/- tolerance; profile in relation to target template



Grinding Specification

Longitudinal profile (corrugation) tolerances

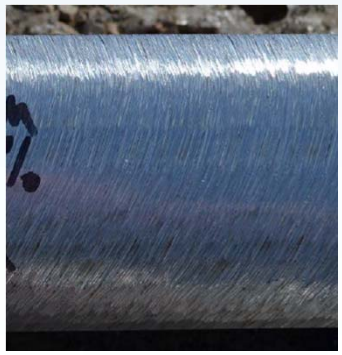
1. **When is grinding needed/corrugation relieved.**
2. **wavelength ranges, tolerances and % exceeding limits**



Grinding Specification

Surface roughness

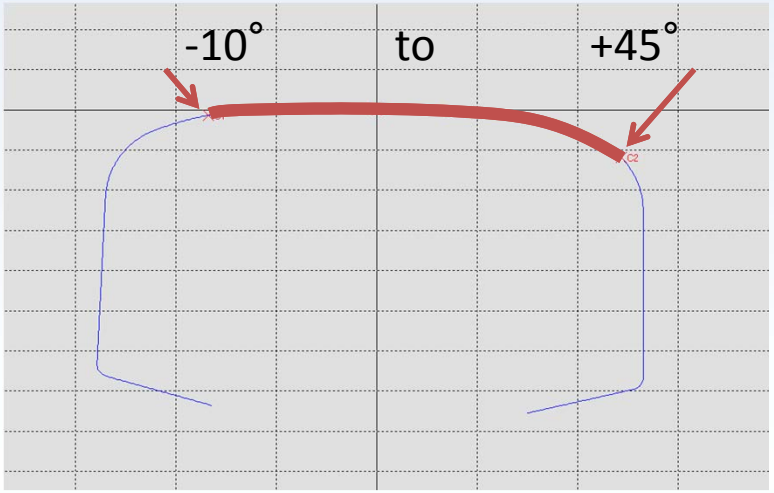
1. Typically measured using the arithmetic mean surface roughness (Ra) value
2. Basic standard is 10µm
3. Transit systems with lighter axle loads could target a lower value



Grinding Specification

Re-Profiling range (angle range field to gauge)

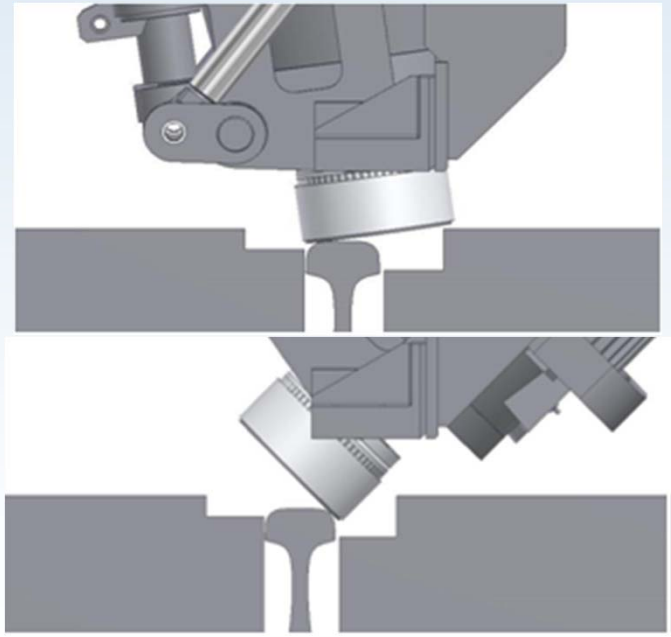
1. Open rail range may be different than embedded rail or specialty track work
2. Range may vary depending on template and railroad requirements



Grinding Specification

Re-Profiling range (clearance restrictions)

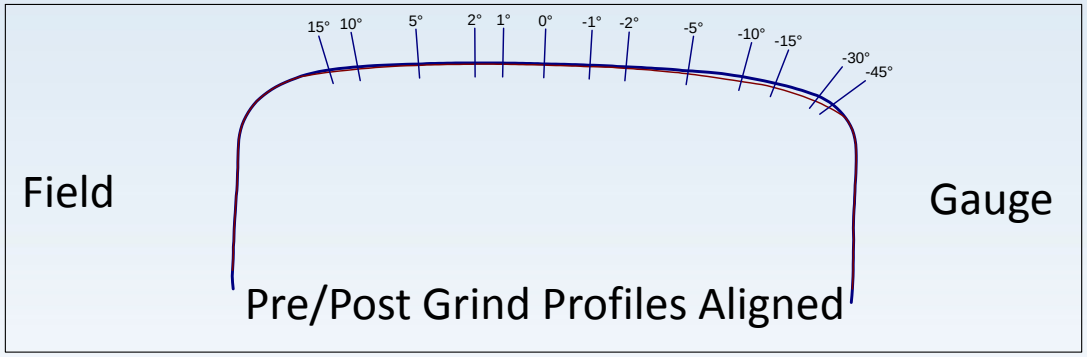
-Similar metal removal still achievable but in a limited angle range

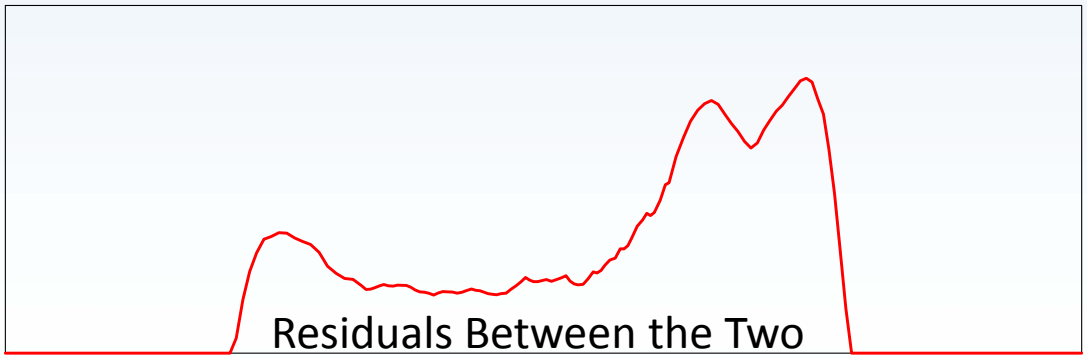


Grinding Specification

Depth of cut requirements

Loram Metal Removal Plot

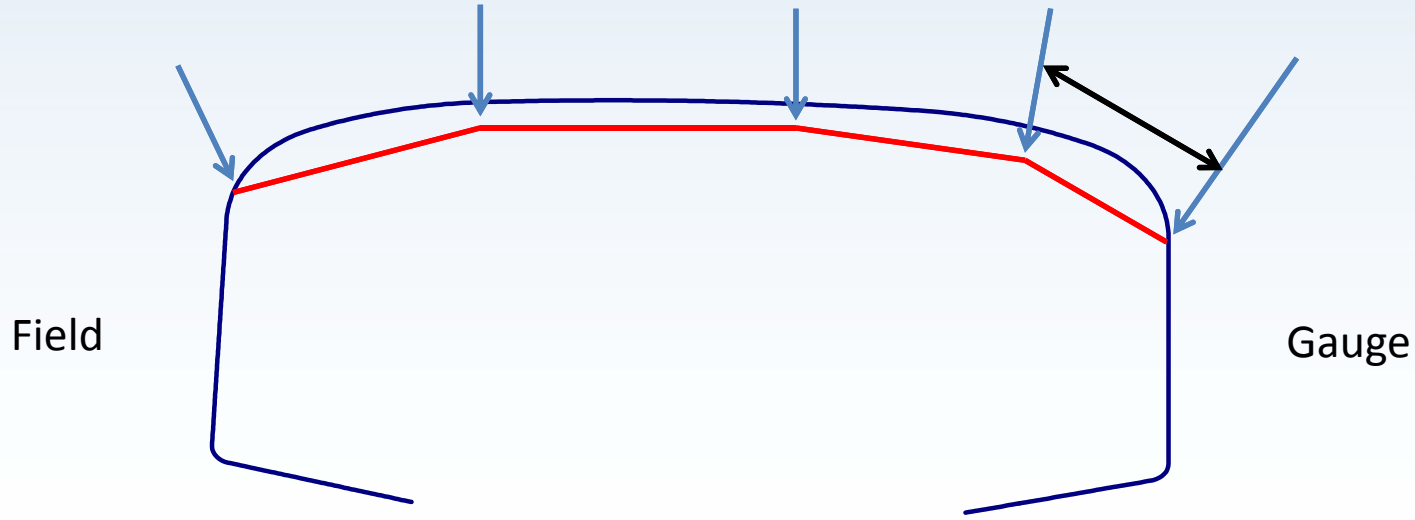




Grinding Specification

Facet width

1. Define maximum width depending on location on railhead
2. Facets should be consistent longitudinally along the rail



Outline

Why grind?

Pre-grind inspection

Developing a specification

Plan and execute the grind

Follow up

Grind Planning

Transverse profile compared to template

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Depth of cut to remove defects

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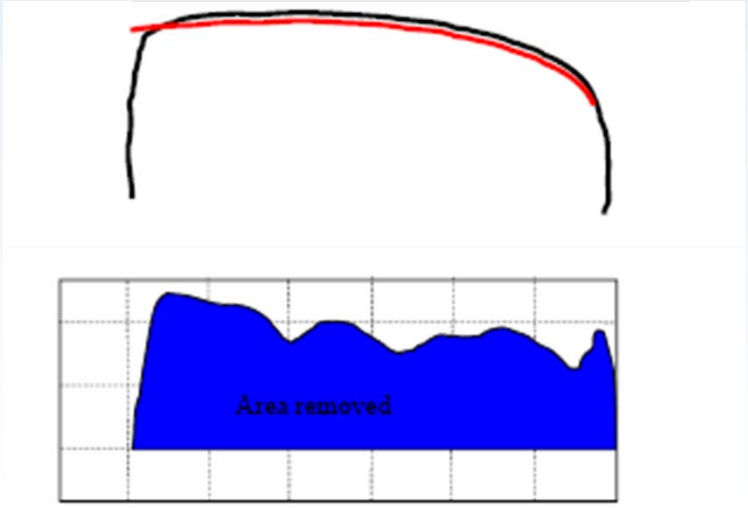
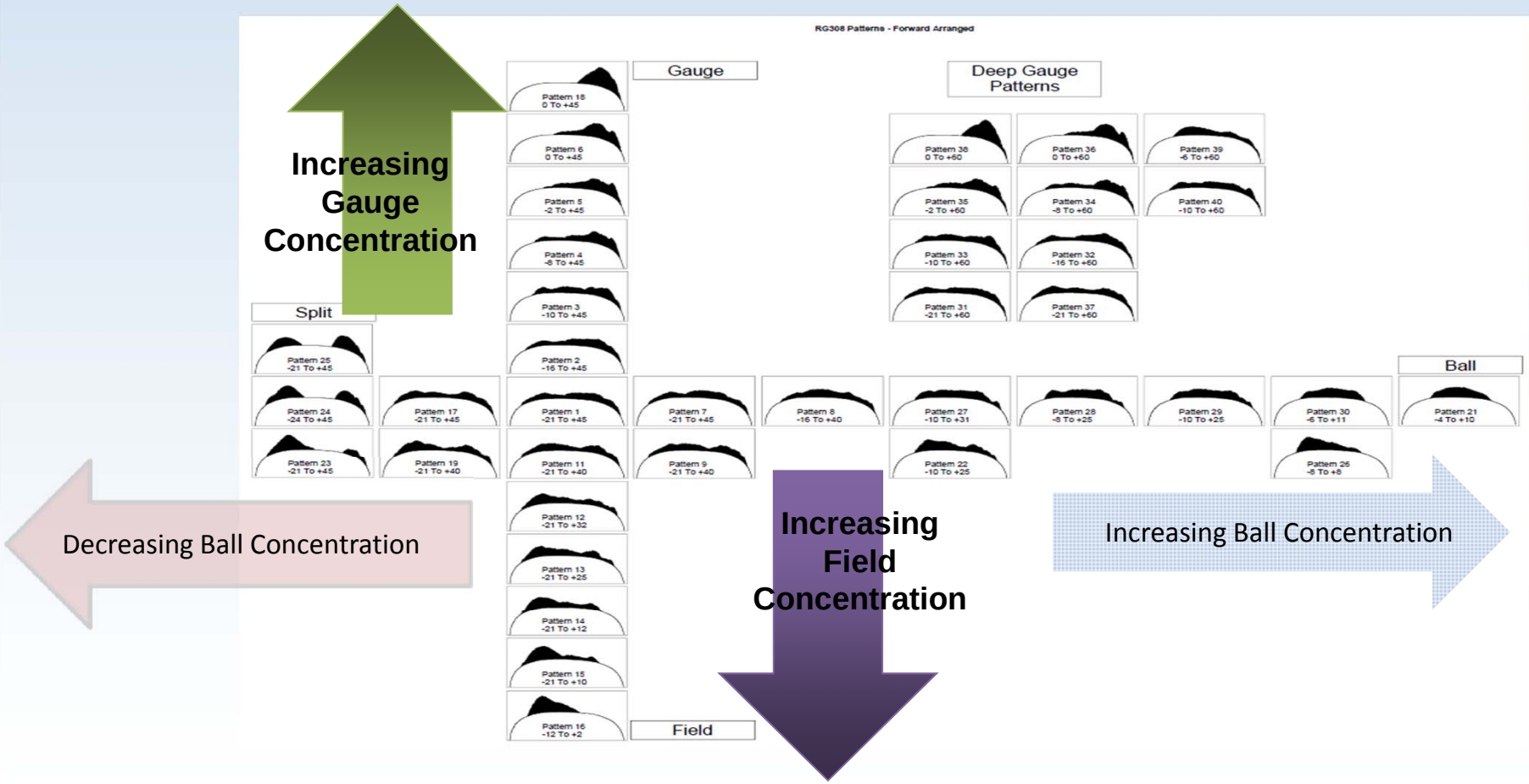
Metal removal needs



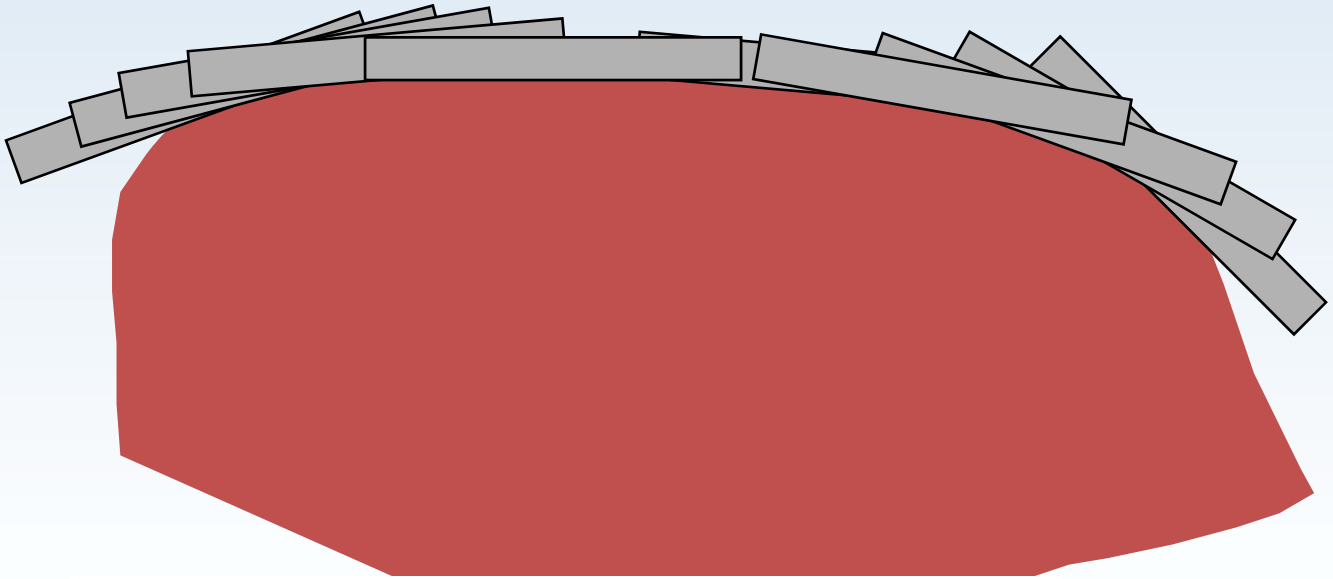
Grind Planning

Grinding patterns to address a variety of needs



Grind Planning

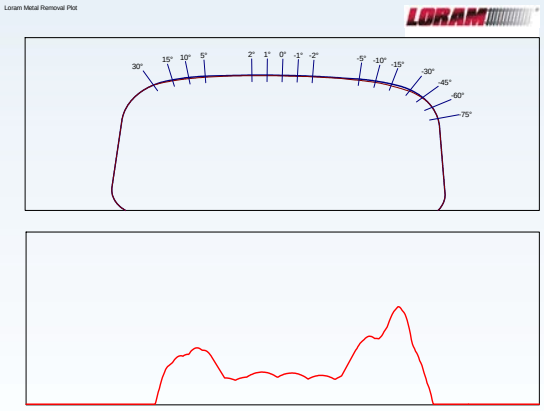
- Location of grind stones to achieve profile
- Depth of cut to remove damaged surface metal



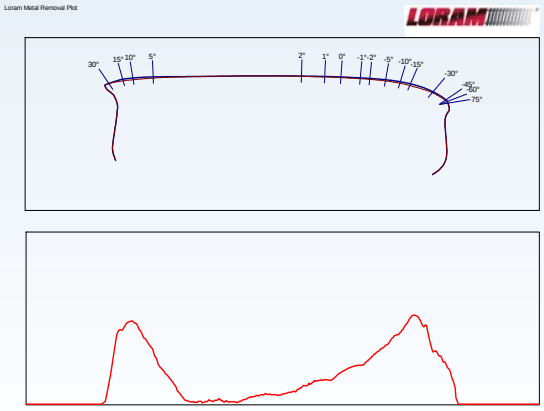
Grind Planning

Existing rail shape greatly affects the metal removal and depth of cut of a grinding pattern

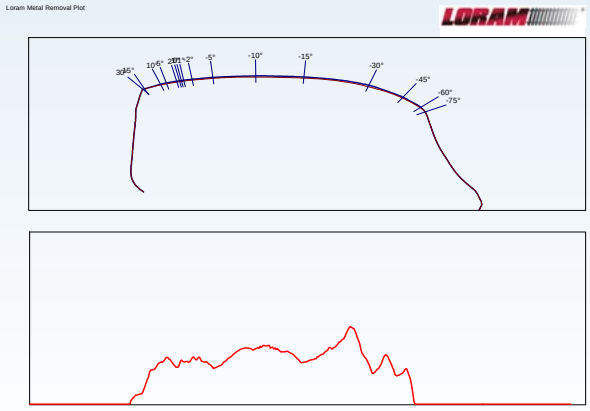
Tangent rail



Flat low rail

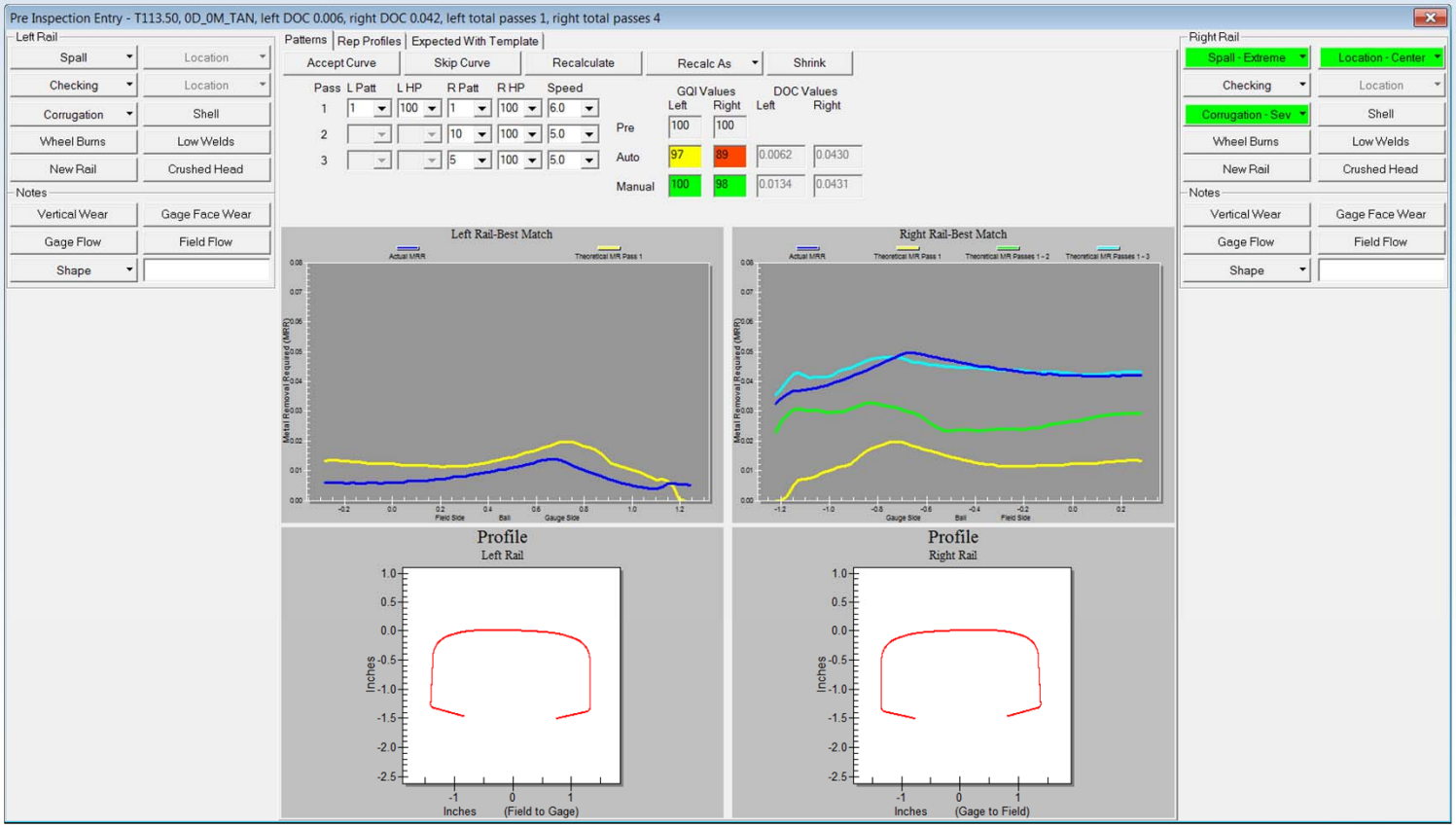


Worn high rail



Grind Planning

Software tools



Grind Planning

Results in a detailed work plan

Track Information								Planned Grind							Work Time		
Chain From	Chain To	Track	Curve Name	Degree of Curve	Direction	Length (chains)	Features	Left Rail Pattern	Right Rail Pattern	Left Rail Passes	Right Rail Passes	Speed	Additional Passes	Comments	Work Time (min)	Total Time (min)	Control Point
311.4	317.6	1	311.39	2.00	L	6.21		***13***	***18***	15	15	7	14/18 at 7 mph, 4/1 at 7 mph	Left: mod corr/Right: mod corr	44.7	45	
359.1	371.3	1	359.12	2.00	R	12.21	Sensor @ MP362.39, Xing @ MP363.70	***24***	***14***	10	10	7	7/4 at 7 mph,	Left: light corr/Right: light corr	49.1	95	
372.8	375.9	1	372.78	2.00	L	3.10		***14***	***23***	15	15	7	25/24 at 7 mph, 4/10 at 7 mph	Left: mod corr/Right: mod corr	29.6	125	
380.6	387.4	1	380.59	2.00	R	6.77	Sensor @ MP385.50	***24***	***14***	10	10	5	8/4 at 5 mph,	Left: mod corr/Right: mod corr	40.3	166	
387.4	396.9	1	387.72	2.00	L	9.56		***25***	***18***	15	15	7	14/11 at 7 mph, 5/9 at 7 mph	Left: mod corr/Right: mod corr	61.1	228	
424.6	432.7	1	424.62	2.00	L	8.12	Sensor @ MP427.43, Sensor @ MP431.12, Xing @ MP431.74	***25***	***23***	15	15	7	14/24 at 7 mph, 5/8 at 7 mph	Left: mod corr/Right: mod corr	54.0	283	
458.4	463	1	458.45	2.00	L	4.52		***14***	***7***	10	5	6	4/X at 6 mph,		26.6	310	
463	485	1	T462.97	0.00		21.98	Xing @ MP468.95, Xing @ MP470.03, Xing @ MP471.73, Xing @ MP473.89, Xing @ MP478.42	11	17	10	10	6	5/7 at 6 mph,	Left: mod corr/Right: mod corr	92.8	403	
310.4	317.8	2	310.43	2.00	L	7.41	Xing @ MP311.36, Sensor @ MP311.83	***13***	***23***	15	15	7	14/19 at 7 mph, 4/7 at 7 mph	Left: mod corr/Right: mod corr	50.6	454	
380	387.6	2	379.96	2.00	R	7.66	Sensor @ MP385.64	***5***	***5***	5	5	6		Right: light corr	19.0	474	
456.6	462.1	2	456.65	2.00	L	5.46	Sensor @ MP459.83	***14***	***7***	10	5	5	2/X at 5 mph,	Left: light corr/Right: light corr	34.3	509	

Grind Planning

Expected productivity rates (8 stone machine)

1. **Mill scale removal – 2500’ to 3000’ per hour**

   0.006 inch Depth at center, 0.015 in^2 metal removed

2. **Profiling – 1500’ to 2000’ per hour**

   0.006 inch Depth at center, 0.025 in^2 metal removed

3. **Severe corrugation removal – 750’ to 1000’ per hour**

   0.025 inch Depth at center, 0.060 in^2 metal removed

Executing the Grind

Scheduling track time

1. One time or multi-interval approach
2. Make the most of available track windows

Quality assurance

1. Have a grinding specification and templates in place
2. Document post-grind measurements (transverse and longitudinal profile) to use as baseline for future years

Follow Up

Schedule a post-grind inspection

6 month to 1 year intervals

- **Inspect running bands**
- **Inspect for RCF and corrugation development**
- **Develop a timeline for the next grind cycle(s)**

Conclusions

Key points

1. **Pre-Grind inspections are important**
2. **Specification helps ensure benefits are realized**
3. **Optimize available grinding windows**
4. **Follow-up to determine future grinding needs**

Thank You For Your Time