Improving Rail Grinding Specifications and QA/QC Procedures for Transit

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Advanced Rail Management

Outline

- Advanced Rail Management Overview
- Why Transits are Grinding
- Types of Equipment
- Typical Specifications
- Types of Grind Programs
- Where and When to Apply a Grind Program
- Implementation of Different Equipment
- QA/QC for Grinding

Advanced Rail Management

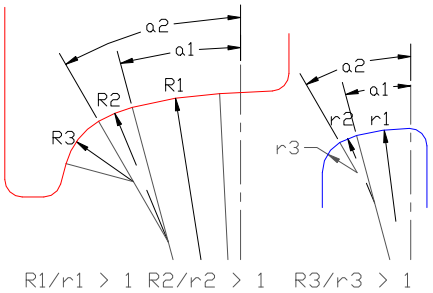
- North America's leading expert in **turnkey rail/wheel maintenance solutions**
  - Advanced Rail Management Corporation 1990
  - Advanced Rail Management (CANADA) Inc. 1990
- Provide a variety of consulting and field services that specialize in technical and practical expertise for heavy haul and transit industry to optimize the **wheel/rail interface** and **vehicle/track interaction**

Advanced Rail Management

QA/QC Services
- Rail Grinding/Profiling
- Wheel Reprofiling
- Data Collection
- Staff Training

Consulting Services
- Wheel Profile Design
- Rail Profile Design
- WRI Studies
- FM Studies

Data Services
- Rail/Wheel Measurement
- Noise Measurement
- Surface cracks and corrugation
- Analysis and Reporting



Why Transits are Grinding

Typically, grind programs have focused on:

1. Mill scale removal
2. Install custom rail profiles
3. Restore rail profiles
4. Remove defects

Ultimately to prolong wheel and rail asset life

In recent years, transit agencies have started to use grinding to focus on noise and vibration

Current Equipment in Use

Several suppliers have grinding equipment available:

1. LORAM- 8-stone, 16-stone, and custom built grinders (hi-rail and railbound)
2. OTI – 12-stone Hi-Rail
3. Rhomberg Sersa – 6-stone Hi-Rail
4. Harsco – custom built grinders (hi-rail and railbound)

Current Equipment in Use

Current Equipment in Use

In recent years, rail milling has also begun to enter the North American market:

1. Rhomberg Sersa – Linsinger
2. Vossloh
3. Plasser American - Robel

Current Equipment in Use

Current Equipment in Use

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)

Typical North American Specifications

- 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

Example Types of Grind Programs

Typically two types of rail grinding (profiling) programs:

1. **Corrective** – nominal to high metal removal rates to address rail surface conditions and restore profiles
   - Typical when no grinding has been done in many years
2. **Preventive** – frequent, light metal removal to control rolling contact fatigue (RCF) and maintain profiles
   - Help achieve the ‘magic wear rate’

Example Types of Grind Programs

In recent years, some transit agencies have begun focusing on “acoustic grinding”

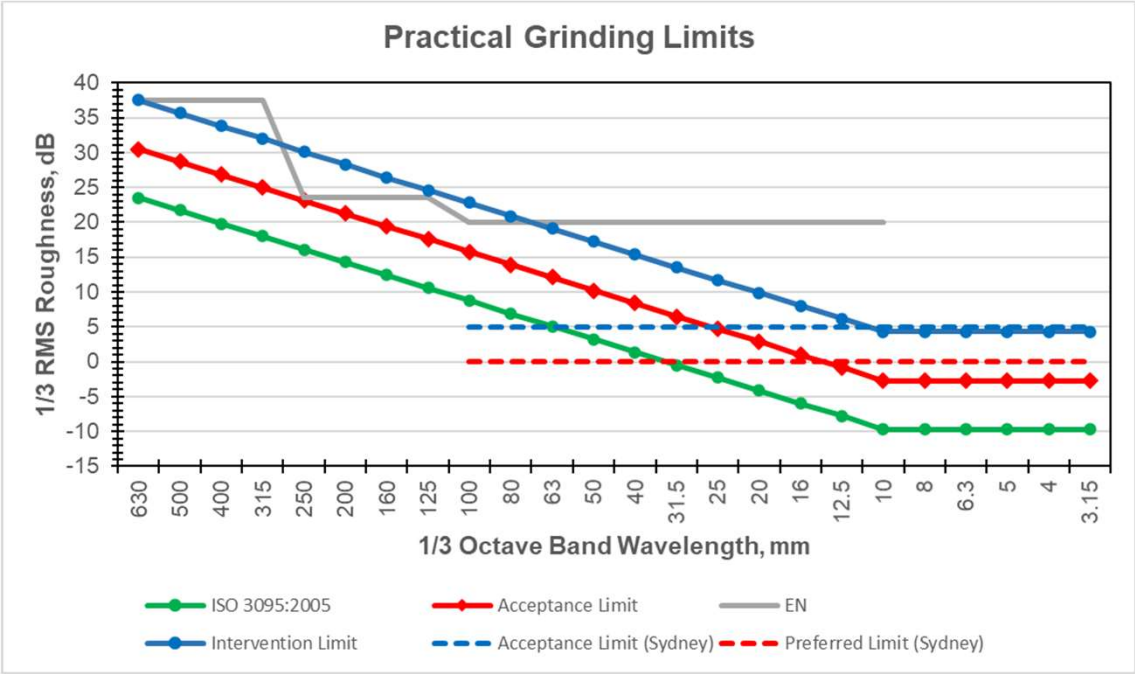
- Maintain rail profile
- Work towards the ‘magic wear rate’
- Control post-grind noise and vibration

Relevant Changes in Specifications

To address the post-grind noise and vibration that can be incurred from rail grinding, transit agencies have started to introduce the following:

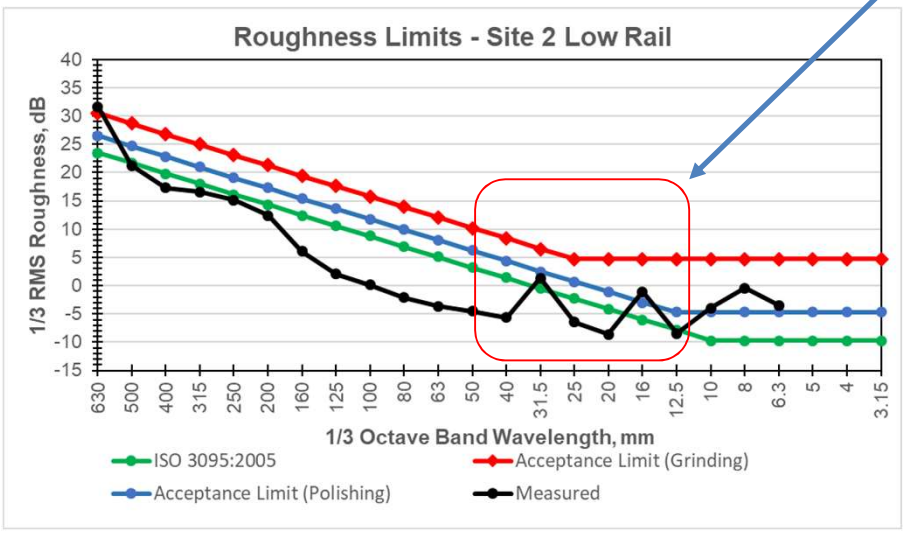
- Requirement for different grit sizes of stones (fine versus coarse)
- Variable grind and 'polish' speeds as well as down pressure for different activities (profiling versus finishing)
- Implementation of ISO3095 standards from European systems
- Stricter surface finish (roughness in microns) requirements
- Performance based results and flexibility for the 'right tool'

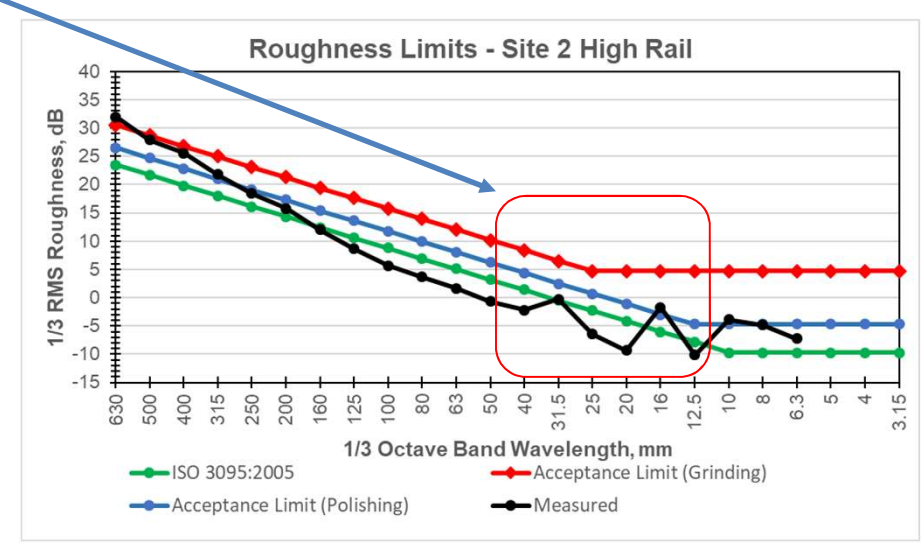
Relevant Changes in Specifications



Relevant Changes in Specifications

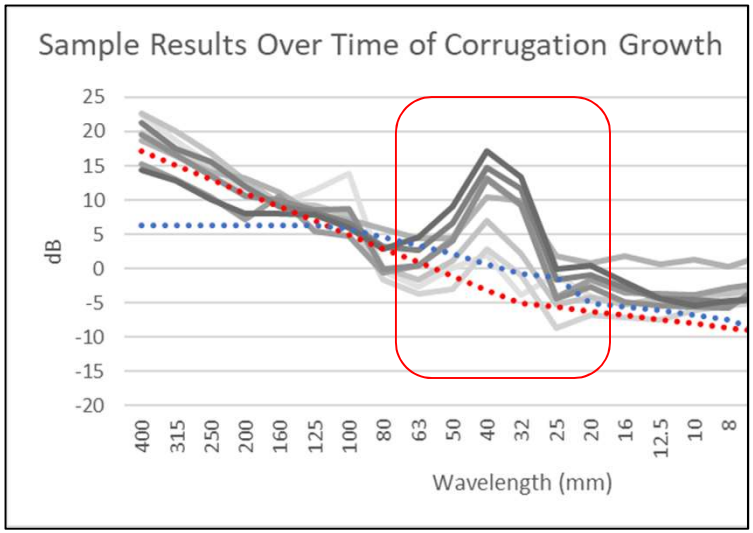
Repeating pattern from grinder – this can be controlled and reduced through grinding speed, down pressure, and stone roughness

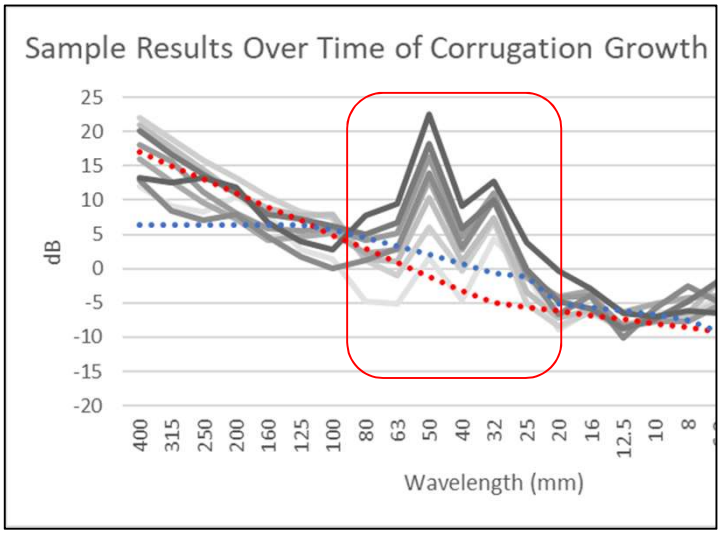




Relevant Changes in Specifications

Corrugation can be measured to determine rate of growth and to help select an intervention period. Wavelengths related to the grind signature (32mm) and corrugation (40 to 50mm) are observed.





When and Why to Use which Method

1. Corrective Work (Grind, Mill, or Replace)
   - Heavy profile work required, long time since last grind, moderate to severe surface defects
2. Preventive Work (Grind or Mill)
   - Minor profile and surface defects, regularly scheduled program
3. Acoustic Finish
   - Noise/vibration sensitive areas, harder rail, frequent noise complaints

Where and When to Use Which Type of Treatment

As an example, the table below provides one approach a system could take to help dictate which tool is the most effective for use of funds and time.

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

Treating Defects

Some defects and conditions are readily addressed with rail grinding

- 16-stone grinder more effective (higher number of stones means more metal removal)
- 30 passes with this grinder removes approx. 0.06” (1.5mm) at 4mph operating speed

Treating Defects

Other defects require rail replacement, although they are typically discrete and localized (but may be widespread, particularly when little prior grinding has occurred). These may be controlled or minimized with grinding or milling.

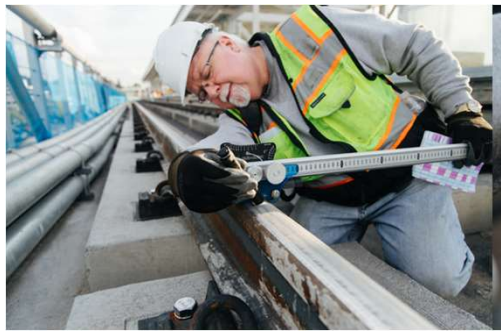
Pre-Grinding Condition

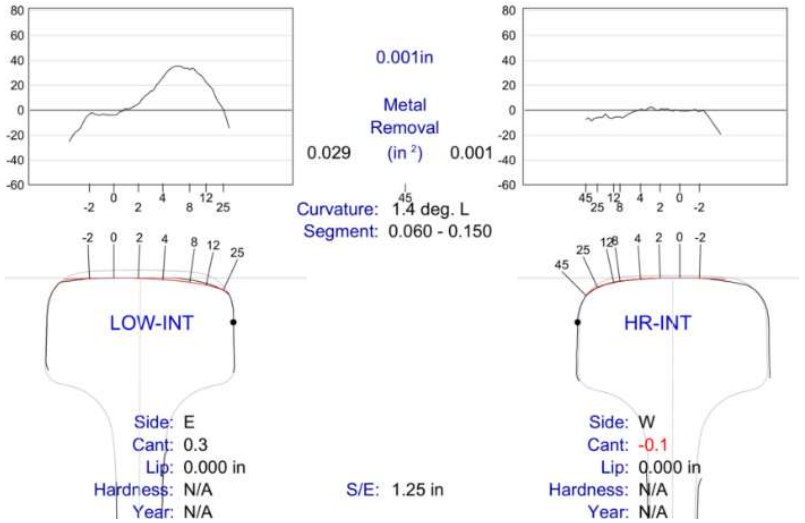
Post-Grinding Condition

QA/QC – How to Report on Success

Traditional QA/QC:

1. Bar Gauge
2. Rail Profile (PQI/GQI)

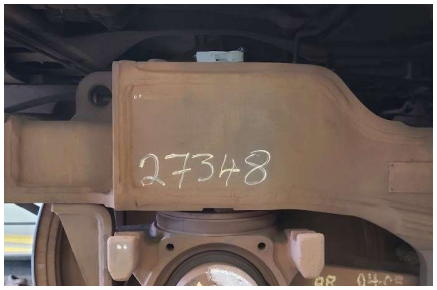


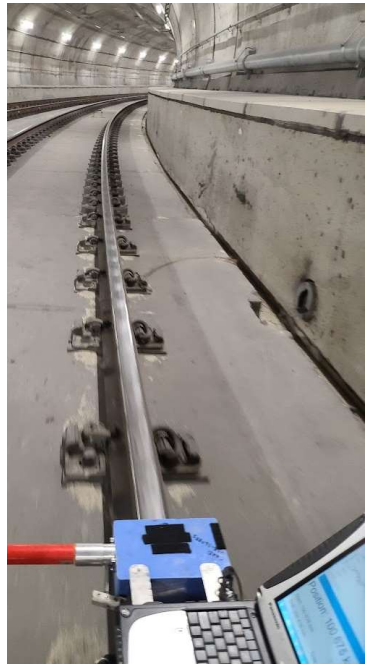


QA/QC – How to Report on Success

New(er) Techniques:

1. Corrugation Analyzers
2. Eddy Current
3. Accelerometers
4. Onboard or Wayside Noise

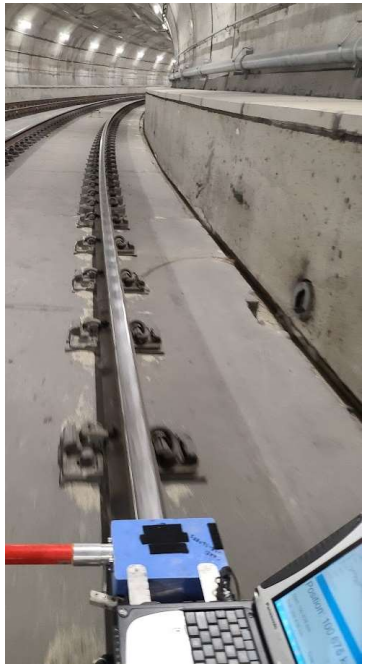




QA/QC – How to Report on Success

Corrugation Analysis:

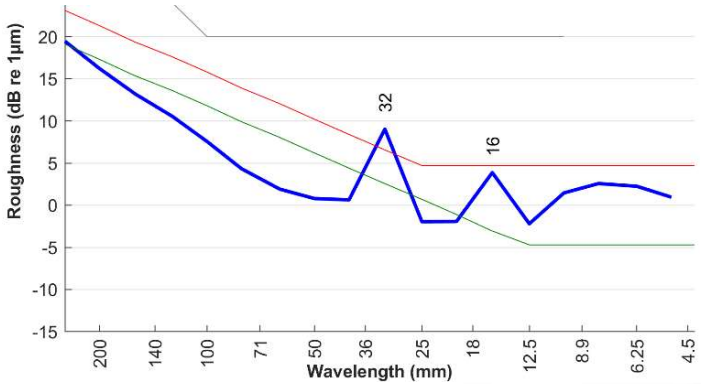
1. ISO3095 – grind quality
2. Rail Corrugation Index (RCI)



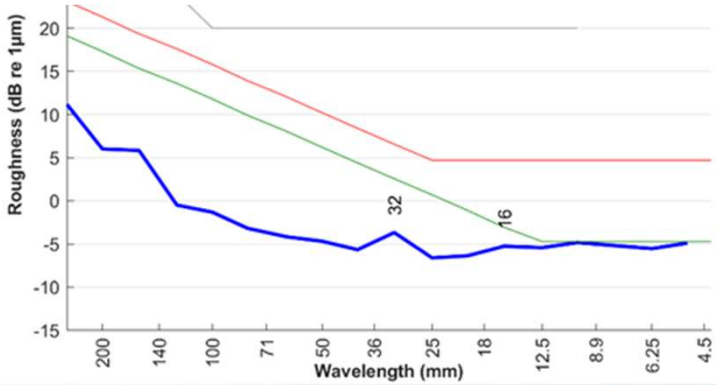
QA/QC – How to Report on Success

1. ISO3095 – grind quality

Initial Grind

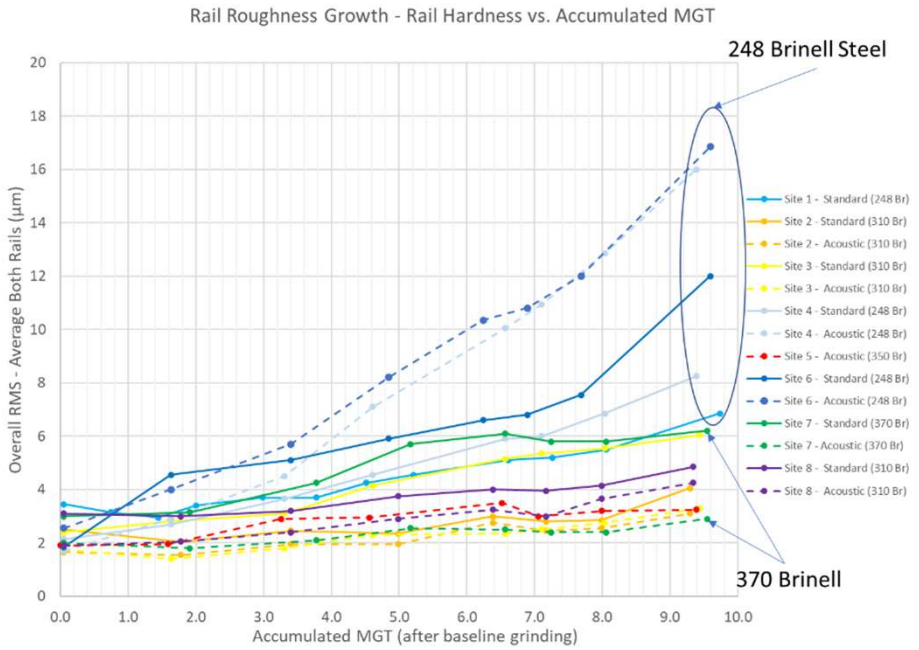


Touch-Up Grind



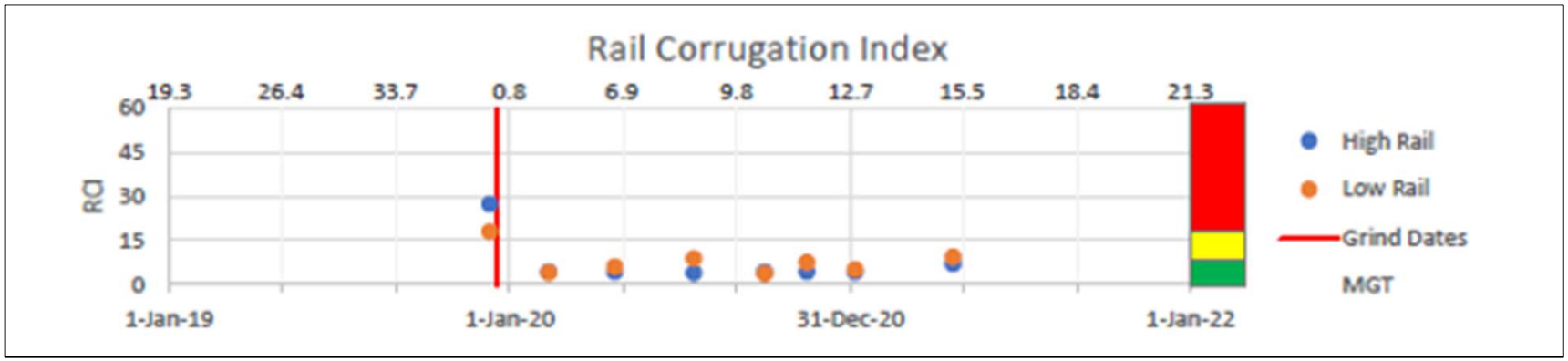
QA/QC – How to Report on Success

Evidence from Vancouver SkyTrain suggests that a finer rail finish is more important the harder the rail is. This rail will ‘hold’ the finish left behind longer than softer steel



QA/QC – How to Report on Success

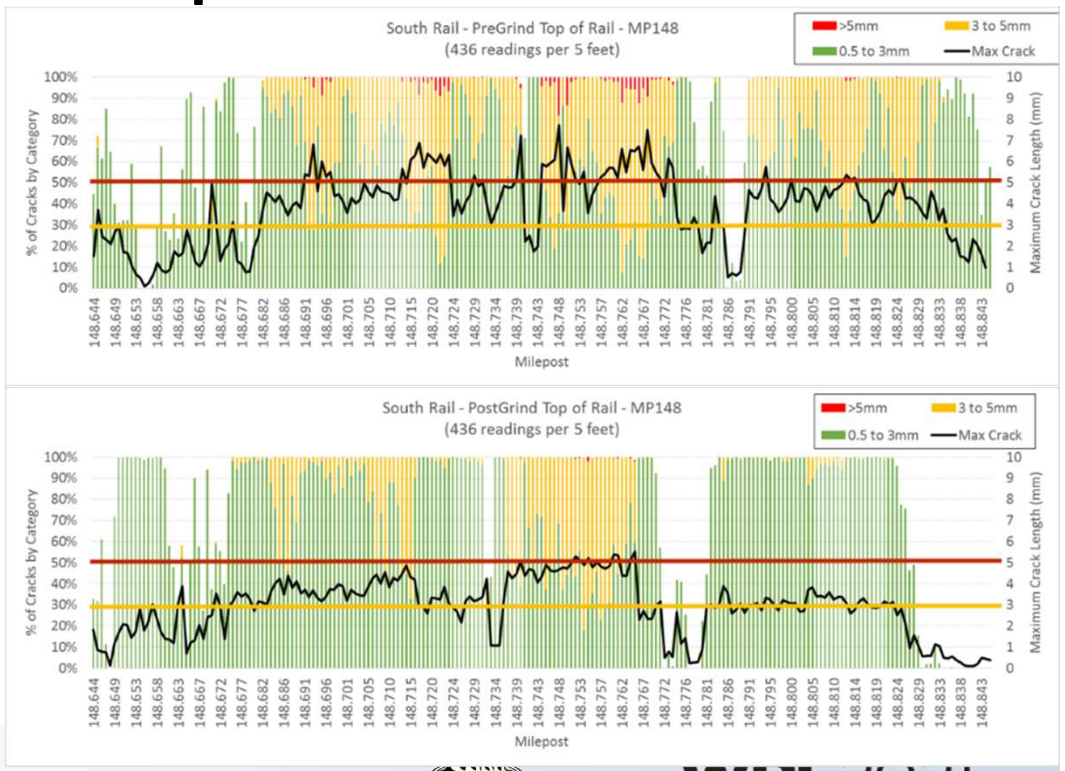
2. Rail Corrugation Index (developed by ARM) is a summarized measurement of the corrugation amplitude



QA/QC – How to Report on Success

Eddy Current for
Rolling Contact Fatigue.

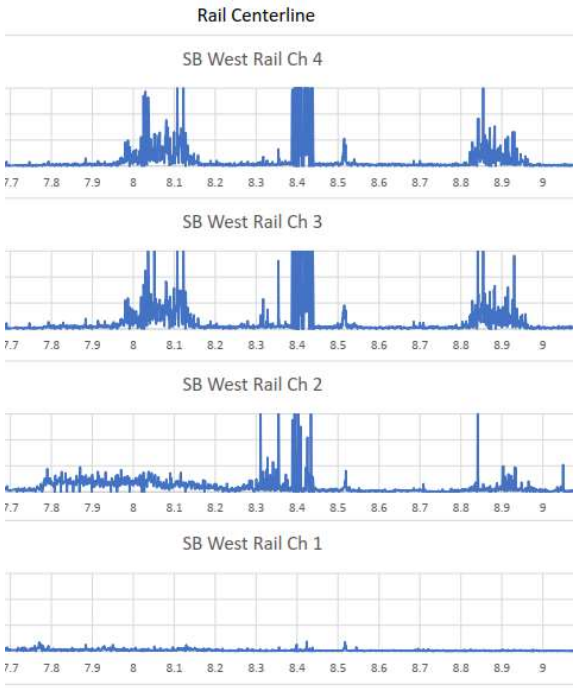
It can be difficult to see remaining RCF or be confident it's fully removed from the rail.



QA/QC – How to Report on Success

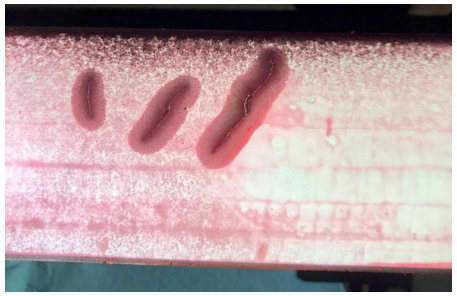
Eddy current data can be used to plan rail maintenance activities by helping inform expected level of effort as well as verify that the work was successful at removing the RCF.

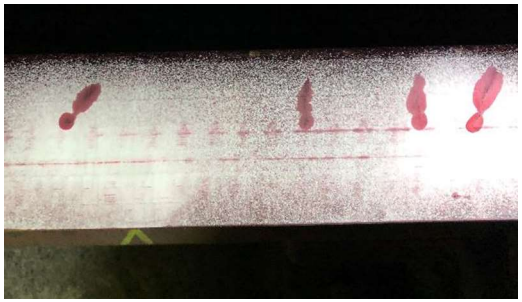
Gauge Corner

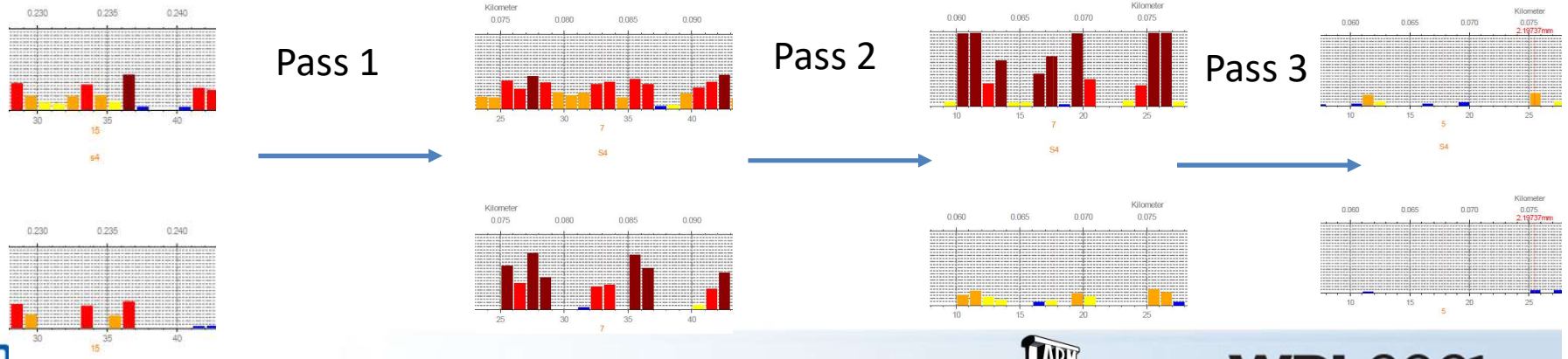


Field Side

QA/QC – How to Report on Success







QA/QC – How to Report on Success

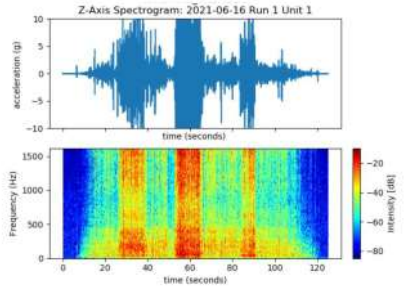
Tri-Axial Accelerometers

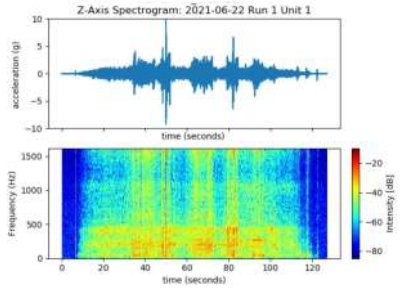
- Inexpensive
- Quick to run
- Can be put on any car
- Snapshot of whole system

Pre-Grind

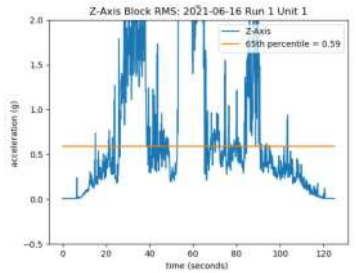
Post-Grind

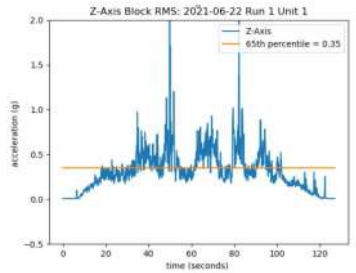
Z-Axis Spectrogram





Z-Axis Block RMS Forces

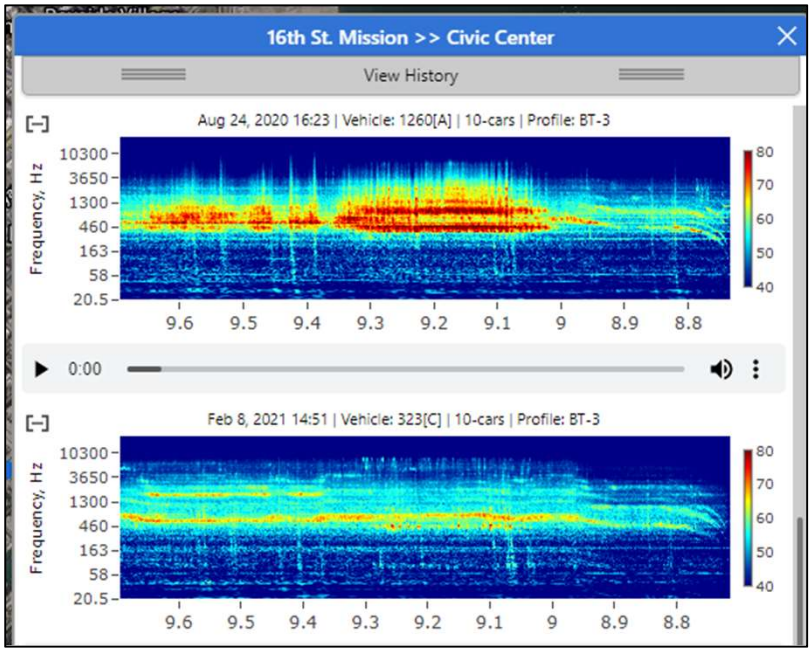




QA/QC – How to Report on Success

Onboard/Wayside noise is a very effective method to measure wheel/rail interface and its impact on passengers and the trackside community.

Decibel thresholds are also easily understood by most.



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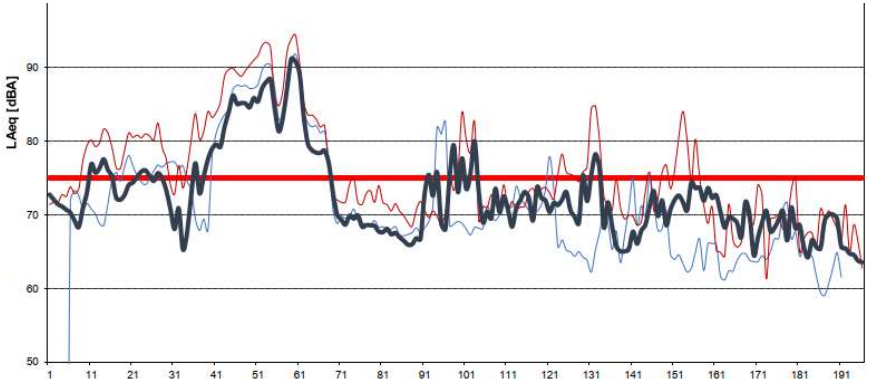

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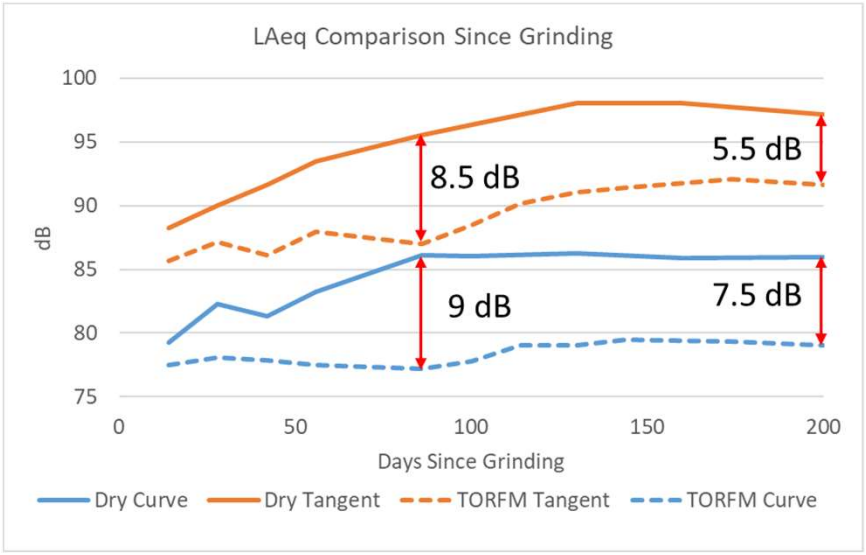
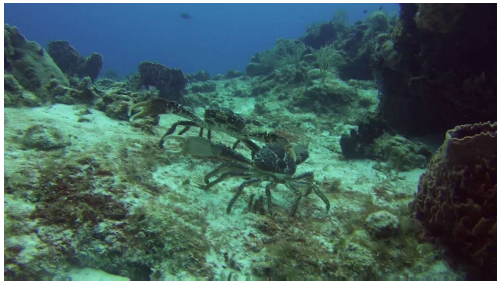


Decibel thresholds are also easily understood by most.

Conclusion

1. Setting up your rail grinding (or rail profiling) specifications beyond just equipment requirements will support performance monitoring.
2. There are lots of tools available to treat rail, ideally a system is in a preventive condition (but that's just not a reality)
3. New technologies can not only help you plan your maintenance effectively but can also be used as good system health indicators

Questions/Discussion



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