Friction Management and Rail Wear
CPs Western Corridor: 2008 - 2016

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Overview

• Background on Rail Wear Review at CP
• Objective/Method to Validate Benefit
• Rail Wear Analysis
• Data Sources/Procedure
• Wear
• Grinding
• Conclusions
Background on Rail Wear and Friction Management at CP

- **NRC “100% Effective Lubrication” Project: 2000-2001**
  - Demonstrated Fuel Savings and Near-Elimination of GF Wear via GF Lubrication.
  - Revealed Increase in TOR Wear Due to Increased AoA with Extensive GF Lubrication.

- **Northern Ontario Friction Management: 2003-present**
  - Outsourcing of Friction Management Oversight to Portec Rail Directing CP Internal Forces.

- **NRC “100% Effective Friction Management” Project: 2004-2005**
  - Demonstrated Reductions in Lateral Forces (24%-40%) and Rail Wear (~50%) with Incorporation of KELTRACK Trackside Freight TOR Friction Control.
Background on Rail Wear and Friction Management at CP

• Validation of Rail Wear Reduction and Fuel Savings: 2007
  o TFM Business Case Escalated for Approval at CP (Fuel and Rail Wear).

• Total Friction Management Deployment: West Corridor
  o 2008 – Present (GF + TOR + Dedicated Resources + Monitoring)
  o TFM Implementation on CP West Corridor
    o 139 GF/255 TOR: Initial Design
    o 139 GF/212 TOR: Following Re-spacing in 2015
Decision to Validate Rail Wear Benefit from Friction Management

• Validation of Benefit Required: Context of Current Operation
  o Dynamic Train Design and Train Speed
  o Curve Specific Replacement Rates
  o Deployment of 18-Inch Tie Plate

• Validation Objective:
  o Friction Management Effect on Rail Wear
  o Review Empirical Evidence from Available Sources of Information
Decision to Validate Rail Wear Benefit from Friction Management

TOR Impacts – Many Variables
- Lateral Forces and Rail Wear
- Rail Cant
- RCF Development
- Fuel Efficiency
- Derailment Potential (L/V, Rail Rollover)
- Noise
- Corrugations
- Hunting Traction / Adhesion
Method of Validation

• Test Results of Original Justification Without Use of Specialized Tools/Analysis
  – L/V and Fuel Consumption
• Use Existing Engineering Practices
• Use Existing Engineering Data and Tools Sets
Method of Validation

- Selected Geometry Car and Rail Grinder as the Most Consistent Data
- Target Curve Grinding Interval 25/30 MGT
- Existing Historical Record
Rail Wear Analysis

• Time Frame: 2014 - Mid 2016
• Selection of Subdivisions
  – With and Without TFM Implementation
• Three Curves per Subdivision
  – 4° Curve, 6° Curve and 9° Curve
  – No Other Disruptive Factors (Crossing, Differential Heavy Grades, etc.)
Data Sources: Analysed Subdivisions

**Shuswap Subdivision**
- Full TFM
- Coal, Intermodal, Grain, Potash

**Cranbrook Subdivision**
- No TFM (GF only)
- Coal, Grain, Potash

**Laggan Subdivision**
- Full TFM
- Intermodal, Grain, Potash
Data Sources: Applicator Uptime

• Applicator Uptime: Key Factor for Achieving Expected Benefits

• Average Uptime Around Examination Curves: 87%
Data Sources: Traffic Conditions


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Data Sources: Track Geometry, Rail Wear, Grinding

• Track Geometry Data **Every Foot**
  – MP, L/R/Tangent, Deg. of Curvature, Wear (Gauge, Vertical)

• Wear Data **Every 15 Feet**
  – MP, Curve/Tangent Info, Gauge Wear, Vertical Wear

• Grinding Information, **One Value per Curve**
  – Metal Removal (Gauge, Vertical) and Grinding Passes
Definitions of Wear

• **Natural Wear**: Wear of Rails Caused by the Railway Vehicles

• **Artificial / Grinding Wear**: Wear Caused by Rail Grinding Activities

• **Combined Wear**: Natural + Grinding Wear

Photo by voestalpine, WRI 2013
Data Analysis Procedure - Part I

• Select Curves for Analysis from Geometry Files

• Geometry Data:
  – Curve / Tangent Transition: Degree < 0.2°
  – Body of Curve: “Maximum Curvature - 0.2°”
    (Ensure Stable Wear Conditions)
Data Analysis Example: Body of Curve

- Use the % “Spiral-Body-Spiral” Length from Geometry Data to Determine Body of Curve Location in Wear Data Files
Data Analysis Procedure – Part II

• Calculate Average Vertical (Height) and Lateral / Gauge (Width) Wear for Body of Each Curve and Each Measurement

• Linear Regression of Wear Rate with MGT Information [mm/100 MGT]
Data Analysis Example: Wear Rates

Shuswap, 8.5° LHC, HR, Combined Wear

Combined Wear Rates:
Vertical (Ht): 2.2mm / 100 MGT
Gauge (Wd): 4.9mm / 100 MGT

Natural Wear Rates:
Vertical (Ht): 1.1mm / 100 MGT
Gauge (Wd): 3.4mm / 100 MGT
Data Analysis: Remarks

• Manual Correction for Rail Change-Outs
• Negative or “Zero” Wear Rates Were Removed from Analysis
• Rail Steel Grade:
  – 4°: Intermediate Grade (325 BHN)
  – 6° and 9°: Premium Grade (370 BHN)
Unknown Factors

• Local Track Influence Between Measurements
• Impact of Different Levels of Data Accuracy in Provided Files
• Other Maintenance Activities that Might Influence Wear
Natural Wear – Low Rail

- LR: Only TOR (Top of Rail) Wear, no GF Wear
- Improvement TFM vs no TFM: Between 21% - 91%
Natural Wear - High Rail

- High Rail: Wear on TOR and GF
- Improvement TFM vs no TFM: Between 25% - 83%
Rail Grade Influence

• Intermediate Grade (4° curve) vs. Premium Rail Grade (6° curve)

• Despite Sharper Curve Radius – Less Wear in 6° Curve.

4° curve - HR

6° curve - HR

Premium Rail Grade: Reduced Wear
Metal removal by grinding

- Considerably Less Metal Removal by Grinding Required for TFM Curves Compared to Untreated Curves
Combined Wear – Low Rail

- Similar Trends as Natural Wear Analysis
- Improvement: TFM vs no TFM: 36-80%
Impact of Grinding

- Specific Grinding Actions can Disguise Rail Wear Behaviour
- Grinding Data: One (Corrective) Grinding Cycle (Laggan) with Higher Metal Removal

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<tr>
<th>4° curve, LR, combined wear</th>
<th>4° curve, LR, natural wear</th>
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<td>Ht Wd wear rate [mm/100MGT]</td>
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With Grinding

Without Grinding
Combined Wear – High Rail

- Similar Trends as Natural Wear Analysis
- Improvement TFM vs no TFM: 25-80%
Considerations

• MGTs in Examination Period Differ Between Subs
• Traffic Type Different Between Subs
• Influence of Unknown Factors?
• Empirical Results Represent “Rough” Trends
Conclusions

• The Mapping of Railway Asset Life is Possible with Existing Railway Measurement Tools/Programs

• Total Friction Management (TFM) Curves Show Less GF and TOR Wear Compared to non-TFM Curves
  – Statement is Valid With and Without Wear Correction for Grinding Activities

• TFM Curves Require Less Metal Removal by Grinding Compared to non-TFM Curves
  – This Can be Attributed to Both, Reduced Wear and Reduced RCF Development Due to TFM
Thank You for Your Attention