

Vehicle-Track Measurement Technologies

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ENSCO

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Summary

Overview of Measurement Systems

Detailed Evaluation of Select Technology

New Era in Advanced Inspection Solutions



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Overview of Measurement Systems

There are six basic categories of measurement system.



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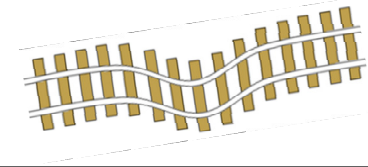
Categories of Measurement Systems

1) Mounted on Vehicle to measure the Vehicle.



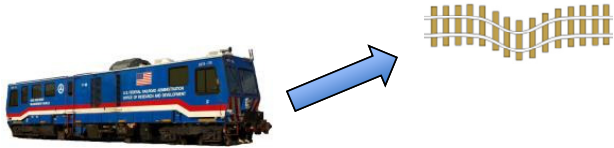
Categories of Measurement Systems

2) Mounted on Track to measure the Track.



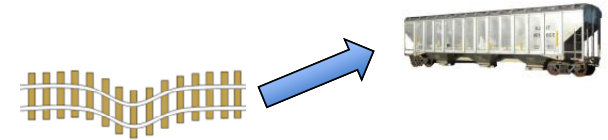
Categories of Measurement Systems

3) Mounted on Vehicle to measure the Track.
(Manned, Unmanned, and Autonomous)



Categories of Measurement Systems

4) Mounted on Track to measure the Vehicle.



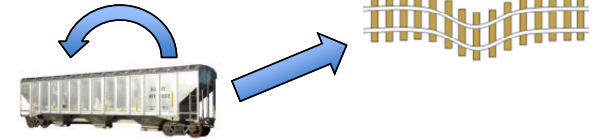
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Categories of Measurement Systems

5) Mounted on Vehicle to measure the Vehicle & Track.



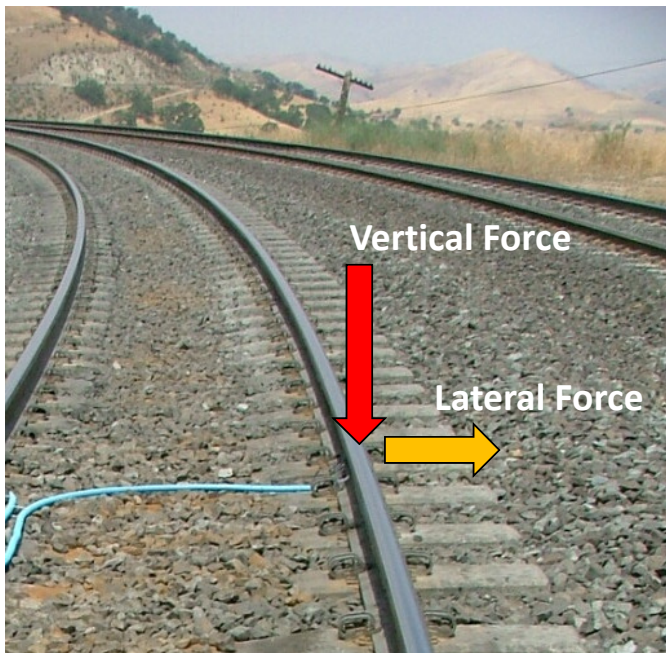
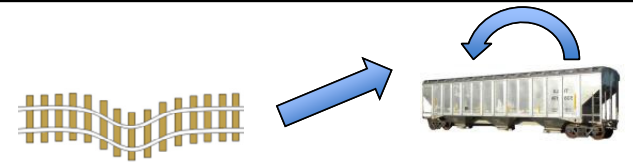
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Categories of Measurement Systems

6) Mounted on Track to measure the Vehicle & Track.



Truck Performance Detectors

Also known as “L/V Detector”

Common Uses:

- Vehicle condition monitoring
- Superelevation assessments
- New Vehicle Fleet Assessments



Track Measurement

Rail Profile Measurement System

Track Geometry Measurement

V/TI Monitor Axle Impact

Ultrasonic Rail Flaw Detector

Machine Vision

Infrastructure Thermal Imaging



Vehicle Measurement

Wheel Profile Detector

**Truck Condition Monitor
(TBOGI)**

Wheel Impact Load Detector

Cracked Wheel Detector

Machine Vision

**Hot Box & Hot/Cold Wheel
Detectors**

**Instrumented Wheel Sets (IWS) &
Truck Performance Detectors (TPD)**



Track Measurement

Vehicle Measurement

Rail Profile Measurement System



Wheel Profile Detector

Track Geometry Measurement



Truck Condition Monitor (TBOGI)

V/TI Monitor Axle Impact



Wheel Impact Load Detector

Ultrasonic Rail Flaw Detector



Cracked Wheel Detector

Machine Vision

Machine Vision

Infrastructure Thermal Imaging

& Hot/Cold Wheel Detectors

Instrumented Wheel Sets (IWS) & Truck Performance Detectors (TPD)

Previously covered in:

WRI 2019



Track Measurement

Vehicle Measurement

Rail Profile Measurement System

Track Geometry Measurement

V/TI Monitor Axle Impact

Ultrasonic Rail Flaw Detector

Machine Vision

Infrastructure Thermal Imaging

Previously covered in:

WRI 2021

Wheel Impact Load Detector

Cracked Wheel Detector

Machine Vision

Hot Box & Hot/Cold Wheel Detectors

Instrumented Wheel Sets (IWS) &
Truck Performance Detectors (TPD)



Track Measurement

Vehicle Measurement

Rail Profile Measurement System

Wheel Profile Detector

Track Geometry Measurement

Truck Condition Monitor
(TBOGI)

V/TI Monitor Axle Impact

Wheel Impact Load Detector

Ultrasonic Rail Flaw Detector

Cracked Wheel Detector

Machine Vision

Previously covered in:

Infrastructure Thermal Imaging

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**Instrumented Wheel Sets (IWS) &
Truck Performance Detectors (TPD)**



Track Measurement

Rail Profile Measurement System

Track Geometry Measurement

V/TI Monitor Axle Impact

Ultrasonic Rail Flaw Detector

Machine Vision

Infrastructure Thermal Imaging

Vehicle Measurement

Wheel Profile Detector

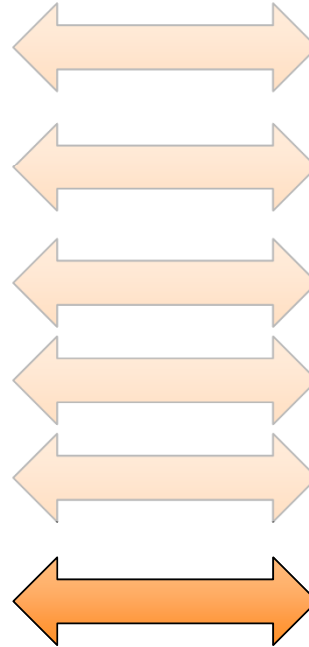
Truck Condition Monitor
(TBOGI)

Wheel Impact Load Detector

Cracked Wheel Detector

Machine Vision

**Hot Box & Hot/Cold Wheel
Detectors**



Instrumented Wheel Sets (IWS) &
Truck Performance Detectors (TPD)



Hot Box Detectors

aka Hot Bearing Detectors
aka HBD



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Bearing Background



Ref: https://www.youtube.com/watch?v=8Qv7y0W_mNM

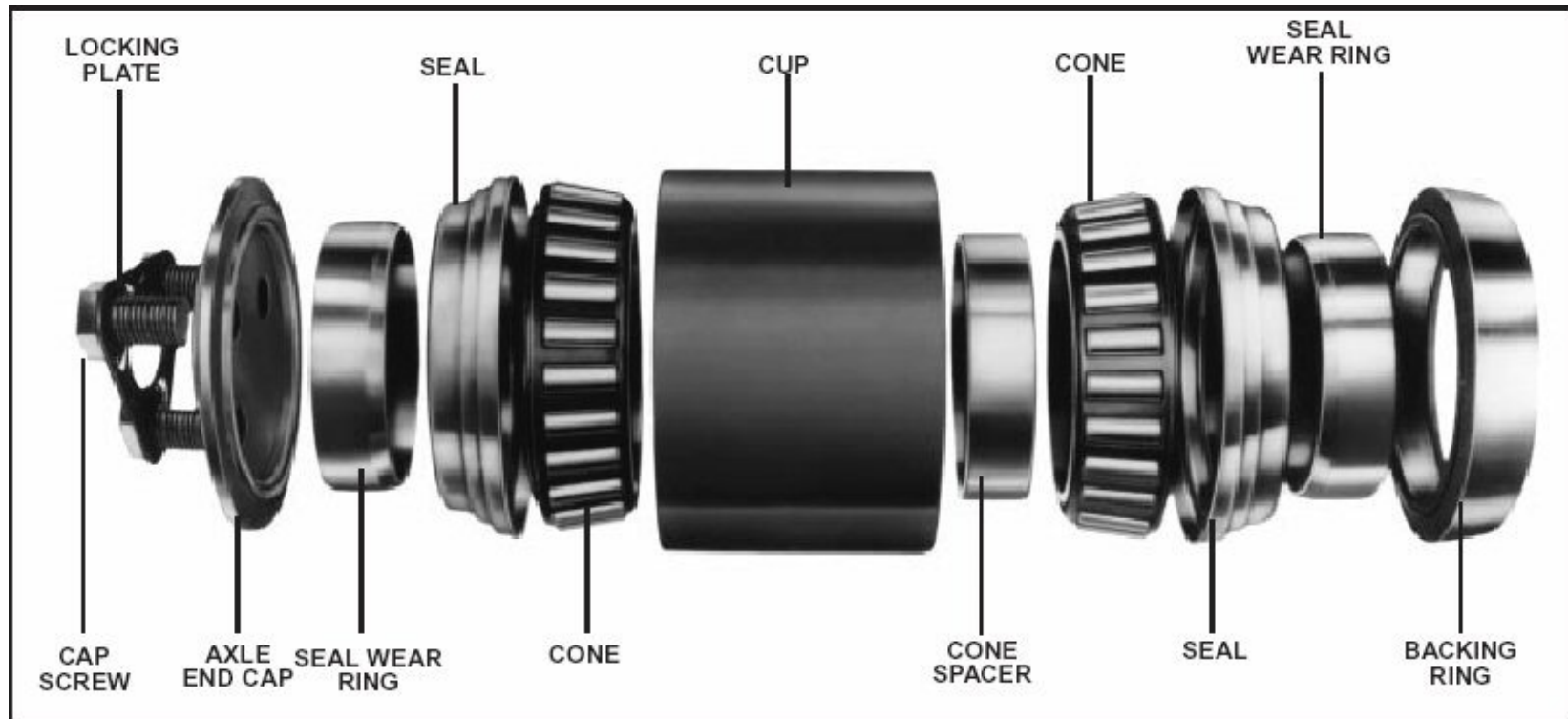


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Bearing Background



Ref: Matthew Dick Master's Thesis: Characterization and Analysis of Rolling Bearing Cage Failures due to Wheel Impacts



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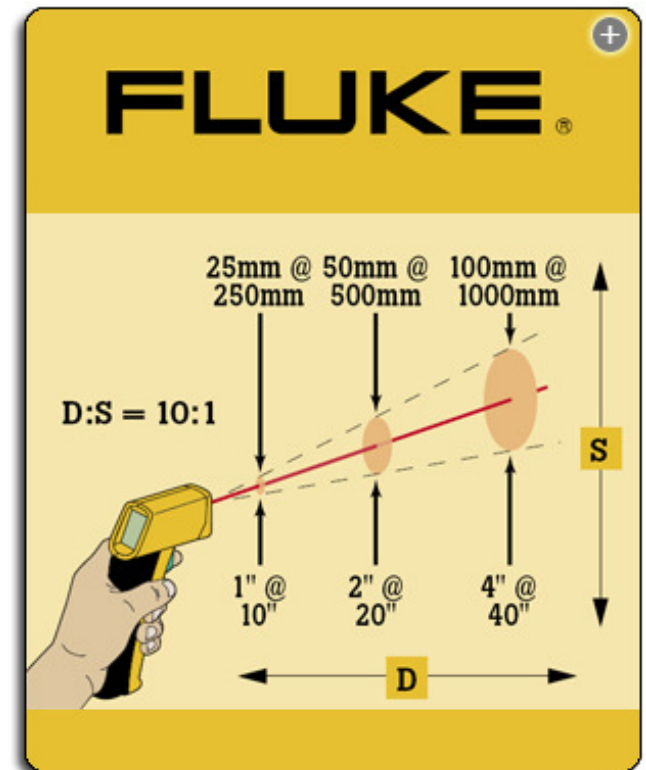
Infrared Temperature Measurement

aka: Infrared Thermometer

Measures Thermal Radiation

Key Items to Know:

- Measurement area is bigger, the further away the object is.
- Measurement assumes a value for thermal radiation emissivity.



Ref: <https://www.powdercoatguide.com/2012/12/ir-thermometer.html>



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Rail

KLDLABS
MEASUREMENT TECHNOLOGIES

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Hot Box Detector Overview



Ref:https://en.wikipedia.org/wiki/Defect_detector#/media/File:Defect_Detector.JPG

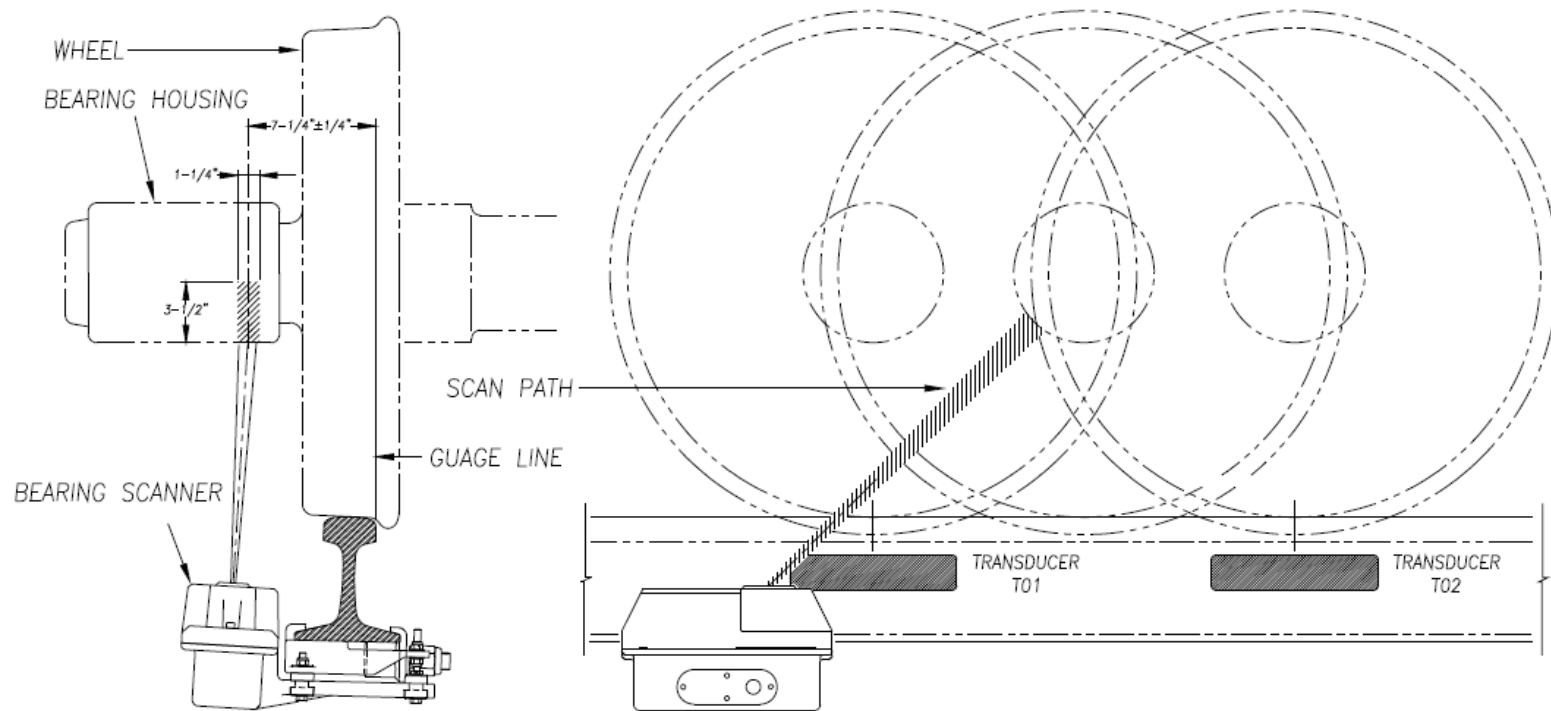


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Hot Box Detector Overview



Ref: https://www.southern-tech.com/images/uploads/product_documents/EUD-2018080-00_Rev6_UP_NG%C2%B2_Operators_Guide.pdf



Patent: US2880309A

Granted: 1959

March 31, 1959

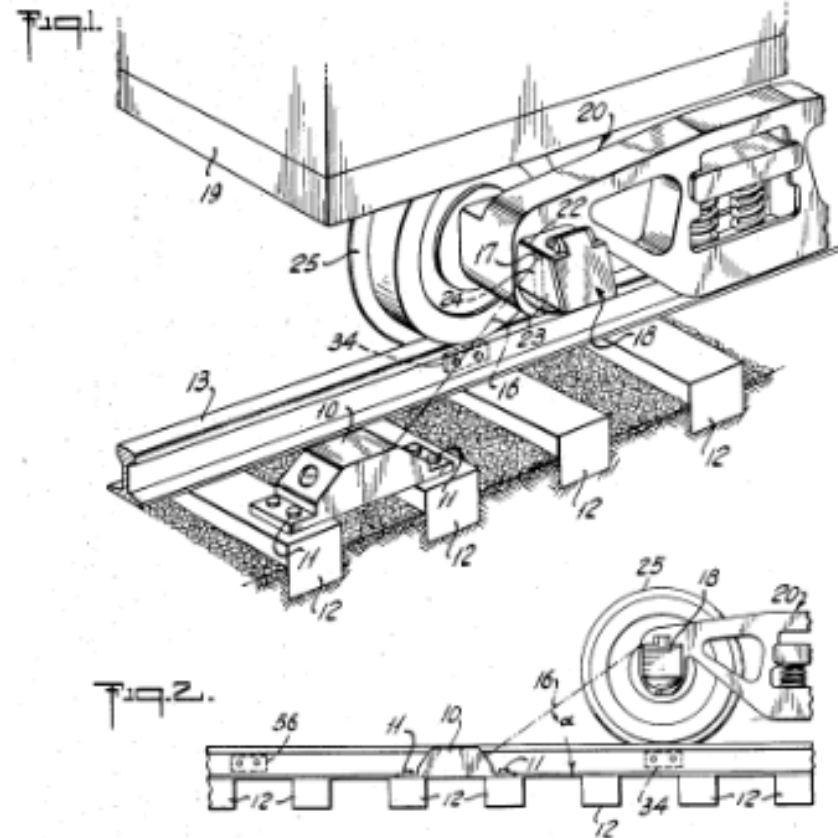
C. A. GALLAGHER ET AL

2,880,309

HOT-BOX DETECTOR

Filed June 30, 1958

3 Sheets-Sheet 1

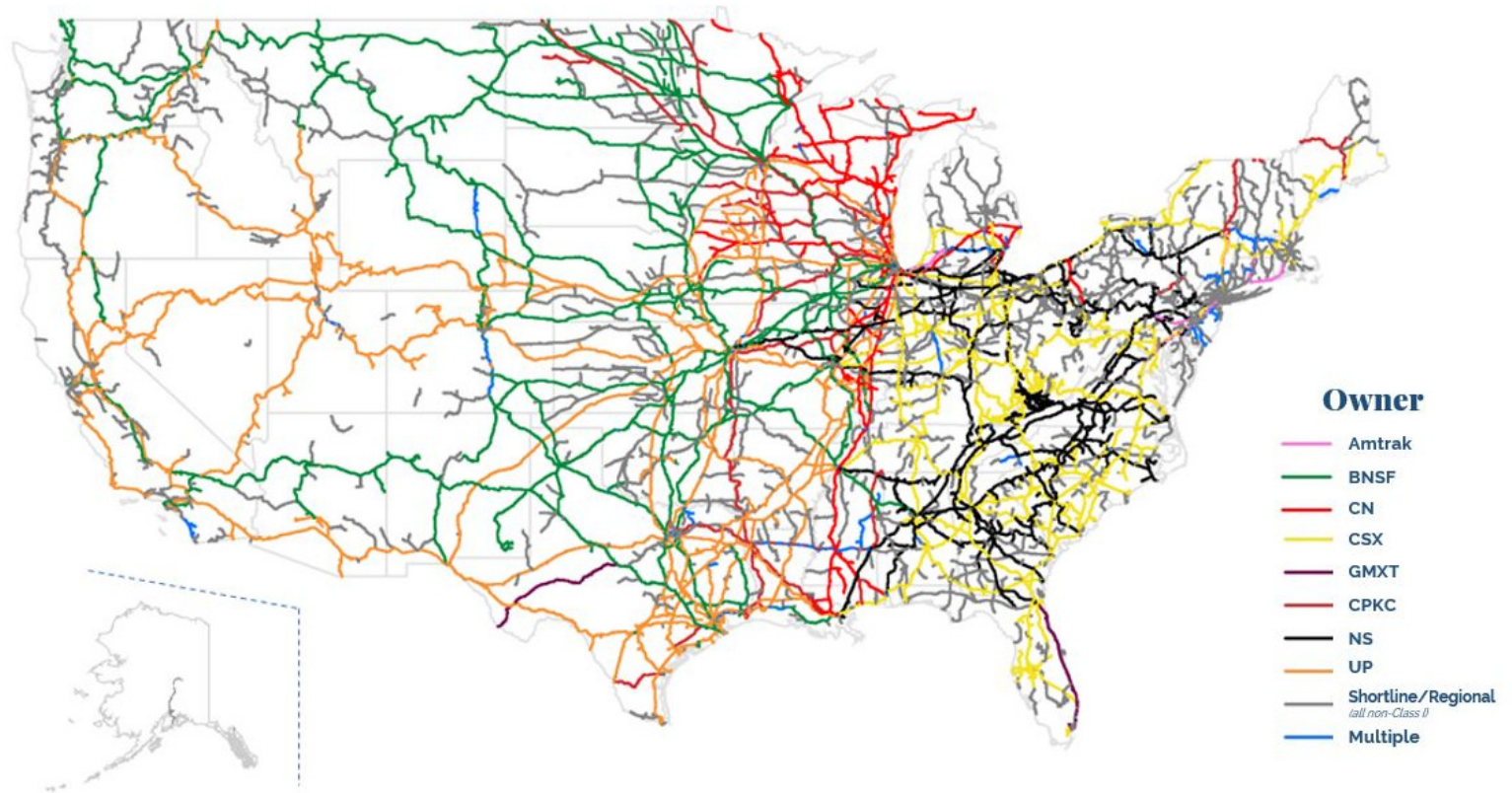


Hot Box Detector Installations

Over **6000** HBD installed on North American Freight Railroads

Average spacing:
25 miles

Common Mainline Spacing:
15~20 miles



Ref: <https://www.aar.org/wp-content/uploads/2021/11/AAR-Freight-Rail-Network-Map-Chart.jpg>



Hot Box Detector Operations

Radio Transmission




HBD



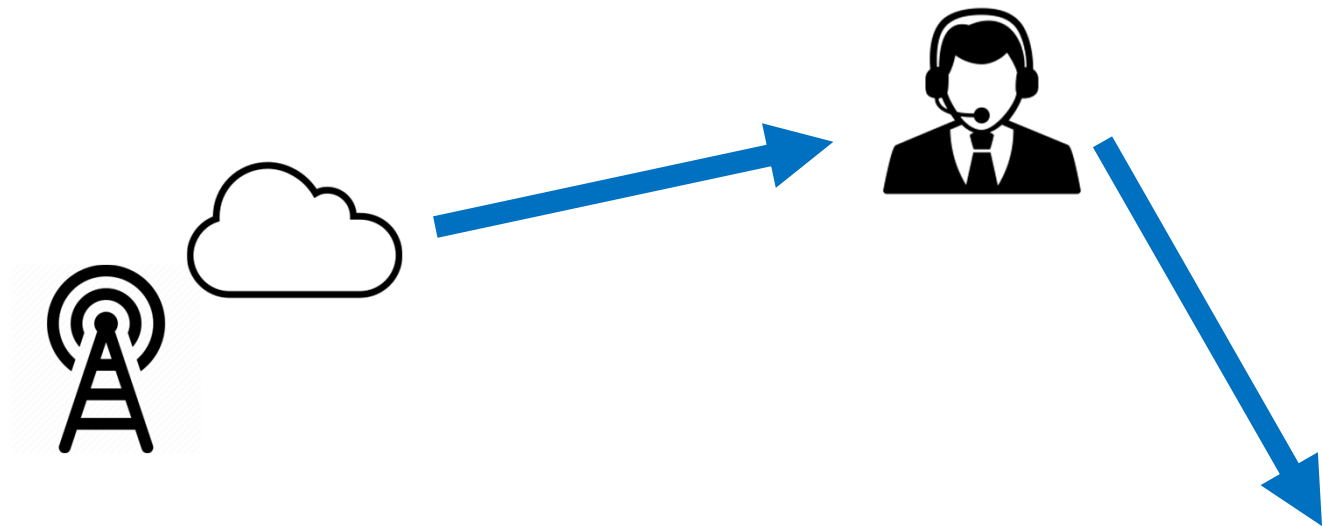
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Hot Box Detector Operations

Dispatch Operations



HBD



AAR Field Manual Alert Rules



**Why Made 50 WM50 –
Overheated Roller Bearing**

**170 Degrees Fahrenheit Over
Ambient Temperature**

**95 Degrees Fahrenheit Over Mate
Bearing**



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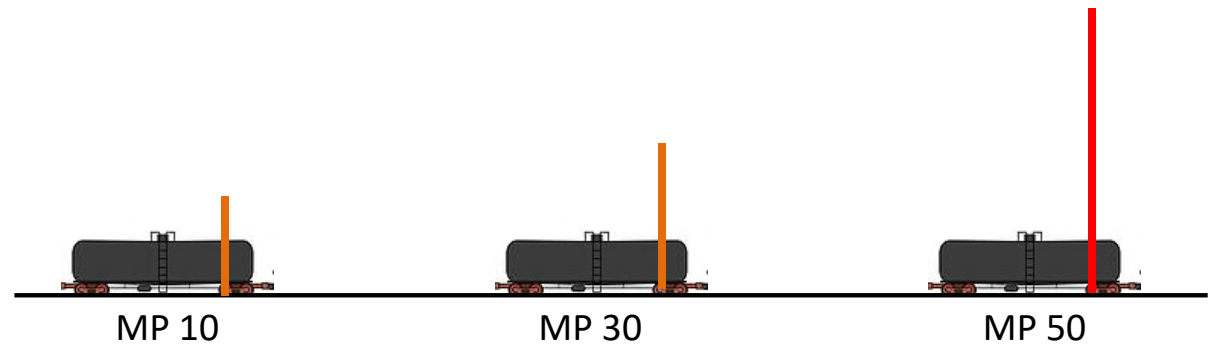


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Custom Alerts

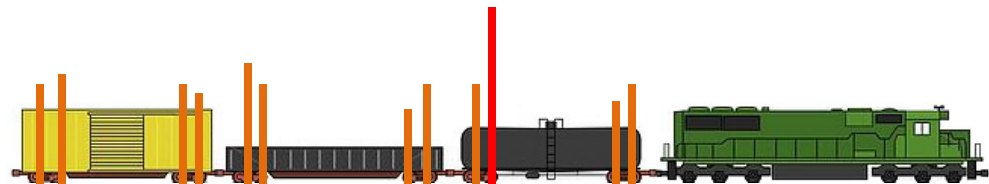
Trending

Many freight railroads have implemented various trending algorithms



Outliers

AAR MSRP S-6001 has various calculations for identifying outliers



In-Process Bearing Burn Off



Completed Bearing Burn Off



Hot Box Detectors

Important Things to Keep in Mind



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1) Wide Variety of Bearing Failure Modes



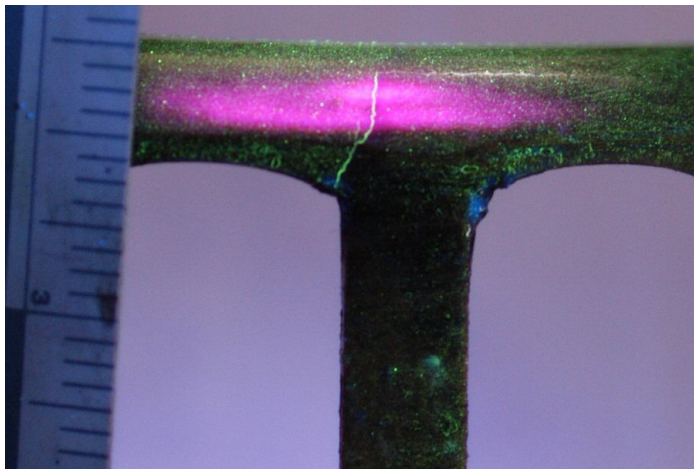
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1) Wide Variety of Bearing Failure Modes

Damage from Wheel Impacts



Example Steel Cage Fatigue from Wheel Impacts



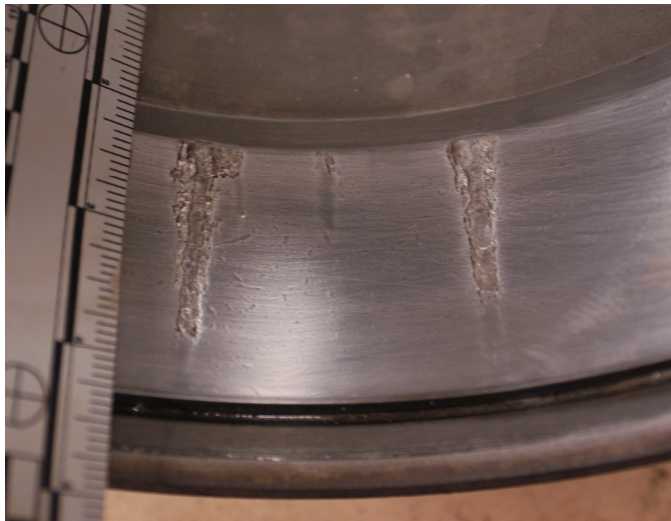
Example Roller Skew



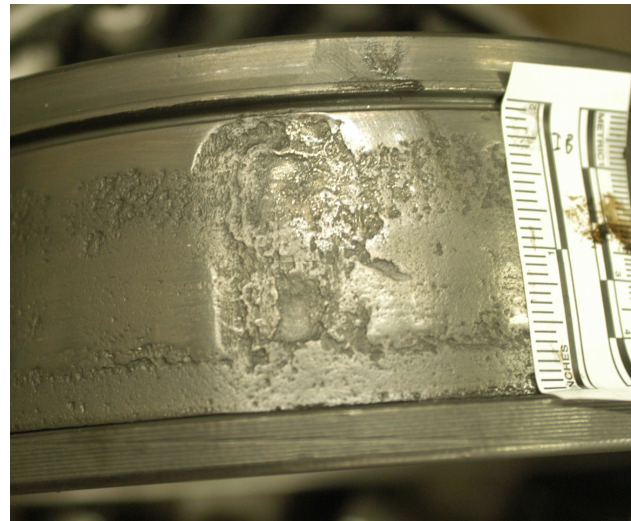
1) Wide Variety of Bearing Failure Modes

Spalling

Cup



Cone



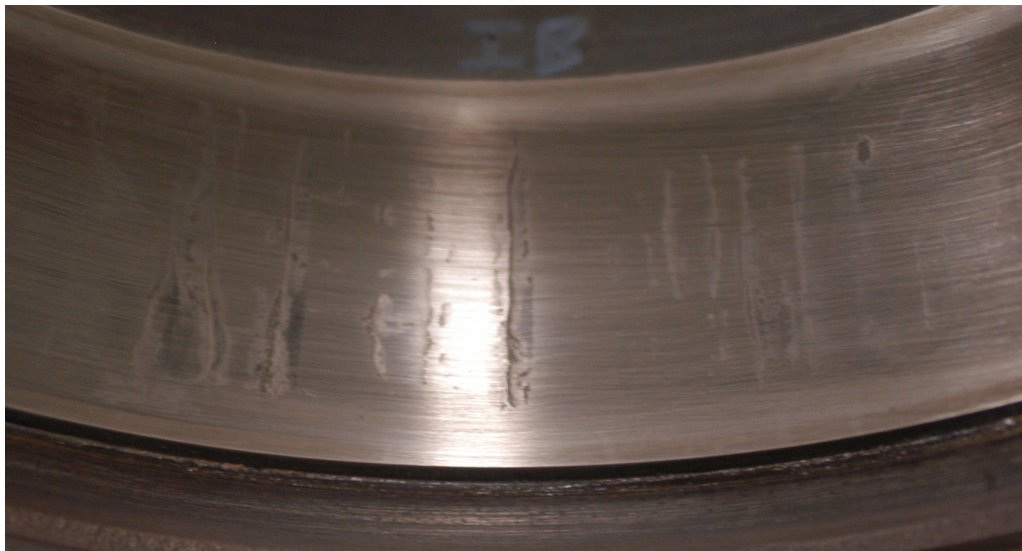
Roller



1) Wide Variety of Bearing Failure Modes

Water Etch

Cup



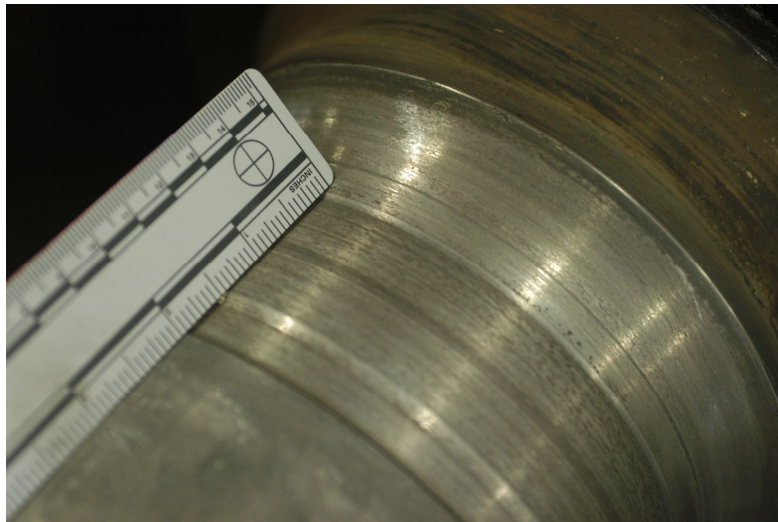
Rollers



1) Wide Variety of Bearing Failure Modes

Fretting

Loss of Press Fit between Journal and Cone



Loss of Axial Load due to fretting at cone/wear ring interface



1) Wide Variety of Bearing Failure Modes

Other failure modes (but less common)

- Cracked Cup
- Issues with Bearing Adapter
- Missing Cap Screw(s)



2) Temperature Measurement Location



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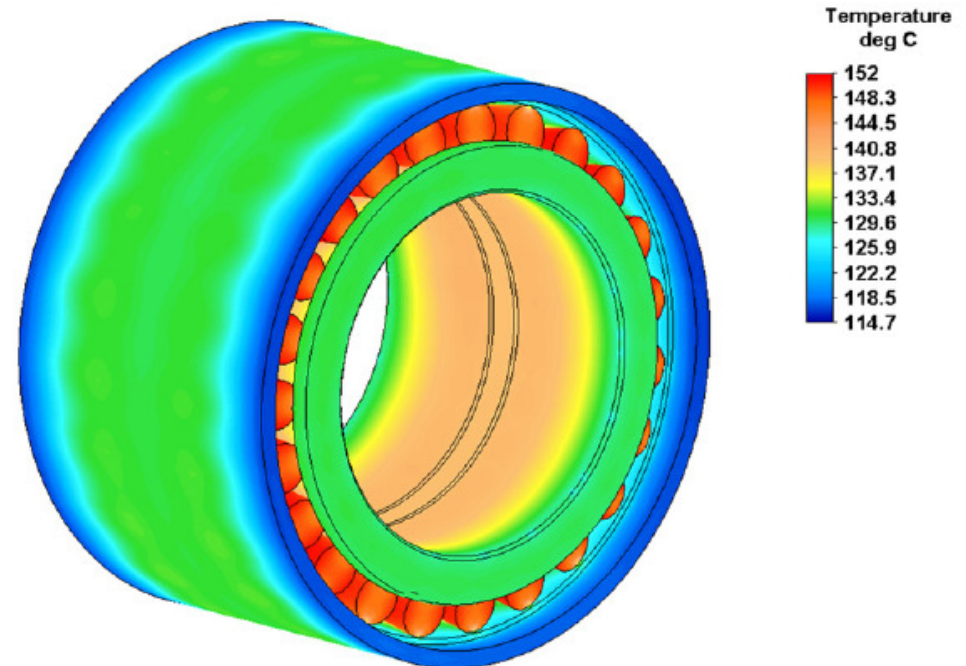


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2) Temperature Measurement Location

Dr. Constantine Tarawneh researched the thermal characteristics.

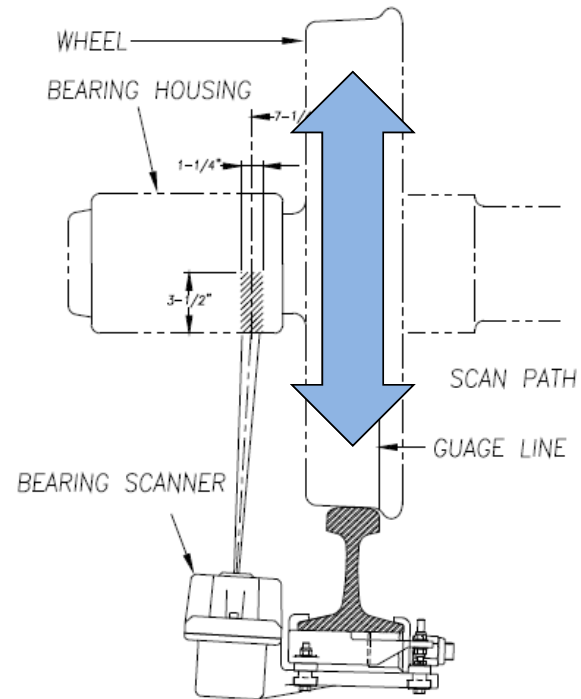
Summary: Temperatures throughout the bearing are varied and complicated.



Ref: <https://www.researchgate.net/publication/270775873>



2) Temperature Measurement Location



- Wheel Diameter
- Wheel Tread Wear
- Rail Head Wear



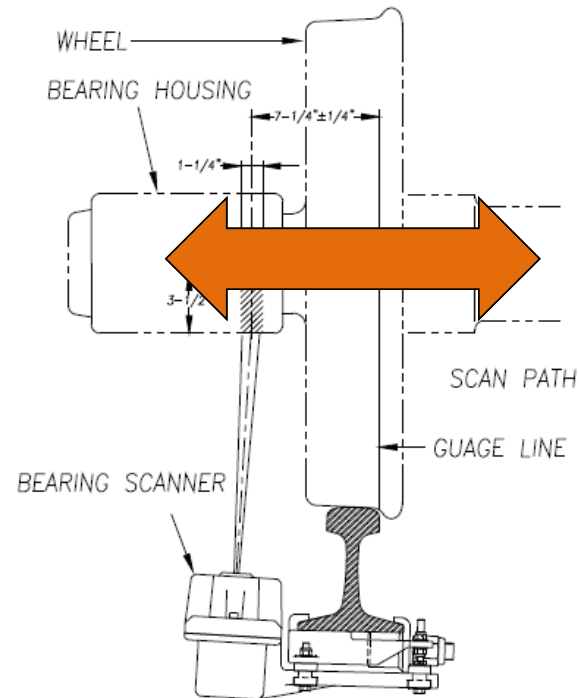
2) Temperature Measurement Location

Wheel Set Lateral Tracking

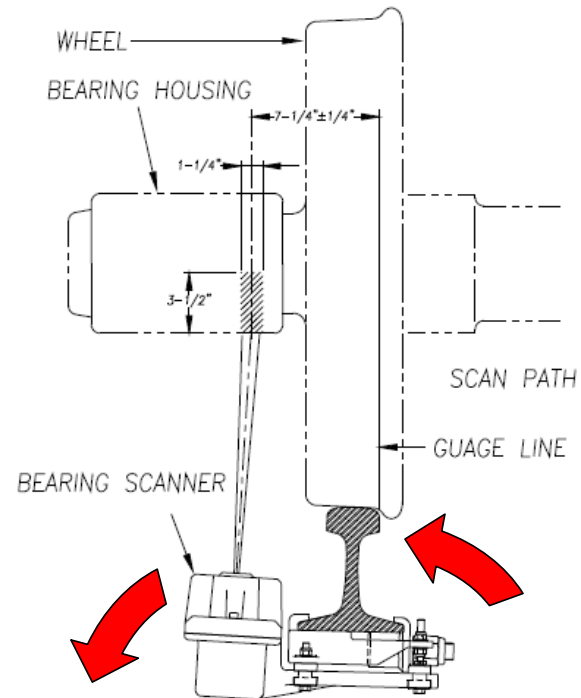
Wheel Set Flange Wear

Rail Gauge Face Wear

Bearing Size/Design



2) Temperature Measurement Location

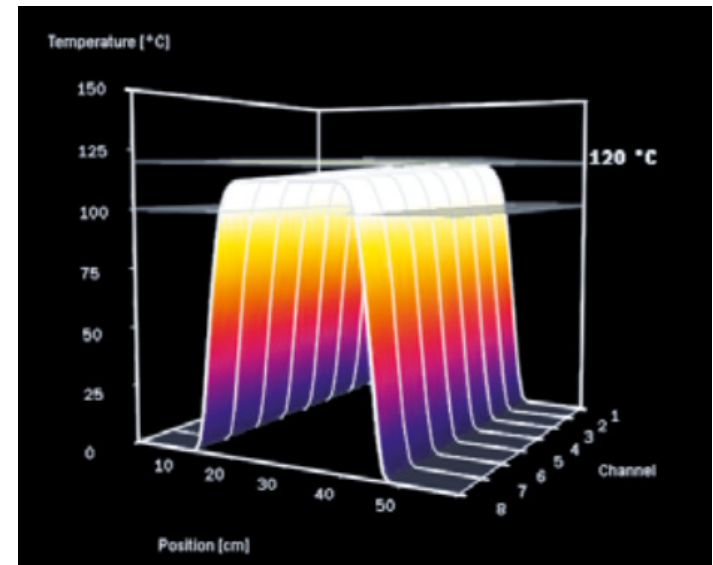


Loose Mounting Bolts
Rail Cant



2) Temperature Measurement Location

Hot Box Detectors with Multi Beam – 8 Channels



Ref: https://pasch.es/pdfs/Ferroviano/Infraestructura/VAE-SignalingSiershahn/PHOENIX_MB_voestalpine.pdf



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3) False Positives & False Negatives



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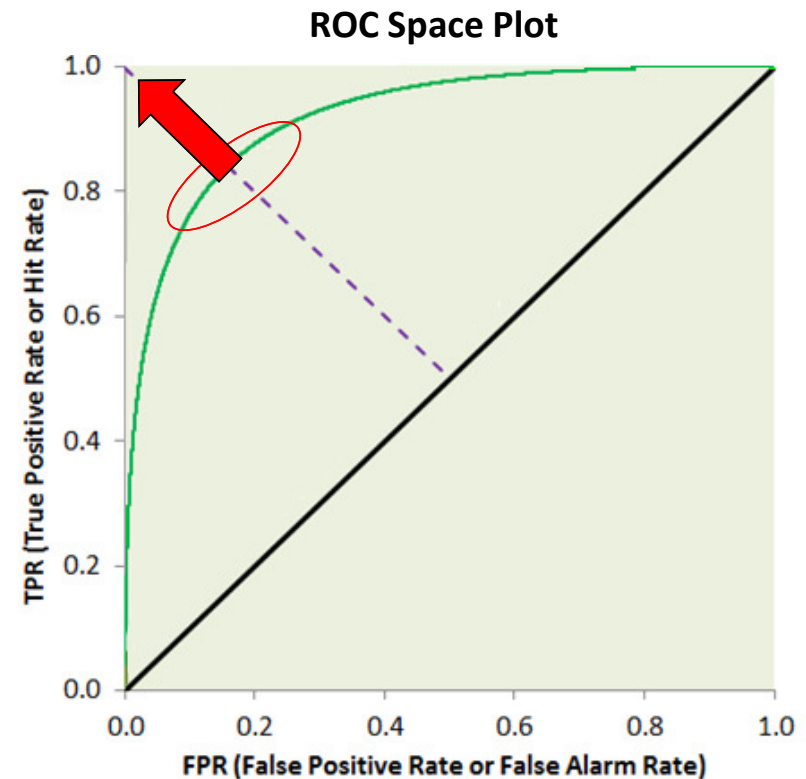
3) False Positives & False Negatives

False Positives:

- Warm bearings but have no defect

False Negatives:

- Issues with HBD (calibration, mounting)
- Issues with measurement location on bearing



4) Calibration & Maintenance



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4) Calibration & Maintenance

AAR MSRP S-6001

2.1 Wayside bearing temperature detectors must be physically inspected and validated at least annually to measure the actual temperature variance from ambient for a roller bearing within ± 5 °F at one temperature between 100 °F and 250 °F.

Manufacturer's Recommended Maintenance

- Preventative Maintenance Visits every 30 to 90 days
- Clean lenses
- Alignment adjustments
- Adjust for rail wear



Hot Box Detectors

Where to go from here?

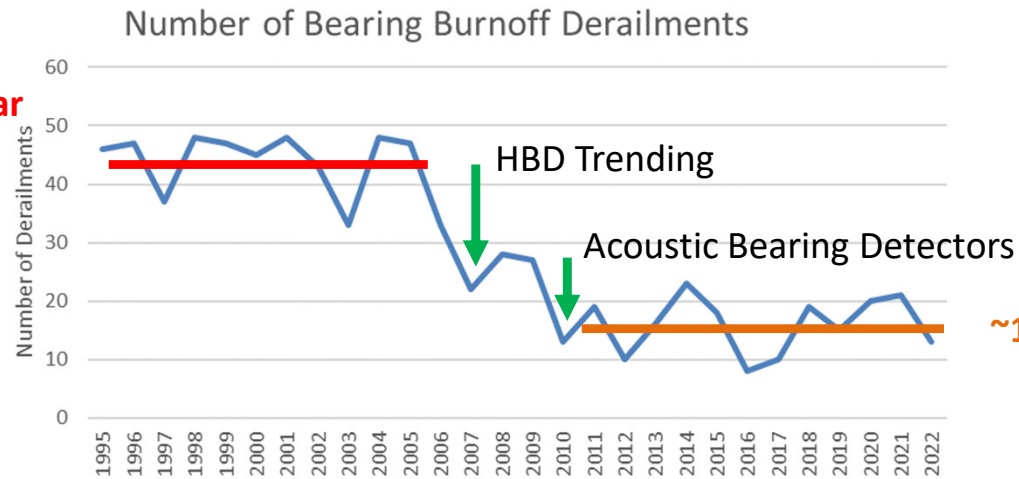


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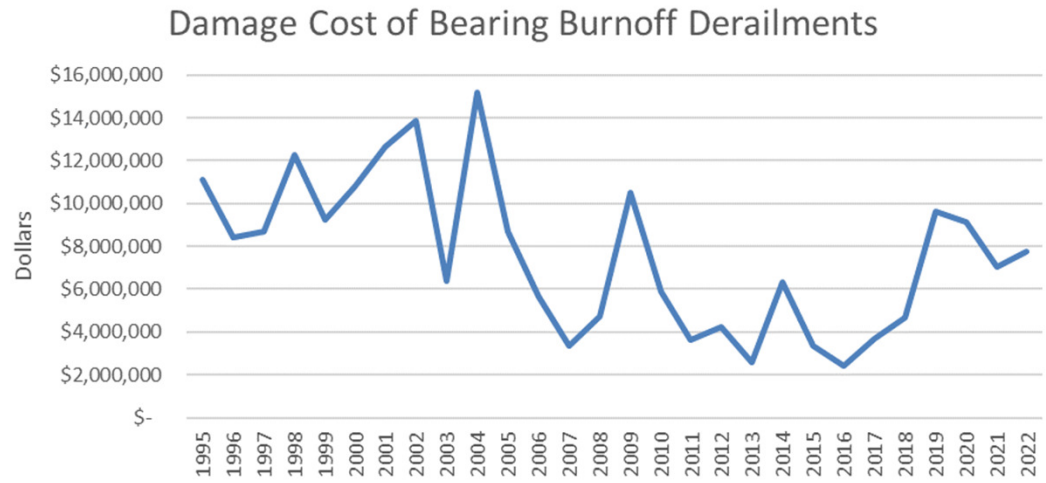


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~43 Derailments per year



~15 Derailments per year



Ref: https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/on_the_fly_download.aspx



Infrastructure Thermal Imaging



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What get's hot?

Third Rail (and associated components)



Overhead Wire (and associated components)



What get's cold?

Leaking Tunnel Walls



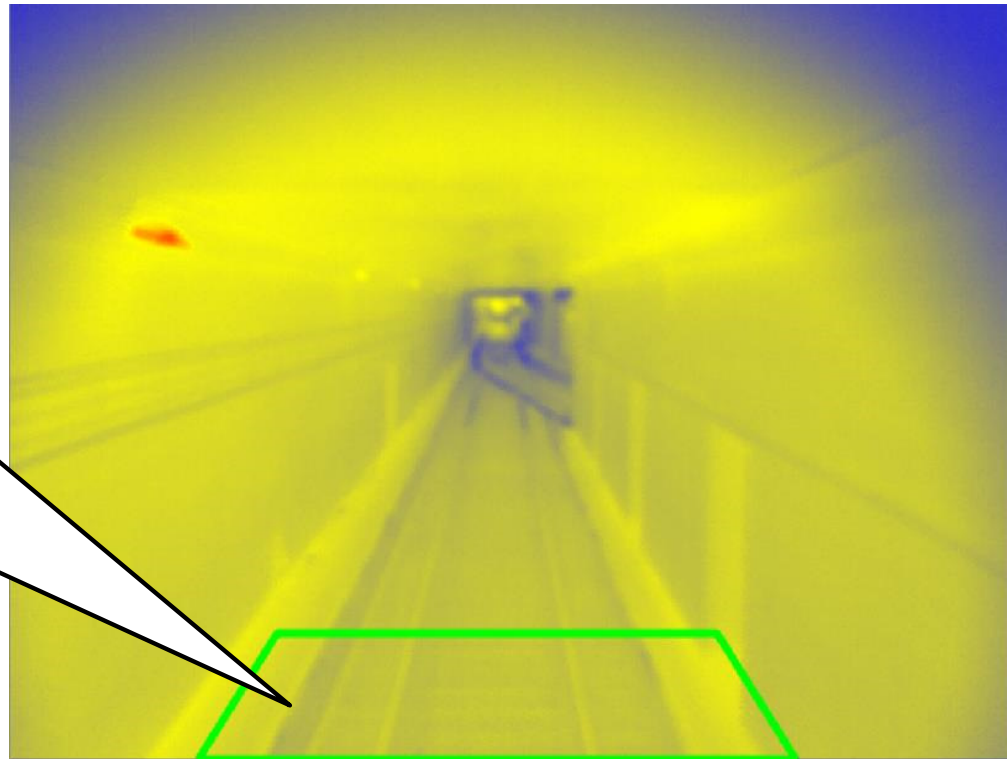
Standing Water in Tunnels



Infrastructure Thermal Inspection

Window of Interest (WOI)

The Maximum, Minimum, and Average Temperature within the WOI is reported on a ft-by-ft basis to create a strip chart.



Patent No.
US11358617B2

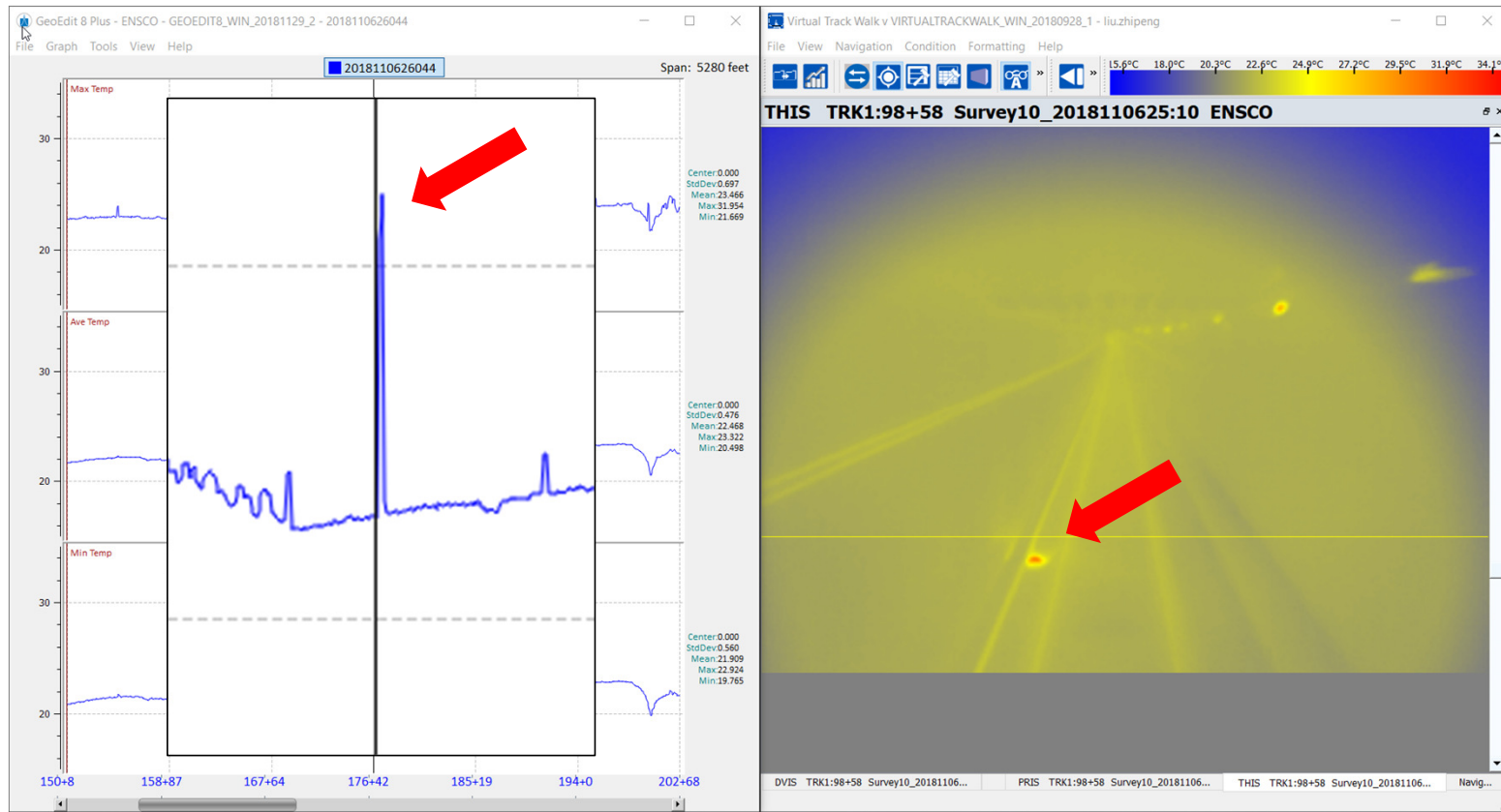


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Example: Hot Third Rail Insulator



Patent No.
US11358617B2

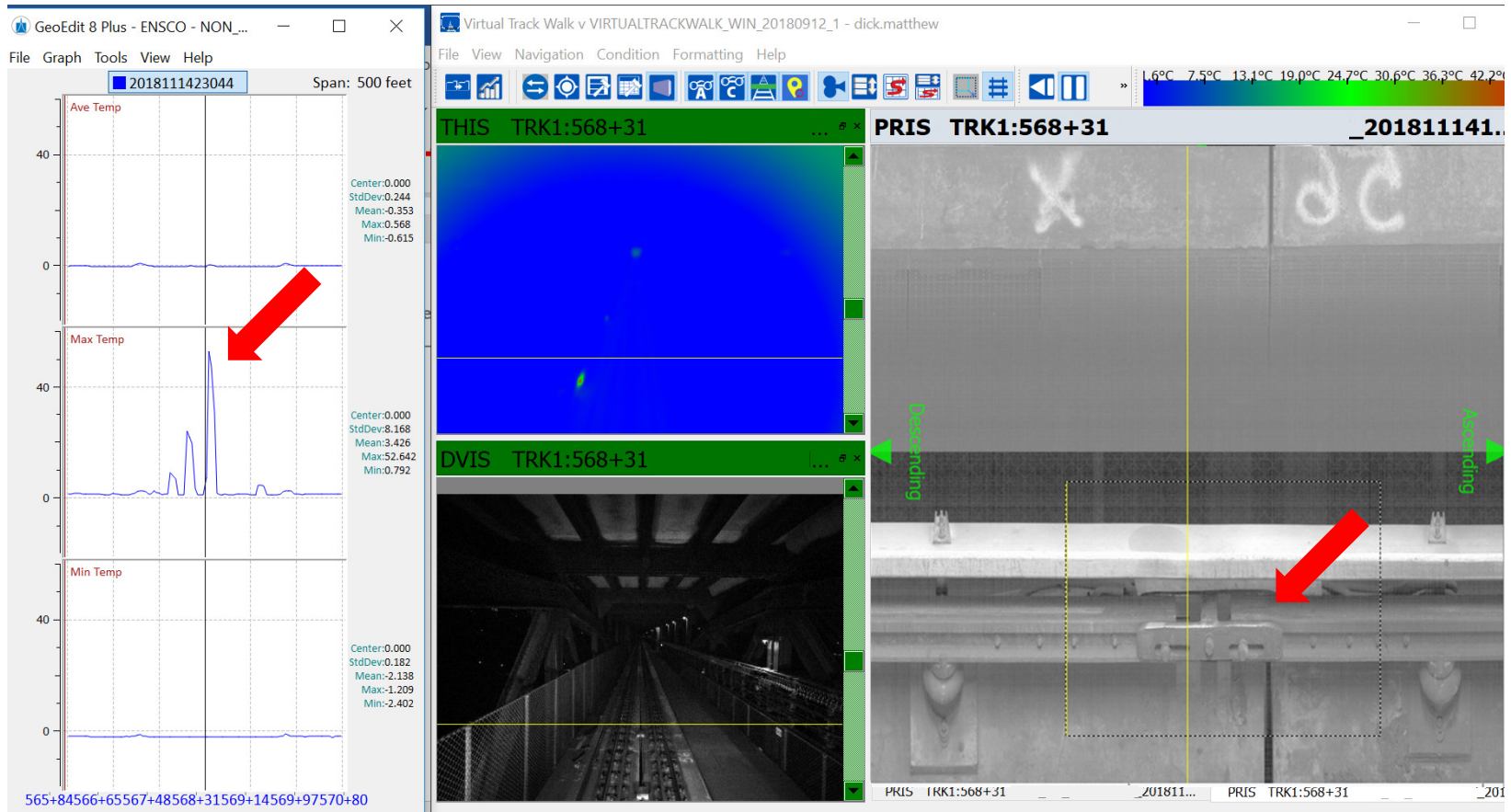


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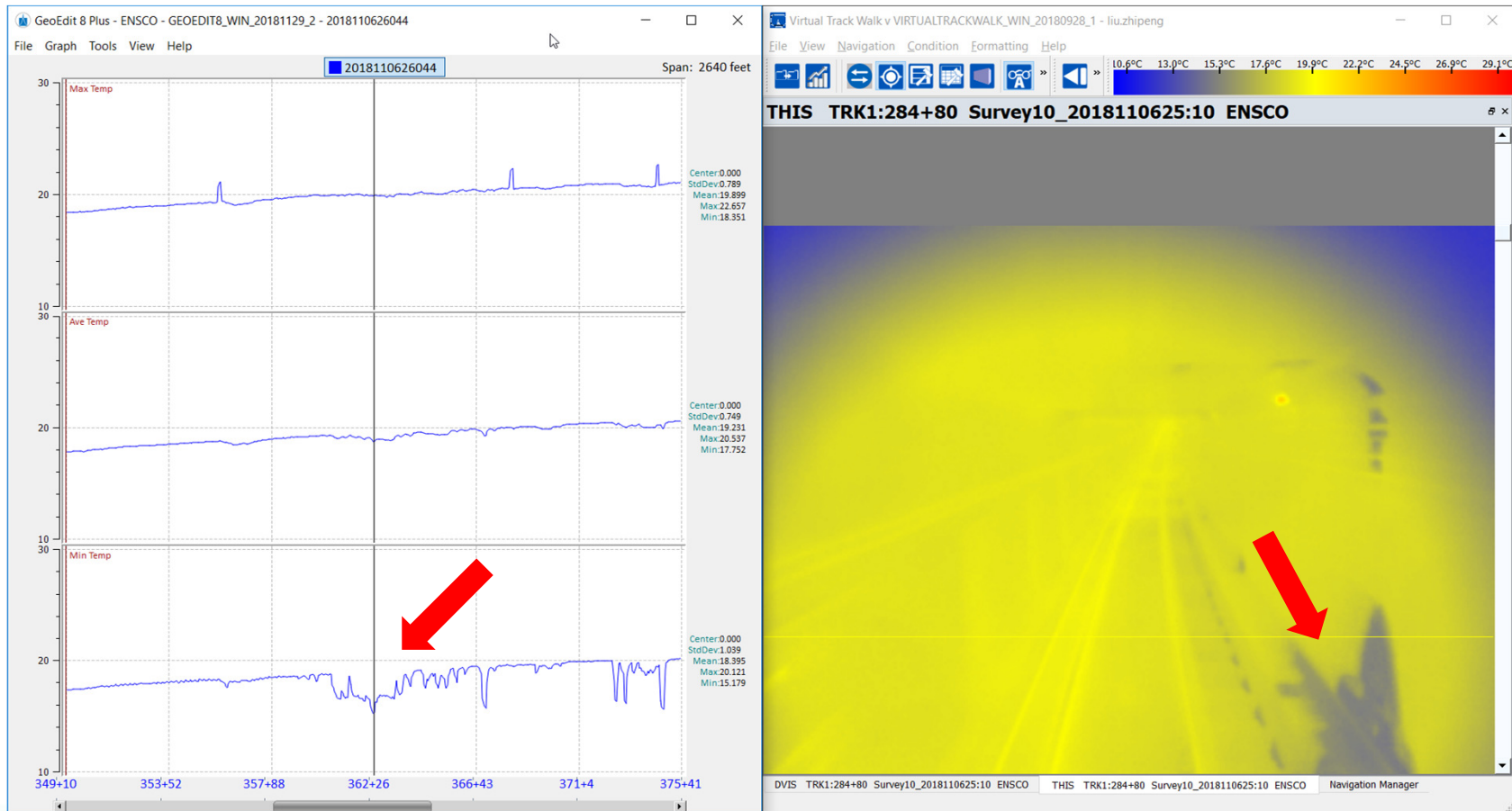
Example: Hot Third Rail Joint



Patent No.
US11358617B2



Example: Leaking Tunnel Wall



Patent No.
US11358617B2



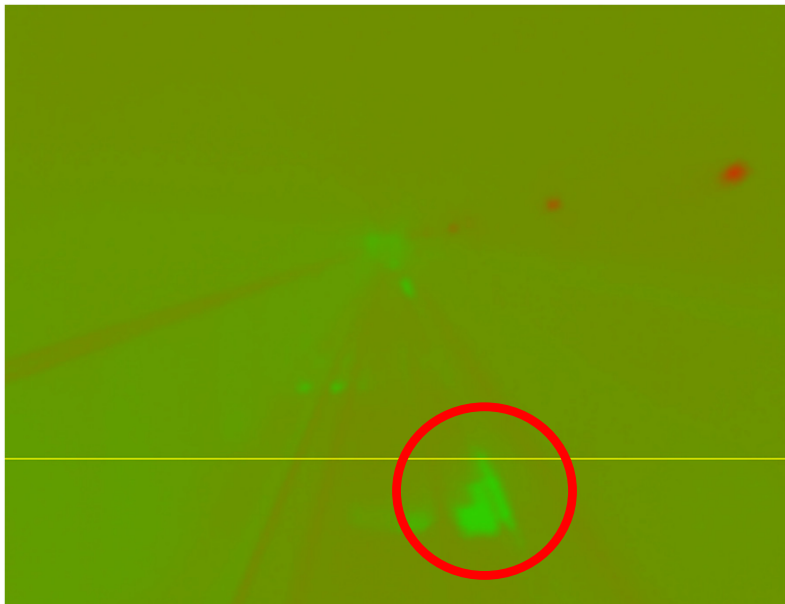
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Example: Rail Base Corrosion at Standing Water

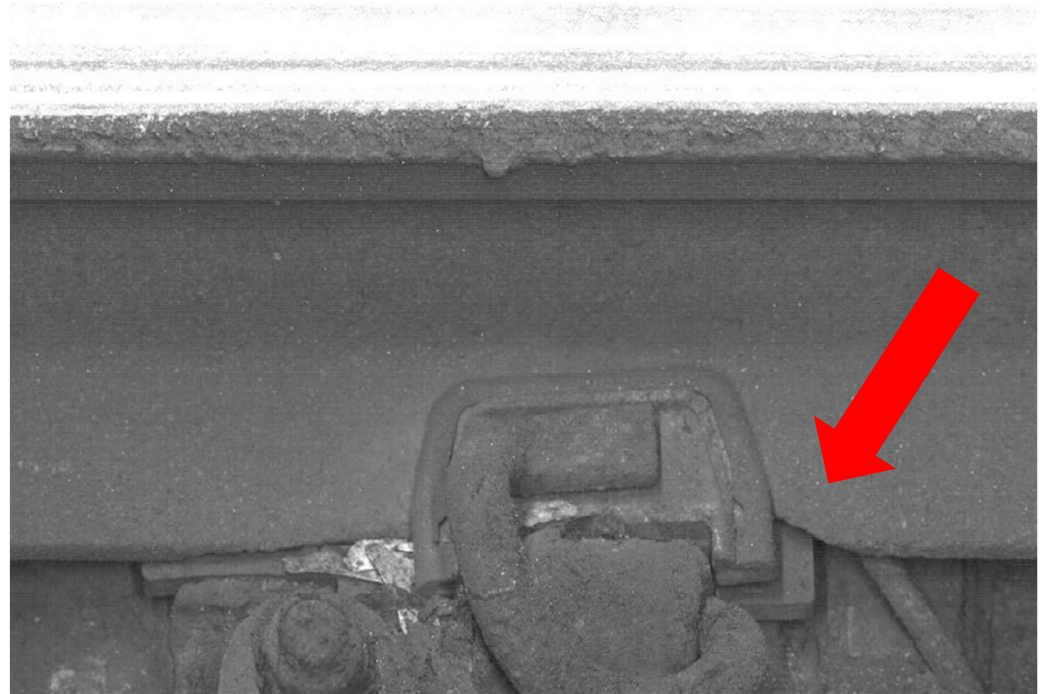
Thermal Imaging Camera



Rail Web & Base Imaging Camera



Example: Rail Base Corrosion at Standing Water



New Era in Advanced Inspection Solutions



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A Wholly Owned Subsidiary of ENSCO, Inc.

Preservation of Legacy

Best of Breed Technology

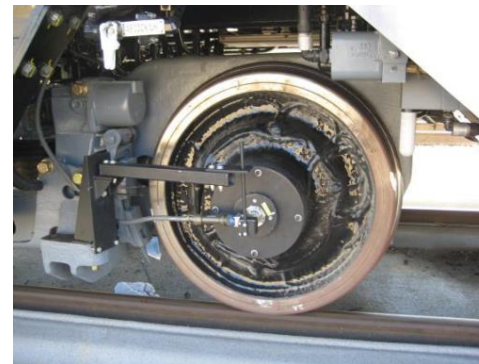
**Expanded Worldwide
Customer Support**



Track Inspection



Vehicle Inspection



Vehicle/Track Interaction Inspection



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QUESTIONS?



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