



TECHNOLOGY AND INNOVATION

CPKC is at the forefront of predictive rail analytics. Through wayside detectors and rolling stock sensors, we gather extensive data on locomotives, railcars and track infrastructure. Using our patented technology, we analyze the feedback to anticipate and address potential issues before they happen.

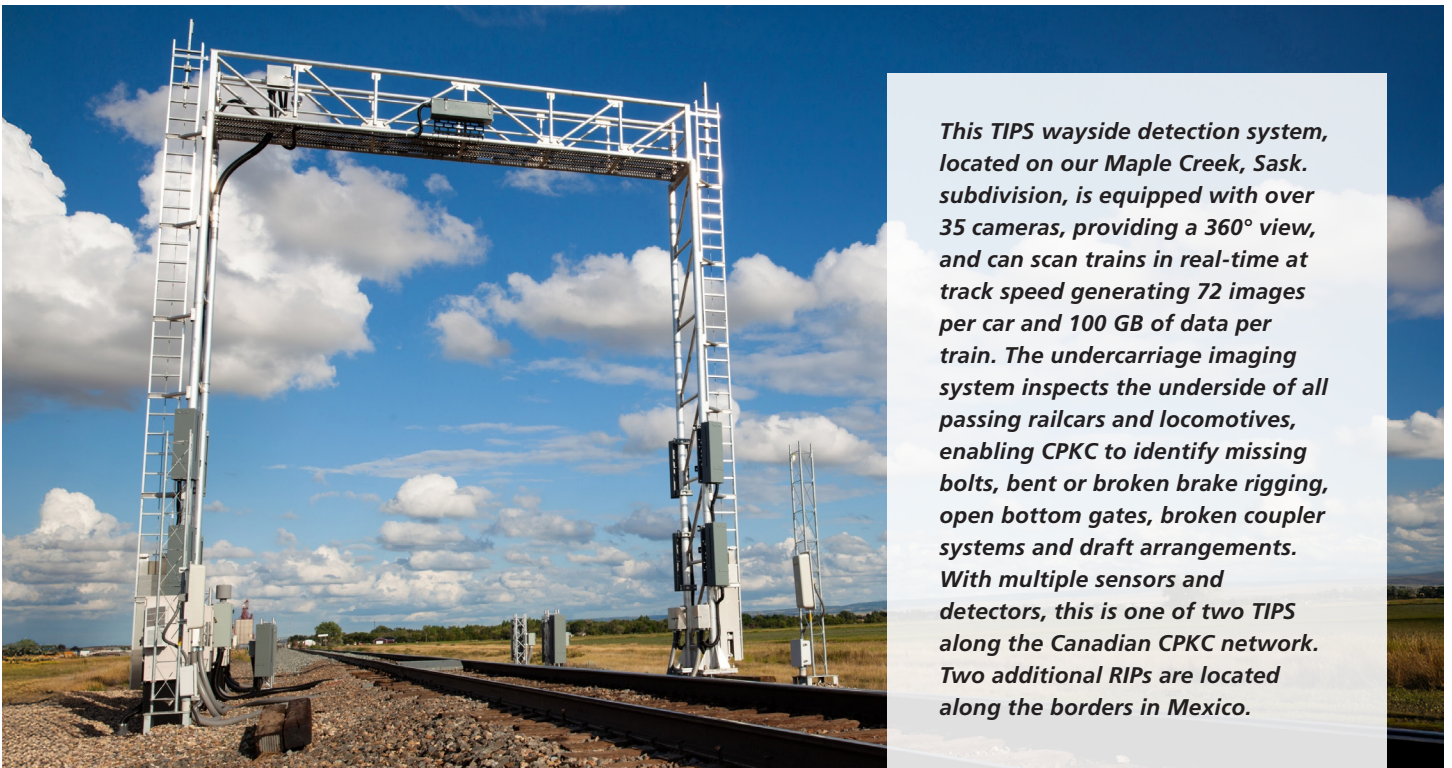
We prioritize safety by leveraging these analytics to focus our infrastructure maintenance projects where they will have the most impact. With our proactive approach we improve reliability, increase train speed and reduce asset as well as terminal dwell times. In 2024, for the second consecutive year, CPKC led the industry with the lowest FRA-reportable train accident frequency among Class 1 railroads, building on Canadian Pacific's legacy of 17 consecutive years of top safety performance.

WAYSIDE TECHNOLOGY

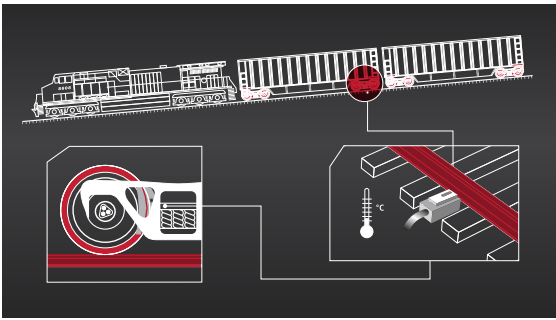
INSPECTION PORTALS

Train Inspection Portal System (TIPS) or Rail Inspection Portal (RIP)

CPKC operates one of the most efficient and safest railways by integrating our industry-leading data analytics and detection technologies into our everyday operations. The inspection portals take several measurements, providing a comprehensive view of passing trains. Critical information goes to our operations, mechanical and engineering teams, enabling proactive issue resolution to enhance both safety and service.



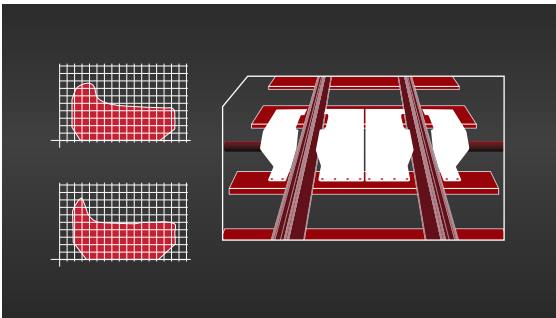
This TIPS wayside detection system, located on our Maple Creek, Sask. subdivision, is equipped with over 35 cameras, providing a 360° view, and can scan trains in real-time at track speed generating 72 images per car and 100 GB of data per train. The undercarriage imaging system inspects the underside of all passing railcars and locomotives, enabling CPKC to identify missing bolts, bent or broken brake rigging, open bottom gates, broken coupler systems and draft arrangements. With multiple sensors and detectors, this is one of two TIPS along the Canadian CPKC network. Two additional RIPs are located along the borders in Mexico.



BET

Brake Effectiveness Testing (BET)

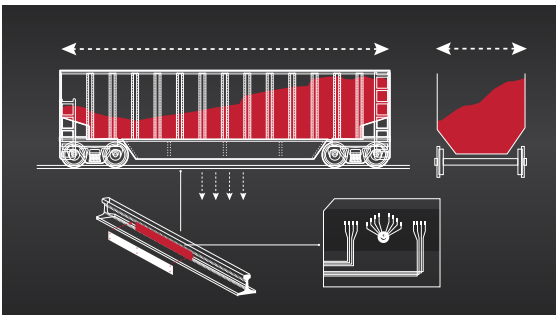
BET infers brake application and release of railcar air brakes. It uses wheel temperature detectors on descending grades where brakes are used to control train speed and on flat terrain where brakes should be released. Low wheel temperatures indicate insufficient braking performance. Braking cars with wheels below a temperature threshold undergo further inspection and repairs if necessary.



Wheel Profile Detector

Wheel Profile Detector

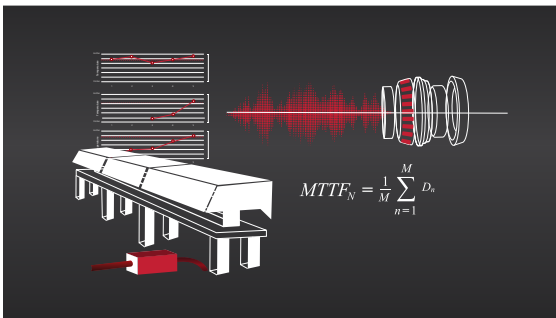
We predict the wheel lifespan based on wheel wear geometry. We analyze car repair records and trends from detectors to accurately forecast wheel wear limits down to a one-month window. Private car owners who want to proactively schedule maintenance can subscribe to our detailed reports and reduce downtime.



Wheel Impact Load Detectors

Wheel Impact Load Detectors

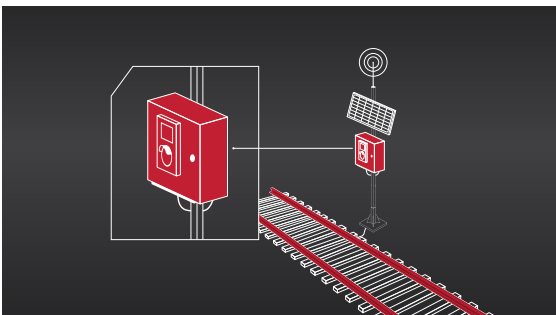
This detector monitors force exerted on the rail through the railcar wheels. We monitor high impact wheels and alert when we detect overweight or imbalanced railcars that risk damaging track. These detectors help us avoid service interruptions before a failure occurs.



Acoustic Bearing Sensors

Acoustic Bearing Sensors

Our patented algorithms use acoustic detector data to predict wheel bearing failures up to three months in advance. Wheels are pulled and repaired as soon as issues are detected, reducing online bearing-related failures by 95 percent.



Optical AEI

Train Air Flow Monitoring

Locomotive event recorders provide another data point to monitor performance. We measure air system charge in cold temperatures to reduce air flow related service interruptions.

Broken Rail Detector (BRD)

Developed in-house, this proprietary technology automatically detects broken rail in non-signalized, or dark territory. We prevent potential derailments by identifying broken rails and halt train movement on the compromised section of track. The BRD allows CPKC the flexibility to add other sensors to further enhance data collection.

Temperature Sensors

Temperature sensors monitor track conditions and trains. Hot bearings flag potential performance failures, cold or hot wheels indicate braking conditions, rail temperature detects potential buckling and ambient air temperature is used to trigger rail inspections in extreme temperatures (hot or cold). When used as an add-on to the existing BRD network, temperature sensors can be deployed on every mile of dark territory, building on the analytics available from sensors in signaled territory. In Centralized Traffic Control (CTC) territory, temperature sensors are modified to function as standalone, utilizing existing power and communication resources for seamless integration into CPKC data analytics.

Optical Automatic Equipment Identification (AEI)

The Optical AEI sensor is another piece of technology developed by CPKC. The sensor updates the train consists, providing equipment location to match components with their respective wayside data. This early detection helps to identify defects on moving trains.



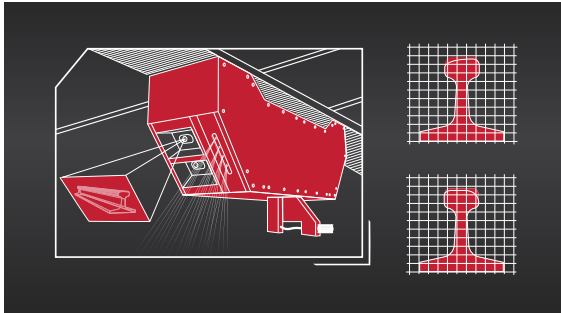
Track Evaluation Train

TRACK INSPECTION FLEET

In combination with our wayside technology systems, CPKC deploys a specialized Track Evaluation Train and fleet of track inspection vehicles. This fleet monitors and tests the integrity of our rail network, including track in our CPKC yards. We maintain a high standard of safety while keeping efficient operations with our 360° approach to built-in technology.

Track Geometry Measurement System (TGMS)

We install a non-contact, laser-based optical measuring system beneath boxcars for near real-time defect detection to predict track deterioration. The TGMS uses a system of lasers and cameras to scan the rail, relaying data about rail profiles, alignment and track deterioration. We analyze and proactively repair track to improve service by reducing derailments and unplanned work outages.



TGMS

Track Component Imaging System (TCIS)

TCIS is a wide, continuous scan to overview more of the track. We measure tie, ballast and fasteners along the CPKC network.

Rail Surface Imaging System (RSIS)

The RSIS uses a line scan camera system to capture a linear image of the track below the test vehicle. A series of machine vision algorithms then segment the head of the rail into sections to assign and quantify the degree of change, indicating potential surface damage.



DGRMS

Deployable Gauge Restraint Measurement System (DGRMS)

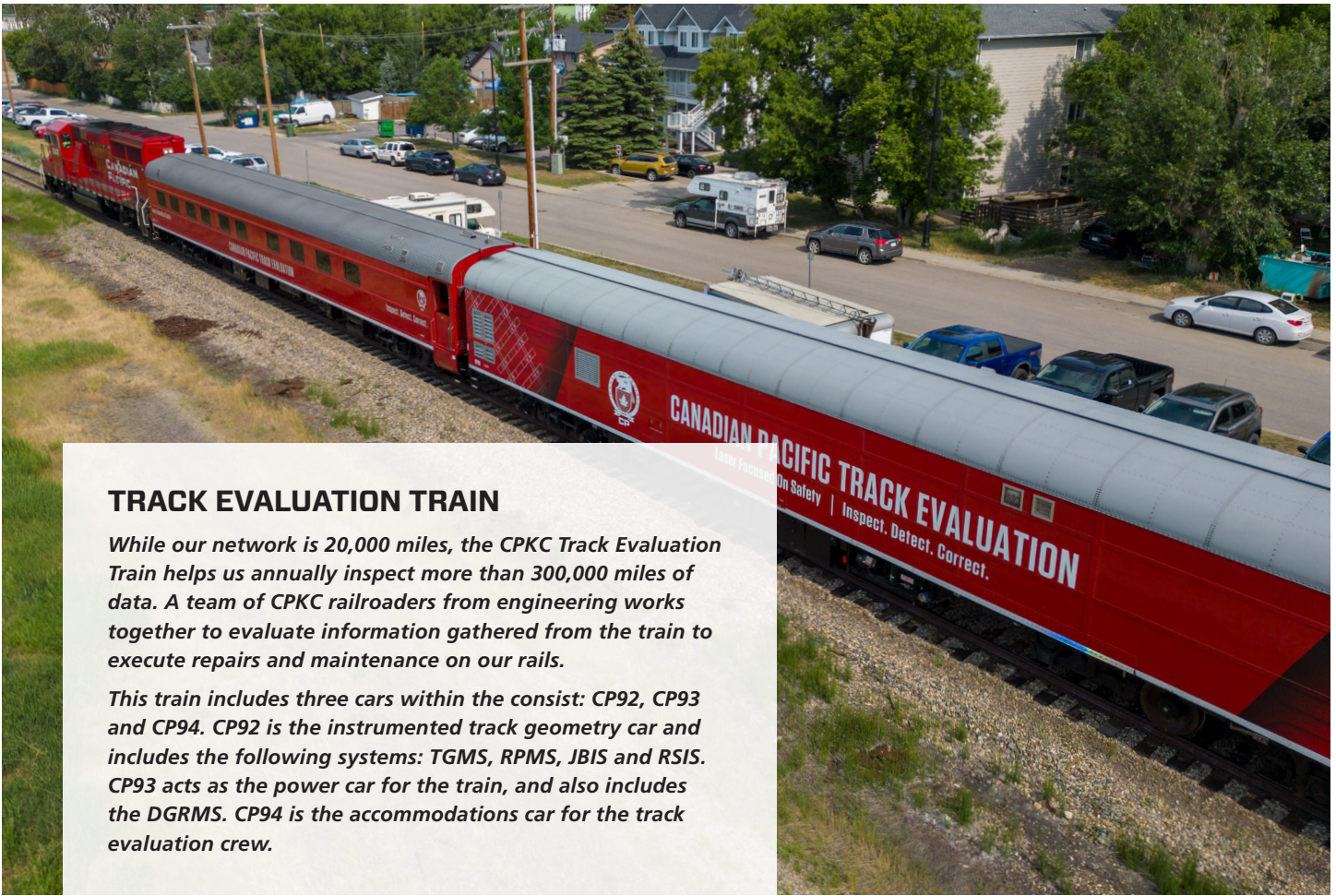
The DGRMS is a deployable axle that replicates realistic conditions. This system generates pressure, putting 40,000 lbs of force downwards and 14,000 lbs of force outwards. This heavy-duty dynamic test evaluates the integrity of the rail to assess tie, fastener and gauge conditions. The DGRMS compares the gauge measurements of track in an unloaded state to a loaded state. The differential in the measurements can provide insight to how well the track is holding gauge.



JBIS

Joint Bar Inspection System (JBIS)

The JBIS uses line scan cameras to continuously scan the track, capturing images of rails and joints. This helps detect cracked rails or joints requiring repair, proactively preventing derailments caused by broken or damaged joints.



TRACK EVALUATION TRAIN

While our network is 20,000 miles, the CPKC Track Evaluation Train helps us annually inspect more than 300,000 miles of data. A team of CPKC railroaders from engineering works together to evaluate information gathered from the train to execute repairs and maintenance on our rails.

This train includes three cars within the consist: CP92, CP93 and CP94. CP92 is the instrumented track geometry car and includes the following systems: TGMS, RPMS, JBIS and RSIS. CP93 acts as the power car for the train, and also includes the DGRMS. CP94 is the accommodations car for the track evaluation crew.



TRACK EVALUATION RAIL CAR

CPKC has six autonomous TGMS boxcars. These cars can operate in consist on revenue trains, including intermodal service trains. The information is conveyed via wireless communication to local track maintenance teams within 48 hours of an inspection. Each urgent defect is validated prior to the field being advised.



RAIL FLAW DETECTION HI-RAIL TRUCKS

These trucks are equipped with state-of-the-art ultrasonic and induction test systems to detect internal rail flaws. AI analysis of the indications gathered by the test equipment is performed nightly. This analysis identifies suspect indications based on small changes over previous tests. Operators mark the defective locations and relay that to the engineering team that changes out the rails before failure. In addition, a JBIS identifies missing nuts, bolts and cracked bars.