

# Track Inspection Products & Services





For more than 50 years, ENSCO's team of engineers has led the rail industry in developing new, advanced technologies for transportation. ENSCO technology and services help customers improve the quality of their operations while making travel safer.



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# Track Inspection Vehicles



Through state-of-the-art engineering, ENSCO designs, builds, operates and delivers world class, turnkey track inspection vehicles and systems that monitor comprehensive performance indicators reflecting track quality and safety. ENSCO has delivered solutions on more than 500 manned and autonomous inspection cars throughout the world to meet the needs of the railway industry.

## Location Determination and Synchronization

ENSCO is the industry's leader in delivering inspection cars and technology around the world. ENSCO's automated track determination software can automatically determine the track and location (milepost, kilometer post, chainage). This capability is key for autonomous operations, but is also useful for manned operations.

Additionally, ENSCO has the unique capability of integrating multiple systems from ENSCO and other suppliers to be synchronized precisely and is able to be viewed in a synchronized manner based on distance along the track.



## Autonomous Operation

Autonomous track inspection is a growing industry practice that has overtaken manned inspection on many railways. Most of ENSCO's inspection technologies can operate autonomously, without human interaction to operate the inspection systems. The advantage of autonomous inspection is reduced costs, increased survey intervals, and a safer working environment. Various vehicle types can be used in autonomous inspection platforms, such as locomotives, freight cars, passenger cars, and custom fabricated vehicles.



## Manned Operation

Manned operation is the traditional method used for automated track inspection. Manned operation still has many applications in today's railway industry, and ENSCO's technologies are well equipped to meet the need. The most common manned vehicle types are shown below.

## Self-propelled Vehicles

Through its relationships with track maintenance machinery manufacturers, ENSCO has designed a variety of self-propelled rail vehicles from small 20-ton class converted work crew carriers to custom 100-ton high-speed rail cars that serve as track inspection platforms.



## Hi-rail Vehicles

ENSCO maintains long-standing relationships with hi-rail vehicle manufacturers to allow for the design and construction of specialized equipment to meet the customer's inspection and testing needs. ENSCO's solutions can be applied to light duty, medium duty, and heavy duty trucks to address a full range of inspection and operational requirements.



## Towed Coaches

As railroad traffic density increases, it becomes difficult to find adequate time for both track inspection and maintenance. On high-speed rail lines, the challenge is even greater. Towed coaches provide cost-effective solutions to railroad track inspection needs. Whether implemented in revenue trains or behind dedicated locomotives, towed coaches can be configured for high-speed and long-haul track inspection operations, improving the capacity of the rail network.



# Track Inspection Services



In addition to supplying inspection vehicles and systems, ENSCO also offers the use of vehicles and systems we own as a service to customers. ENSCO owns and operates the equipment. This provides railways and transits access to cutting edge track inspection technology and our in-house experts.

## Hi-rail Inspection Vehicles

ENSCO owns and operates a fleet of hi-rail inspection vehicles used for conducting automated track inspection services. The hi-rail systems are fully calibrated and staffed by experienced ENSCO staff. Automated inspection technologies offered from the hi-rail fleet include track geometry, rail profile, third rail measurement, joint bar inspection, track component inspection, and driver view imaging.

## Portable Inspection System for Rail Bound Vehicles

ENSCO also owns and operates portable track geometry, rail profile, and third rail measurement systems that are temporarily installed on rail bound vehicles. These portable systems can be installed on passenger rail bound equipment, such as cab cars, coaches, and business cars.

## Inspection technologies offered by ENSCO as a service include:

- Track Geometry Measurement System (TGMS)
- Rail Profile Measurement System (RPMS)
- Third-Rail (Power Rail) Measurement System (TRMS)
- Joint Bar (Fish Plate) Inspection System (JBIS)
- Track Component Imaging System (TCIS)
- Driver View Imaging System (DVIS)
- Rail Surface Imaging System (RSIS)
- Clearance Measurement System (CMS)
- Ultrasonic Rail Flaw System (URFS)

# Inspection Solutions By Area

## Track Geometry

Track geometry can degrade quickly, causing derailment risk. Measuring and monitoring track geometry is key to ensure safety and directing track maintenance efficiently.

### Track Geometry Measurement System (TGMS)

The Track Geometry Measurement System is the fundamental system to directly measure all the key track geometry conditions such as gage (gauge), curvature, crosslevel, warp, twist, profile (surface, top), and alignment. Its measurements replace the manual measurements made by field personnel.



### Vehicle/Track Interaction (V/TI) Monitor

Many track geometry conditions combine multiple factors to cause a derailment risk. The Vehicle/Track Interaction (V/TI) Monitor uses the actual rail vehicle response to the track to assess the track condition. The V/TI operates autonomously and is a great addition to the Track Geometry Measurement System (TGMS) to ensure complete track geometry condition assessment. Since the V/TI operates autonomously, it can find rapidly changing conditions.



### Ride Quality Measurement System (RQMS)

The Ride Quality Measurement System (RQMS) has similar measurements to the V/TI Monitor, but with the difference that it can be synchronized with other measurement systems, such as a TGMS, and measure continuously allowing for strip chart data to be plotted alongside other measurement systems data.



# Inspection Solutions By Area

## Rail and Joints

Rail and Joints is the most expensive asset a railway owns and maintains. ENSCO's rail inspection technologies aid in achieving maximum safety with optimum efficiency.

### Ultrasonic Rail Flaw System (URFS)

Detecting and resolving rail flaws is an essential part of track maintenance. ENSCO's Ultrasonic Rail Flaw System (URFS) provides state-of-the-art rail flaw detection while being integrated with other track inspection systems.



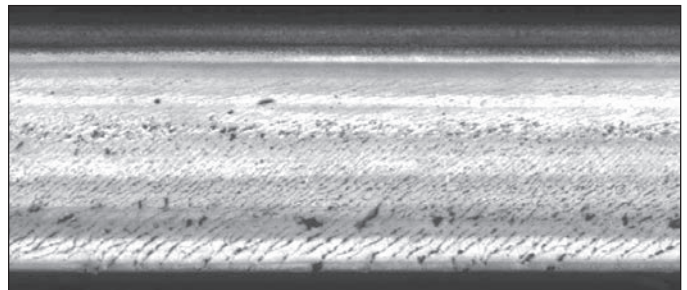
### Rail Profile Measurement System (RPMS)

Rail wear measurement is critical to assess the rail's life and ensure continued safety. ENSCO's Rail Profile Measurement System (RPMS) provides the industry with high accuracy measurement from both autonomous and manned operations.



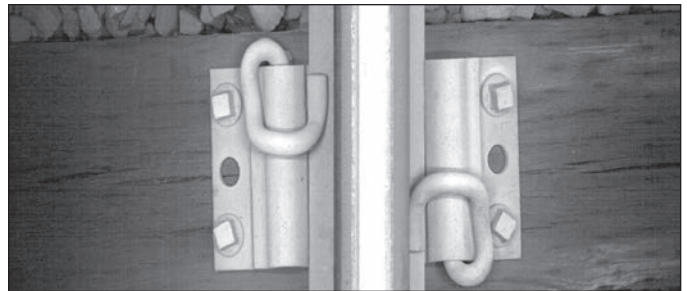
### Rail Surface Imaging System (RSIS)

Assessing rail surface conditions are extremely important to avoid rail breaks resulting from Rolling Contact Fatigue (RCF) and other surface damage conditions. ENSCO's Rail Surface Imaging System (RSIS) collects high-resolution images of the rail surface. It automatically converts them to strip chart data to allow for synchronization with other data sets, such as rail wear, allowing for optimum rail grinding planning.



### Rail Component Imaging System (RCIS)

ENSCO's Rail Component Imaging System (RCIS) provides the same functionality as the RSIS, and will also allow for a combined inspection of both the rail and the fasteners at the same time.



### Vehicle/Track Interaction (V/TI) Monitor

The V/TI has proven to be invaluable for detecting rapidly changing rail surface conditions such as battered joints, broken joints, broken frogs, broken rail, and engine burns.





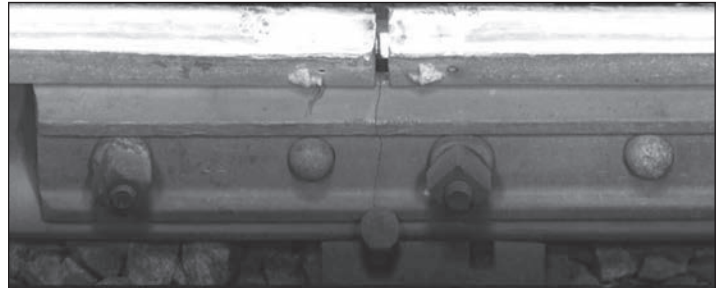
### Rail Corrugation Measurement System (RCMS)

Rail corrugation can be frustrating, leading to noise, poor ride quality, and safety issues. ENSCO's Rail Corrugation Measurement System (RCMS) identifies the corrugation condition in detail to allow for targeted rail maintenance planning.



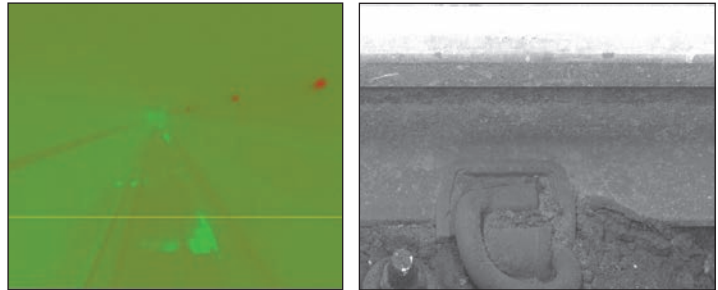
### Joint Bar Imaging System (JBIS)

Failures of joint bars (fish plates) and associated bolts continue to focus area of all railways. ENSCO's Joint Bar Imaging System (JBIS) automatically detects rail joints and insulated joints and determines if there is a failure, such as a cracked joint bar or missing bolt. The JBIS also detects broken rails.



### Thermal Imaging System (THIS)

ENSCO's Thermal Imaging System detects cold spots caused by leaking or pooling water in tunnels. The system's detection is synchronized with our Joint Bar Imaging System to aid in identifying rail base corrosion which, if undetected, can lead to broken rails.



### Ride Quality Measurement System (RQMS)

ENSCO's RQMS has the same functionality as the V/TI, but may also synchronize with other inspection systems. When paired with the Rail Surface Imaging System (RSIS), the RQMS is able to have a measurement of the rail surface condition along with its image.



### Predictive Rail Temperature System (PRTS)

Heat inspections and slow orders for hot rail can be challenging when using only local weather data. ENSCO's Predictive Rail Temperature System (PRTS) utilizes proven and validated algorithms to predict peak rail temperatures in advance to better plan operations.



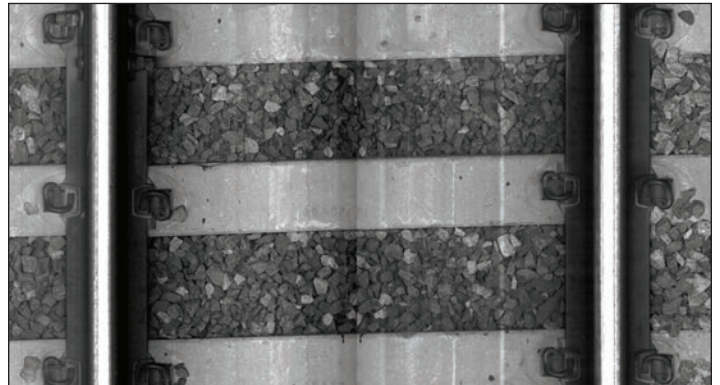
# Inspection Solutions By Area

## Ties (Sleepers) & Fasteners

Ties (sleepers) and their fasteners are a critical railway asset responsible for keeping the track together. Deteriorated ties or fasteners can rapidly raise safety risk. ENSCO's offered technologies aid in the thorough and rapid inspection of ties and fasteners.

### Track Component Imaging System (TCIS)

To get an overall inspection of ties and fasteners, the Track Component Imaging System (TCIS) is second to none. It provides high resolution machine vision imagery to the fidelity to see small cracks in concrete ties. Automatic detection of tie and fastener defects enable the TCIS to be valuable inspection system for any railway.



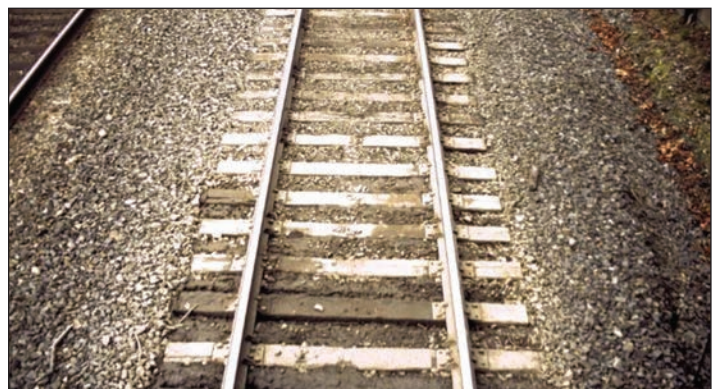
### Rail Component Imaging System (RCIS)

Similar to the TCIS, the Rail Component Imaging System (RCIS) provides high resolution machine vision imagery of the fasteners and tie portion near the fasteners. The RCIS provides a cost effective method to automatically inspect fasteners and the critical portion of the ties near the fasteners, while also performing a thorough inspection of the rail surface.



### Track View Imaging System (TVIS)

ENSCO's Track View Imaging System operates similarly to the Track Component Imaging System (TCIS), but it utilizes an area scan camera. This allows it to provide overview imagery of the ties and fasteners in a cost effectively manner. The TVIS is synchronized with all other systems, and it is very useful to provide context to defective conditions detected by other systems.



## Deployable Gage Restraint Measurement System (DGRMS)

Gage (gauge) widening can be caused by many factors including tie and fastener condition that result in the rails moving laterally or rotating due to rail cant. The Deployable Gage Restraint Measurement System (DGRMS) is applied known vertical and lateral loads into the rails to simulate real-life loads into the track allowing for gage to be measured under load. Additionally, the DGRMS measures gage away from the load allowing for additional useful calculations to assess the tie and fasteners' ability to hold gage.



## Portable Track Loading Fixture (PTLF)

Similar to the DGRMS, the Portable Track Loading Fixture (PTLF) is used to assess the tie's ability to hold gage (gauge). The PTLF is a hand tool used to do spot checks of loaded gage. The PTLF is also very useful to be used with a Track Geometry Measurement System (TGMS) mounted on a light vehicle such as a hi-rail (road rail vehicle) to measure gage under load at suspect locations identified by the TGMS.



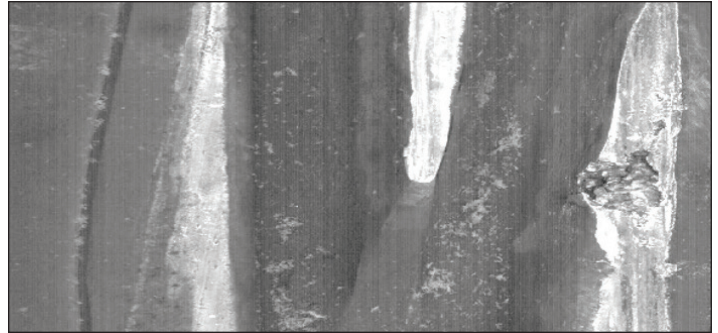
# Inspection Solutions By Area

## Special Trackwork

Special Trackwork such as turnouts (switch and crossings), diamonds, road crossings (level crossings), and derails have unique features that require tailored technologies to aid in assessing their conditions. ENSCO's special trackwork inspection technologies provide in-depth condition assessment to aid in optimum safety and operation of these types of special trackwork.

### Point Asset Inspection System (PAIS)

Point assets such as turnouts, diamonds, road crossings, and derails can deteriorate creating challenging safety risks to any railway. ENSCO's Point Asset Inspection System combines laser profiling and machine vision technologies to create a comprehensive assessment of the point asset's condition including key measurements, rail wear, frog and switch blade wear, and broken and missing components.



### Track Geometry Measurement System (TGMS)

Track geometry in turnouts can deteriorate to create challenging derailment risk conditions. Using ENSCO's TGMS allows for pin-pointed measurement of all the key geometry measurements to ensure proper operation of a railway's turnouts.



### Vehicle/Track Interaction (V/TI) Monitor

The V/TI Monitor is an invaluable tool to assess wheel/rail impact conditions at turnout components such as frogs, switch points, and heel blocks. The V/TI Monitor has identified countless defective conditions in turnouts and aided to prevent critical safety risks.



### Ride Quality Measurement System (RQMS)

Similar to the V/TI, the RQMS makes the same wheel/rail impact measurement that is useful for assessing turnout component condition. An added advantage of the RQMS is to have the measurement data synchronized with other systems, such as the Point Asset Inspection System (PAIS).



# Inspection Solutions By Area

## Vehicle/Track Interaction

Measurement and control of vehicle/track interaction is paramount to any railway to ensure that derailments are prevented, and optimum ride quality is maintained. ENSCO is the leader in vehicle/track interaction technologies to aid railways to achieve optimum performance.

### Vehicle/Track Interaction (V/TI) Monitor

The industry's leading method to monitor passenger transit vehicle/track interaction is the V/TI. It is installed on multiple revenue vehicle types to assess the vehicle/track interaction performance across all vehicle types. Since the V/TI is autonomous, it always inspects and provides a continuous safety net to ensure optimum railway operations.



### Ride Quality Measurement System (RQMS)

The RQMS operates similar to the V/TI Monitor, but has the advantage that it is synchronized with other measurement systems. When the RQMS is installed on a revenue vehicle with other systems, such as a Track Geometry Measurement System (TGMS), it provides invaluable insights to understand what track geometry conditions are driving undesired vehicle/track interaction conditions.



### Instrumented Wheel Sets (IWS)

Instrumented Wheel Sets are the industry standard method of directly measure wheel forces from vehicle/track interaction. ENSCO has unique features with our IWS that allow it to be synchronized with all other systems and operate autonomously. This provides a valuable ability to consistently monitor wheel/rail interaction and correlate with track geometry and rail profile conditions.



### Automated VAMPIRE® Vehicle/Track Interaction Software

ENSCO offering of Automated VAMPIRE allows for it produce all the same data of the V/TI, RQMS, and IWS but in a virtual, digital twin manner. The Automated VAMPIRE solution is combined with an autonomous or manned Track Geometry Measurement System (TGMS) to produce invaluable data to aid in derailment prevention but also provide insightful data for track maintenance planning in the Automated Maintenance Advisor (AMA) software.



# Inspection Solutions By Area

## Power Infrastructure

Measurement and monitoring power infrastructure such as overhead wire (catenary) and third rail (power rail) is just as important as the track infrastructure itself to ensure safe and efficient operations. ENSCO offers a full suite of inspection technologies to aid our customers with their power infrastructure condition monitoring.

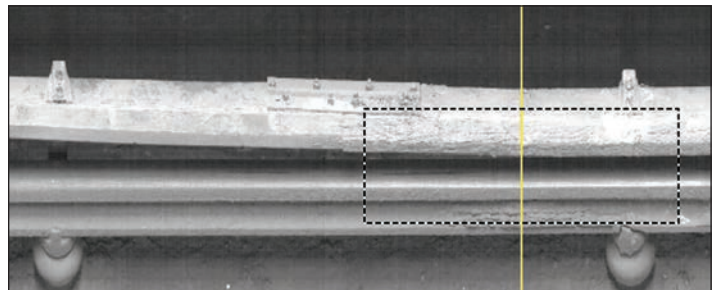
### Third Rail Measurement System (TRMS)

Deteriorating conditions can cause the relative position of the third rail (power rail) to the running rails can create several issues including contact shoe breakage or clearance encroachments. ENSCO's Third Rail Measurement System measures the third rail position to ensure it is within safe tolerances.



### Third Rail Imaging System (TRIS)

The third rail (power rail) has multiple components that can become damaged or missing causing safety concerns. ENSCO's Third Rail Imaging System creates high resolution images of the third rail components including the coverboard, isolators, and goosenecks. Automated algorithms and human review are available to identify defective conditions.



### Overhead Wire Measurement System (OWMS)

The position of overhead wire (catenary wire) is critical to prevent dewirements. ENSCO with its partner provides height, stagger, and wire wear measurement to ensure the overhead wire is within maintenance tolerances.



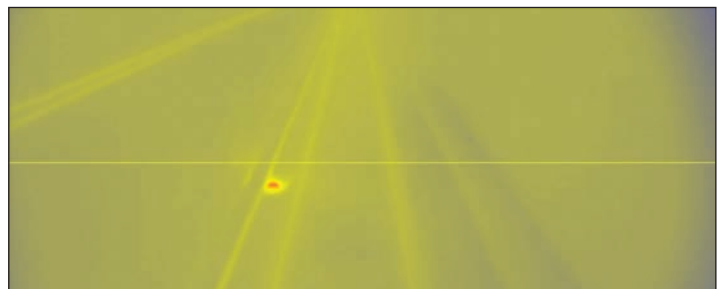
### Overhead Wire Imaging System (OWIS)

ENSCO's Overhead Wire Imaging System provides overview imagery of the overhead wire and pantograph. The OWIS is synchronized with all other inspection systems such that it can provide useful context images corresponding with other inspection systems, such as at a defective condition identified by the Overhead Wire Measurement System (OWMS).



### Thermal Imaging System (THIS)

Both third rail and overhead wire systems can suffer from hot spots that can have potential fire hazard or component failure. ENSCO's Thermal Imaging System captures thermal images and processed with specialty algorithms to accurately identify hot spots.



# Inspection Solutions By Area

## Signal & Train Control



Signaling and train control systems operating at their peak performance is key to any railway to maximize safety and minimize train delays. For this reason, ENSCO offers technology targeted for assessing the condition on train control and signaling systems.

### Signal & Communication System (SCIS)

The full and proper operation of track circuits and train control systems are key to railway operations. The SCIS is used to measure AC track circuits and associated train control systems in addition to wayside train control systems to ensure that they are operating as intended. The SCIS provides an added level of protection as an independent condition monitoring tool to the train control system itself.



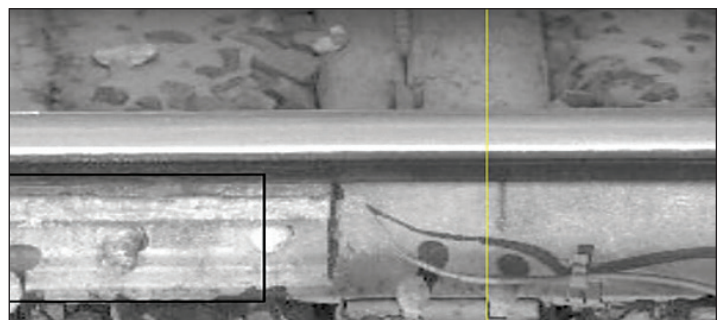
### Track Component Imaging System (TCIS)

The machine vision capability of the TCIS allows for a visual inspection of train control components installed on the track such as balises and transponders. This allows railways to identify problems of broken, missing, or incorrectly located wayside transponders which can result in incorrect train control operations.



### Joint Bar Imaging System (JBIS)

The JBIS imagery allows for the visual inspection of important track circuit components such as bond wires to aid in diagnosing track circuit challenges. These wires and connections can become damaged or partially damaged causing issues with track circuits, train control systems, and road crossing protection systems.



# Track Geometry Measurement System (TGMS)



Track Geometry Measurement is the most important method in the rail industry for assessing track safety and maintenance planning. Measuring and analyzing track geometry regularly is proven to prevent track-related derailments, which can result in catastrophic damage. ENSCO's Track Geometry Measurement System (TGMS) is the leader in the industry for reliability and measurement reproducibility.



## Derailment Prevention

Track geometry conditions are a major driver to causing derailments vehicle/track interaction derailments such as spreading gage (gauge), wheel climb, and rail rollover type derailments. But additionally, track geometry conditions can drive other types of derailments such as broken rail, broken fasteners, and thermal misalignment type derailments. The TGMS provides the key capability to ensure that the track geometry condition is within limits to ensure safe operations.

## Ride Quality

Various track geometry conditions drive passenger ride quality comfort. The TGMS produces Track Quality Indices (TQI) that are invaluable for identifying specific track geometry conditions resulting in rough ride conditions.

## Track Geometry Measurements

The Track Geometry Measurement System measures all the fundamental track geometry measurements such as gage (gauge), curvature, crosslevel, warp, twist, profile (surface, top), and alignment.

## System Variations:

**Carbody Mounting:** ENSCO can directly mount the measurement beam to the carbody instead of the truck (bogie), allowing for easier installations and maintenance on the vehicle. Carbody mounting also has higher reliability of lens cleanliness and shock and vibration, both critical for autonomous operation.

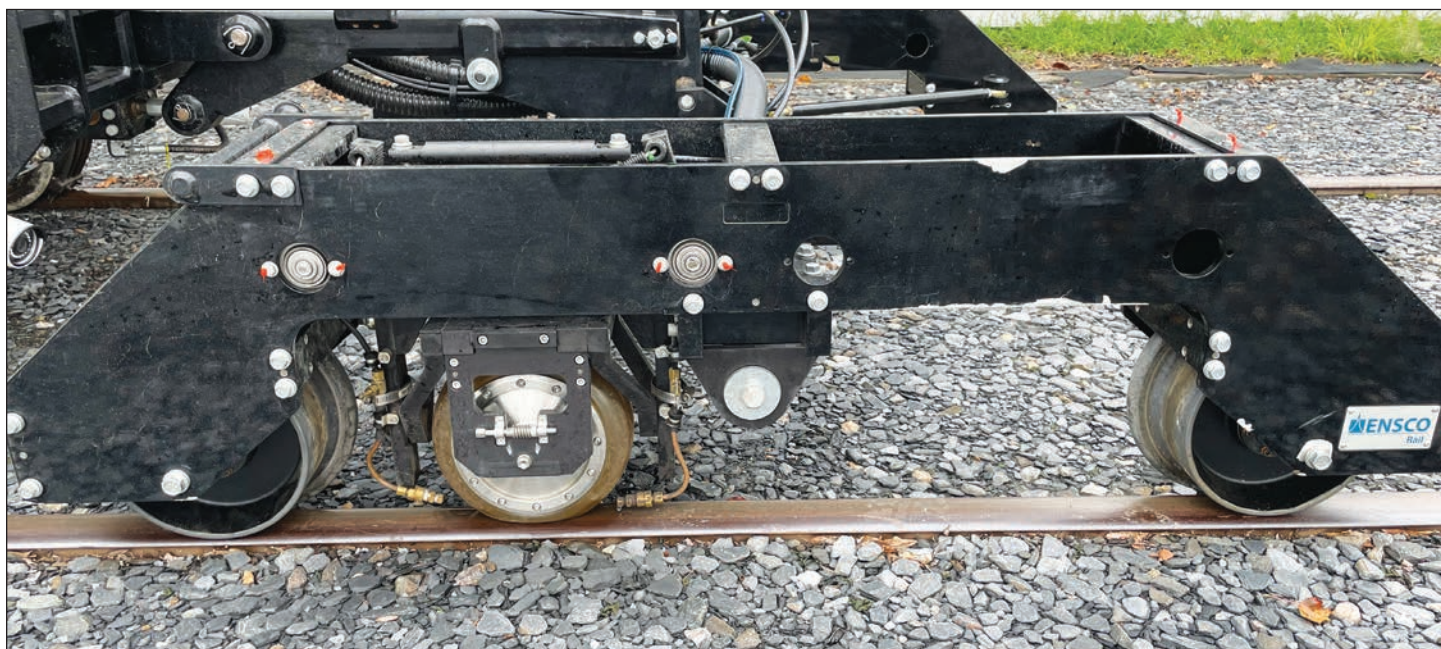
**Zero Speed Measurement:** All standard inertial-based track geometry measurement systems have a slow speed cutoff of some measurement channels. ENSCO's Zero Speed add-on capability provides all track geometry parameters down to zero speed.

## System Integration

A major advantage of ENSCO's TGMS is that it is fully integrated with all other measurement systems. This enables the correlation of track geometry measurement data with other measurements such as ride quality, and machine vision imagery, such as ballast and tie (sleeper) images from the Track Component Imaging System (TCIS).



# Ultrasonic Rail Flaw System (URFS)



ENSCO Rail, the leader in innovative, reliable, automated track inspection, offers the latest product in its suite of railway track inspection and maintenance planning products: the Ultrasonic Rail Flaw System (URFS). Rail flaw detection technology is the most reliable method in the rail industry for preventing broken rails, the leading cause of track-related derailments, which can result in catastrophic damage.

## Ultrasonic Rail Flaw System (URFS)

**The most reliable method in the rail industry for preventing broken rails, the leading cause of track-related derailments.**

The ENSCO URFS is set to revolutionize the rail industry with improved prevention of broken rails and welds by using complementary technologies and skills sets. URFS will help railways meet regulatory requirements, prevent derailments, and keep their railways running safely and efficiently.

The ENSCO URFS is focused on bringing value to the industry by reducing false-stops, increasing productivity through automation, increasing accuracy of true-positive detections, and measuring corresponding conditions to aid in the prediction and prevention of rail flaws.

With more than 50 years of experience developing technologies with world class engineering staff for the rail industry, ENSCO is pleased to offer URFS in its portfolio of products. URFS seamlessly integrates with other ENSCO automated track inspection technologies, such as Zero-Speed Track Geometry and Rail Profile Measurement, as well as machine vision technology. This provides multiple benefits, allowing customers to ensure highly accurate defect location, data cross correlation and analysis, and standardization of operator controls to minimize training requirements. In addition, combining URFS with ENSCO Rail complementary machine vision inspection technologies, including our patented Rail Surface Imaging System and Joint Bar Imaging System, allows customers to significantly improve the assessment of overall rail integrity.



# Rail Profile Measurement System (RPMS)

Rail wear is one of the most important measurements to manage rail assets. ENSCO's Rail Profile Measurement System (RPMS) is an add-on laser profiling system to the Track Geometry Measurement System (TGMS) that provides the rail profile measurements needed for rail maintenance and management.

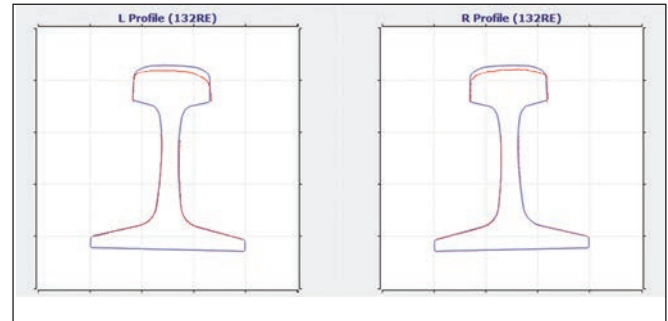
## Rail Maintenance

Rail is one of the most expensive assets a railway needs to maintain. ENSCO's RPMS provide key measurements for planning rail maintenance, including grinding and rail replacement. Additionally, its measurements can be used with the Autonomous Maintenance Advisor (AMA) to predict rail wear trends to identify where and when rail maintenance will be required.



## Rail Profile Measurements

- The RPMS allows for key measurements such as vertical and horizontal rail wear, and rail cant (inclination).
- ENSCO's system offers multiple methods to automatically identify rail size and properly compare to new rail templates.
- Rail Profile measurements can also be used for wheel/rail interaction assessment, such as equivalent conicity calculations and VAMPIRE® simulations.



## System Variations:

**Carbody Mounting:** ENSCO has the unique ability to mount the TGMS & RPMS measurement beam to the carbody instead of the truck (bogie). This allows for easier installations and maintenance on the vehicle. Additionally, it has the advantage of higher reliability of lens cleanliness and shock & vibration, both critical for autonomous operation.

**Gage Side Only Measurement:** ENSCO's standard RPMS uses field and gage (gauge) side lasers to measure both sides of the rail. ENSCO also offers a Gage Side Only RPMS, which only has measurement lasers on the gage side. This system provides the benefit of reduced cost and size compared to the full rail profile version, while still providing all the same measurements except the field side wear and lip.

# Rail Corrugation Measurement System (RCMS)

Rail corrugation can be more than a nuisance and create safety risks if unmeasured and unresolved. The repeated worn surface patterns in the rail surface can produce not only high levels of noise but also elevated wheel/rail contact forces that can result in further safety concerns.

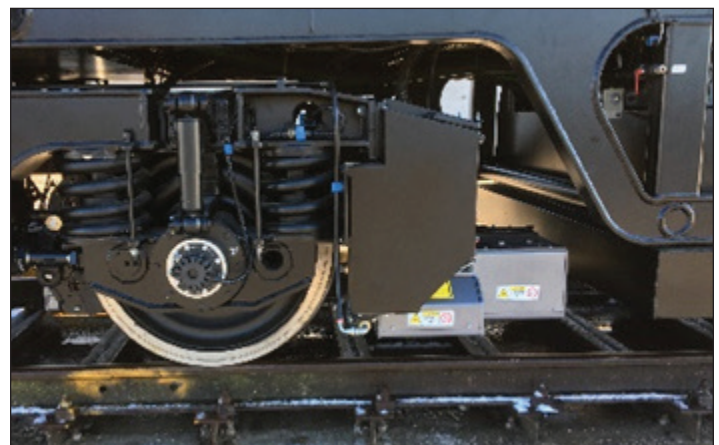
ENSCO's highly accurate Rail Corrugation Measurement System (RCMS) evaluates corrugation over multiple critical wavelength bands allowing for in-depth assessment. Measurements are key to identifying locations of needed rail maintenance to resolve corrugation to regain optimum wheel/rail behavior.



## System Variations:

**Laser-Based:** ENSCO's laser-based system provides the highest accuracy possible for corrugation measurement. Additionally, it can measure down to zero speed. ENSCO's laser-based RCMS is an add-on system to ENSCO's RPMS.

**Acceleration-Based:** ENSCO offers, an acceleration-based corrugation system that offers extremely value and a small installation size through its partner.



# Vehicle/Track Interaction (V/TI) Monitor

ENSCO's autonomous Vehicle/Track Interaction (V/TI) Monitor is the most widely used, cost-effective method to autonomously inspect track and aid in reducing track caused derailments.

V/TIs are stand-alone systems installed on revenue vehicles such as locomotives or passenger coaches to access the condition of track and vehicles through acceleration monitoring to provide real-time alerting and proactive maintenance planning.

The V/TI measures ride quality, wheel/rail impacts, such as battered and broken joints, and short-chord track surface conditions, such as mud spots and pumping joints. Identified risk conditions are transmitted via cellular network, received as email alerts and viewed in TrackIT®.

With a fleet of V/TIs' autonomous measurement, railways achieve a constant safety net to identify quickly deteriorating conditions (and precursor conditions) and report them to field personnel for remediation to ensure smooth operations.

The V/TI Monitor is based on research sponsored by the Federal Railroad Administration (FRA) and ENSCO's internal research and development.



## Ride Quality Measurement System (RQMS)

The ENSCO Ride Quality Measurement System (RQMS) provides invaluable complementary track condition data and track geometry. Carbody, suspension and wheel acceleration data can be synchronized with track geometry data and machine vision data. Using our advanced signal processing algorithms, sensors can locate rough ride locations, battered joints, engine burns, crushed rail heads, etc.

### Ride Quality

The RQMS is a great way to measure passenger ride comfort directly and correlate the measurements with other systems such as the Track Geometry Measurement System (TGMS), to identify specific track geometry conditions to correct.



### Derailment Prevention

The RQMS ability to measure wheel/rail impact conditions, provides a great source to identify at-risk rail conditions that can result in a broken rail or failures in turnouts such as broken frogs, or chipped switch points. Additionally the RQMS can be synchronized with other systems, including the Rail Surface Imaging System (RSIS), to provide an image of the defective condition.



# Clearance Measurement System (CMS)

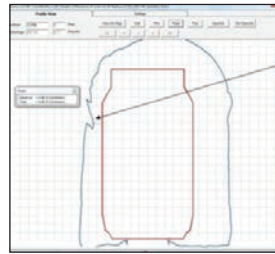
ENSCO's Clearance Measurement System (CMS) provides real-time, high resolution Right-of-Way Clearance Assessment of Railway Lines including Structure Gauge, Tunnel Clearance, Object Encroachment, Track Centerline Offset, Rolling Stock Kinematic Analysis and Platform Track Interface Analysis ("Mind the Gap").



Measurements are made at track speed with a LiDAR distance laser that is typically mounted on the front of the vehicle and produces a high-resolution, virtual model of your railway corridor.

## Structure Gauge

The ENSCO Clearance Measurement System automatically takes measurements at track speed with a LiDAR distance laser and measures the structure gauge to ensure the safe transport of rail passengers and cargo without the risk of getting too close to the infrastructure.



## Tunnel Clearance

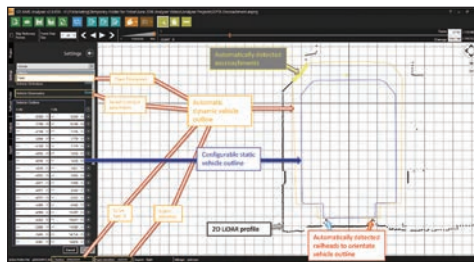
Uncertainty about tunnel clearances can be costly and dangerous. The ENSCO Clearance Measurement System measures and validates tunnel clearance and provides the clearance assessment data necessary to avoid tunnel and rail system damage.



## Object Encroachment

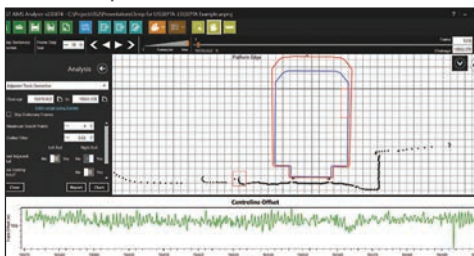
The ENSCO Clearance Measurement System detects vegetation and other objects encroaching on rails that might cause unsafe conditions.

The Clearance Measurement System measures track clearance and detects vegetation and other objects encroaching on rails that might cause unsafe conditions.



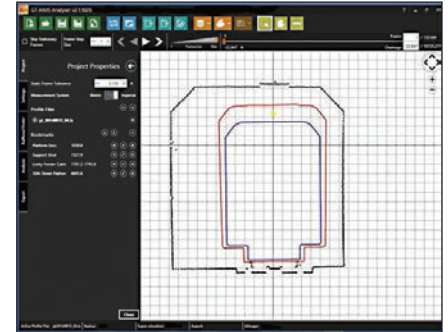
## Track Centerline Offset

The ENSCO Clearance Measurement System automatically takes measurements at track speed with a LiDAR distance laser. Using the CMS software, you can calculate the minimum distance between adjacent tracks and identify exceptions.



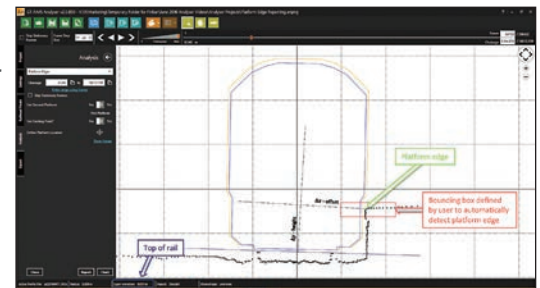
## Vegetation Encroachment

The ENSCO Clearance Measurement System detects vegetation and other objects encroaching on rails that might cause unsafe conditions. The Clearance Measurement System measures track clearance and detects vegetation and other objects encroaching on rails that might cause unsafe conditions.



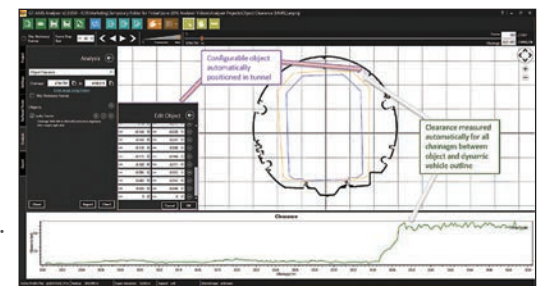
## Platform/Track Interaction "Mind The Gap"

The ENSCO Clearance Measurement System helps you make minding the gap easier by measuring and managing rail platform/train interface for safer passenger boarding and deboarding. The Clearance Measurement System calculates the horizontal and vertical offset of the platform edge from the track centerline.



## Rolling Stock Kinematic Envelope

The ENSCO Clearance Measurement System automatically takes measurements at track speed with a LiDAR distance laser and measures the structure gauge which varies with curvature of the line and maximum speeds allowed. Using the CMS software, you can calculate the rolling stock kinematic behavior based on measured parameters and features of train design that may affect the kinematic envelope.



*The Clearance Measurement System is available as a purchased system or as a contracted service.*

# Deployable Gage Restraint Measurement System (DGRMS)

The Deployable Gage Restraint Measurement System (DGRMS) is the rail industry's preferred method to measure gage restraint at high speeds from a rail bound vehicle. The DGRMS features a hydraulically actuated split axle that applied known vertical and lateral loads into the rails allowing for measurements of loaded and unloaded gage at high survey speeds.

## Derailment Prevention

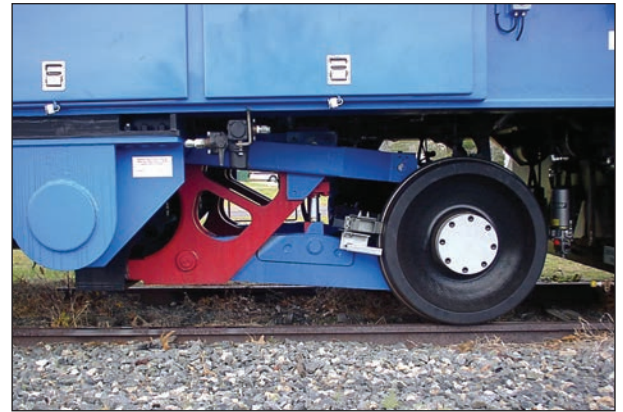
The DGRMS identifies locations of weakened tie and fastener support of holding gage (gauge). As gage widening derailments are the most common type of track geometry caused derailments, the DGRMS is a key tool for any railway to prevent these types of derailments.

## Measurements During Winter Conditions

The DGRMS has the unique ability to still be able to assess tie, fastener, and gage conditions even when the track is covered in snow. This has proven to be an invaluable capability for railways operating in heavy winter conditions.

## Key Features of the DGRMS:

- Measures the ability for ties (sleepers) and fasteners to hold gage (gauge)
- Detects areas of weak track that can cause a gage widening derailment
- Additionally can detect areas of concrete tie rail base deterioration that can induce safety risk rail cant (rail inclination).



# Portable Track Loading Fixture (PTLF)

ENSCO's manually operated Portable Track Loading Fixture (PTLF) is the industry's go-to method for spot checking gage (gauge) strength. The PTLF is compliant to the American Railway Engineering Maintenance-of-way Association (AREMA) and Federal Railroad Administration (FRA) standards for gage strength.

Using the PTLF helps to identify locations of high derailment risk caused by gage widening conditions caused by weakened ties (sleepers) or broken or missing fasteners.

Track Inspectors can use the PTLF to spot check locations of concern, or check gage under load after measuring with a hi-rail mounted Track Geometry Measurement System (TGMS).

The PTLF serves to bring a complete gage strength assessment to a railway when used in combination with a Deployable Gage Restraint Measurement System (DGRMS) which performs similar measurements, but at high speed from a rail bound vehicle.

The PTLF is based on research sponsored by the FRA and ENSCO internal research and development.



# Third Rail Measurement System (TRMS)

ENSCO's Third Rail Measurement System is an add-on to our Rail Profile Measurement System to accurately measure the relative vertical and horizontal height of the third rail (power rail) to the nearest running rail. It utilizes public safe lasers to accurately make measurements. Measuring and maintaining the third rail geometry is critical to ensuring efficient traction power operations on any transit.



## Third Rail Position Measurement

The position of the third rail (power rail) is extremely important to ensure safe and uninterrupted transit operations. When the third rail position is out of tolerance it can cause damage to contact shoes or lose contact entirely causing excessive arching. The TRMS is an important measurement system to ensure the third rail is ready for smooth operations.

### System Variations:

#### Top Contact Third Rail:

This configuration is used when the contact shoe contacts on the top of the third rail.

#### Bottom Contact Third Rail:

This configuration is used when the contact shoe contacts on the bottom of the third rail.



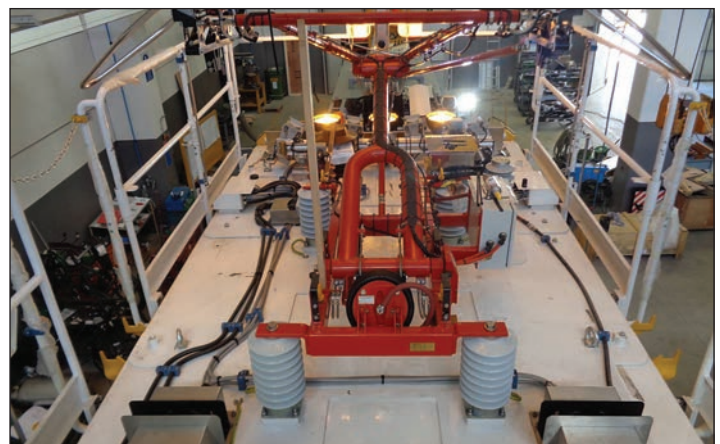
# Overhead Wire Measurement System (OWMS)

ENSCO with our partner provides the Overhead Wire Measurement System (OWMS). It measures the height, stagger, and wear parameters of overhead wire utilizing laser and camera technology. The OWMS can be mounted adjacent to a pantograph or mounted without a pantograph. Motions of the carbody are corrected for in the measurements to ensure accurate data.



## Overhead Wire (Catenary) Measurement

- Height and stagger measurements are key to ensure uninterrupted transit operations.
- When height (vertical height of the overhead wire above top of rail) or stagger (horizontal offset from the track center) exceed thresholds, they can lead to a risk of a dewirement where the overhead wire comes off the pantograph and becomes entangled.
- Additionally, the overhead wire will wear over time ultimately limiting its useful lifespan.
- The OWMS is critical to ensure the overhead wire is ready for operations.



# Point Asset Inspection System (PAIS)

ENSCO's Point Asset Inspection System (PAIS) is a combination of multiple inspection systems tailored specifically for inspecting special trackwork assets such as turnouts (switch & crossing), diamonds, road crossings (level crossings), and derails. The PAIS combines the following inspection systems together to provide a comprehensive inspection system:



- **Rail Profile Measurement System (RPMS):** ENSCO's standard RPMS tailored for use with the PAIS where additional laser profiling capability is added and higher sampling rates are used to gain detailed measurements of components such as frogs and switch points. Additionally, the RPMS provides key measurements of the guard rail.
- **Track Component Imaging System (TCIS):** ENSCO's TCIS is used to obtain detailed machine vision images of turnout components such as tie bearers (sleepers), fasteners, and tie rods.
- **Joint Bar Imaging System (JBIS):** ENSCO's JBIS captures detailed images of turnout components such as switch point blades, heel blocks, frogs and guard rails.
- **Additional Inspection Systems:** ENSCO's unique ability to synchronize all inspection data allows for additional systems such as the Track Geometry Measurement System (TGMS) and Ride Quality Measurement System (RQMS) to be included with the above detailed inspection data at point assets.

ENSCO's PAIS utilizes data from all the above systems to capture data at the designated point asset locations and provide an organized data set for automated algorithms and detailed inspector review in the office using Virtual Track Walk® (VTW).

# Signal and Communication Inspection System (SCIS)



ENSCO's Signal and Communication Inspection System (SCIS) is a comprehensive onboard system used to monitor train control, PTC and track circuit health. The SCIS is synchronized with the track recording vehicle's location, i.e., chainage, milepost, etc., and GPS information. Real-time data is viewed on the track recording vehicle similar to a track geometry stripchart. The SCIS identifies exceptions where measured conditions do not meet design requirements. Measured data can be viewed in the office to further evaluate conditions.

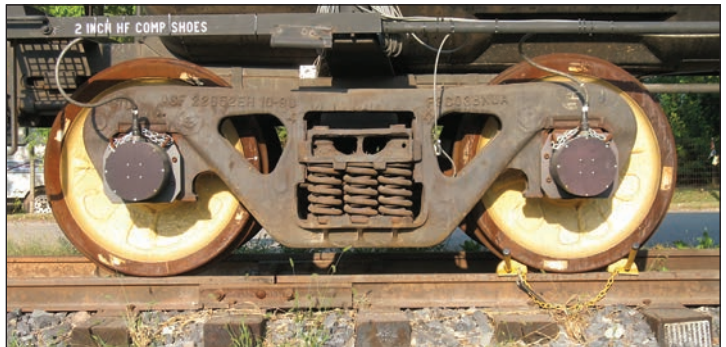
## Inspection Antenna

The SCIS measures actual track circuit conditions continuously, using custom antennas mounted on a track recording vehicle. Each antenna looks for specific carrier frequencies and signals from both DC and AC track circuits. The SCIS can pinpoint locations of degraded conditions, such as impedance bonds, insulated joints, and stray current locations.

ENSCO's SCIS uses various custom and standard antennas to receive and record wayside transponder messages. The SCIS confirms wayside transponder functionality, location and signal strength. Should any transponder health condition exceed the threshold, the SCIS will create exceptions with location and GPS coordinates.

# Instrumented Wheel Sets (IWS)

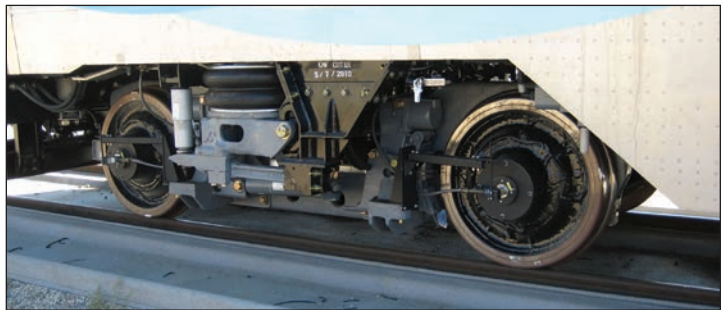
ENSCO has produced more than 40 Instrumented Wheel Sets (IWS) for passenger cars, freight cars, and transit cars since 1975. ENSCO's IWS use a fully calibrated strain gauge array that produces real-time vertical, lateral and longitudinal wheel/rail force measurements. The IWS also measure the wheel/rail contact location.



The IWS provide a continuous measurement at all speeds and flag exception locations when parameters exceed set thresholds. ENSCO's IWS has been successfully used to qualify many passenger and freight cars.

The IWS is used both at customer locations and at the Transportation Technology Center (TTC) which often uses IWS with vehicle testing occurring at the site.

ENSCO has extensive experience conducting vehicle qualifications and instrumented wheel set testing throughout the railroad and transit industry. Additionally, ENSCO has an internal team of vehicle/track interaction professionals, who support interpreting the IWS data and conduct vehicle/track interaction simulations, using programs such as VAMPIRE®.



## Automated VAMPIRE® Vehicle/Track Interaction Software for Digital Twin

Assess your track infrastructure more thoroughly for less cost using the Digital Twin capabilities of VAMPIRE®

ENSCO has acquired the source code for VAMPIRE®, the world-renowned vehicle/track interaction software used for vehicle and track assessments in simulation. VAMPIRE® has historically been used by engineers and consultants to manually perform simulations of rolling stock traversing tracks and predicting key items such as derailment risk, wheel/rail forces, ride quality, and wear index.

With control of the source code, ENSCO has implemented automated VAMPIRE® to operate in the cloud or onboard inspection vehicles. It automatically simulates vehicles with measured track geometry and rail profile data in near real-time without human intervention.



### Derailment Prevention

- Reduce derailments by identifying and dealing with high-risk locations before they cause a problem
- Performance Based Maintenance
- Establish performance-based track geometry tolerances that ensure safety and maximize effective and efficient use of maintenance resources.

Prioritize measured geometry defects using vehicle dynamics derailment risk results from simulations over each defect location. Users can also import the results of the Automated VAMPIRE® can be imported into the Automated Maintenance Advisor for track condition deterioration trending.



# Joint Bar Imaging System (JBIS)

Broken joints and rails are the leading factor of track caused derailments. ENSCO's patented Joint Bar Imaging System (JBIS) employs patented vision inspection technology and methods to perform a detailed inspection of joint bars (fish plates) and rails using high-speed cameras. The JBIS provides an in-depth visual assessment of joints and rails, ensuring that cracks and defective conditions do not lead to a derailment or further failure. The JBIS, developed in partnership with the Federal Railroad Administration's (FRA) Office of Research and Development, increases inspection efficiency by reducing labor costs associated with traditional joint bar evaluation methods.



## Joint Bar Inspection

The JBIS performs automated crack detection on joint bars (fish plates) and rails. It also detects missing bolts according to business logic, measure rail gap, and deliver joint bar inventory reports. The system generates real-time exception reports, including continuous line scan images of suspect locations, and automatically inventories all joint bars and cracks in a permanent database.

## Broken Rail Detection

ENSCO's JBIS also inspects the web and base of the rail for cracked rail conditions. This serves as a valuable addition to the Ultrasonic Rail Flaw System (URFS) to provide both a visual and internal assessment of rail flaws.

# Track Component Imaging System (TCIS)

ENSCO's Track Component Imaging System (TCIS) is the premier method to capture high resolution imagery of the whole tie (sleeper) and fasteners. The TCIS features linescan cameras sampling at high frequency to produce detailed images where ENSCO's industry leading machine vision algorithms can automatically identify defective conditions.



## Tie Inspection (Sleeper Inspection)

ENSCO's TCIS produces the high-resolution imagery required for inspecting concrete and wood ties (sleepers) to the detail to identify small cracks in the concrete. Automated algorithms and human review using Virtual Track Walk (VTW) enable an automated methodology to perform tie inspections from the office.

## Fastener Inspection

Missing, broken, or misaligned fasteners are detected by the TCIS. But more importantly, the TCIS has configurable business logic to identify groups of fastener defects associated to railway's internal standards. This fastener defect grouping logic provides an invaluable method of narrowing the railway's focus on locations of high risk.

## Ballast Inspection

In addition to the tie inspection, the TCIS also automatically inspects the ballast condition to look for characteristics associated to fouling. This ballast assessment from the TCIS is paired well with other systems such as Track Geometry Measurement System (TGMS) and Ground Penetrating Radar (GPR) to provide a full assessment of the ballast.



# Rail Surface Imaging System (RSIS)

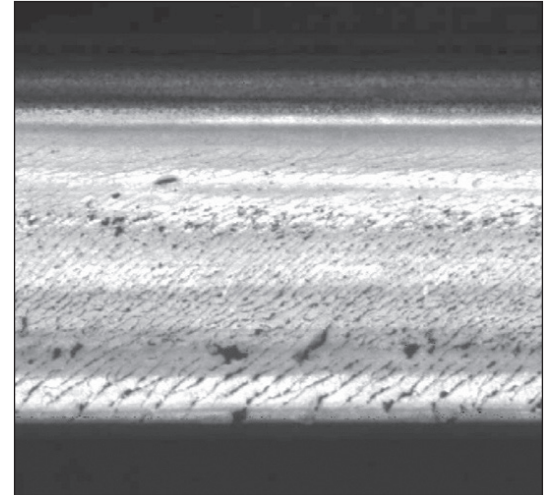
Rail surface condition assessment is fundamental to assuring optimum rail safety. Rolling Contact Fatigue (RCF), also known as head checking, can cause broken rails that can potentially cause a derailment. Additionally, RCF and other types of surface damage can interfere with ultrasonic rail flaw testing, leaving the rail at risk of having unknown internal rail flaws.

ENSCO's innovative Rail Surface Imaging System (RSIS) uses high-speed cameras to capture detailed images of the rail surface without contacting the rail surface. At the same time, ENSCO's patented algorithms assess the rail surface to determine the level of severity of RCF and surface damage which can be seen in strip charts synchronized with the images and other inspection data.

## Rail Surface Imaging Advantages:

- Non-contact
- High vehicle speed
- Images processed to strip chart measurements
- Synchronized with other inspection system data
- Used to prioritize rail grinding / rail milling
- Used to proactively identify surface condition locations that interfere with ultrasonic rail flaw testing

The RSIS can be an add-on to the JBIS or TCIS. Or alternatively it can operate stand-alone.



# Rail Component Imaging System (RCIS)

ENSCO's Rail Component Imaging System (RCIS) combines the best of the Rail Surface Imaging System (RSIS) and the Track Component Imaging System (TCIS). The RCIS captures high-resolution images of the rail surface, fasteners, and tie (sleeper) near the fasteners.

Rail surface data is automatically processed to strip charts aiding in rail maintenance planning, the same as the RSIS.

Fasteners are automatically assessed to identify defective conditions, the same as the TCIS.

## Fastener Inspection

Just as the TCIS does, the RCIS detects missing, broken, or misaligned fasteners. The RCIS has configurable business logic to identify groups of fastener defects associated with the railway's internal standards. This fastener defect grouping logic provides an invaluable method of narrowing the railway's focus on locations of high risk.

## Tie Inspection (Sleeper Inspection)

ENSCO's RCIS produces the high-resolution imagery near the rail base of ties (sleepers). This allows for the automated inspection of concrete tie cracking near the base of the rail.



# Driver View Imaging System (DVIS)

ENSCO's Driver View Imaging System (DVIS) utilizes an area scan camera to provide an overall view of the track and surrounding right-of-way. It has the unique advantage that it is synchronized with all other inspection systems on the vehicle. This allows it to be a useful source of imagery to provide context to any defective condition identified on other systems.



## Right-of-Way Video

ENSCO DVIS provides a great source of imagery to assess the right-of-way with corresponding measurement data. A common pairing is combining the DVIS with the Clearance Measurement System (CMS) to detect clearance infringement conditions with an associated image showing the infringement.

ENSCO offers the DVIS in the following configurations:

### Infrared Lighting

Using infrared has the unique advantage of not interfering with passengers or oncoming train traffic. Infrared use is preferred on passenger transits.



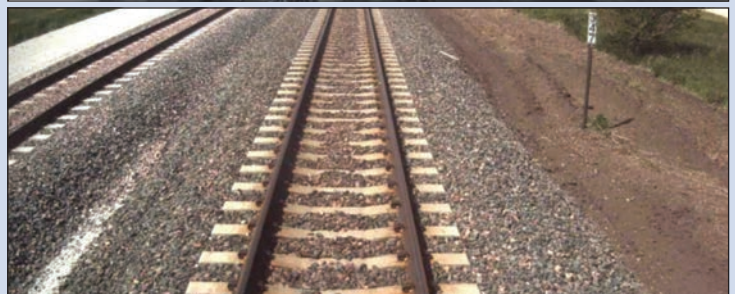
### Visual Lighting

An advantage of using visual light is that is able to produce color images. This can be an advantage to see Right-of-Way conditions that cause discolorations.



### No Lighting

In some instances no lighting is required when there are minimal or no tunnels and surveying is performed during daytime. This method is commonly used with freight railways.



# Track View Imaging System (TVIS)

The Track View Imaging System (TVIS) operates similarly to the Driver View Imaging System (DVIS), but is directed to produce detailed images of the track bed. Additionally, similar to the DVIS, the TVIS is offered with both infrared and visual light options.



## Tie and Ballast Assessment

Just like the DVIS, it has the unique advantage that it is synchronized with all other inspection systems on the vehicle. This allows it to be a useful source of imagery to provide context to any defective condition identified on other systems, such as overviews of the ballast conditions associated to Track Geometry Measurement System (TGMS) or Ground Penetrating Radar (GPR) data.

## Turnout Assessment

The TVIS also provides a valuable overview images of turnouts. Synchronized data from other system such as the Ride Quality Measurement System (RQMS) and Point Asset Inspection System (PAIS), paired with the TVIS provides brings great context to the assets' condition.

# Tunnel Wall Imaging System (TWIS)



The Tunnel Wall Imaging System (TWIS) operates similarly to the Driver View Imaging System (DVIS), but is directed to produce detailed images of the tunnel walls. Just like the DVIS, it has the unique advantage that it is synchronized with all other inspection systems on the vehicle. This allows it to be a useful source of imagery to provide context to any defective condition identified on other systems, such as tunnel clearance encroachments detected by the Clearance Measurement System (CMS). Additionally, similar to the DVIS, the TWIS is offered with both infrared and visual light options.



## Tunnel Water Leaks

When ENSCO's TWIS is paired with our Thermal Imaging System (THIS), the combination has the unique capability to find locations of tunnel water leaks. The thermal imaging provides a clear indication of where water is present and the detailed images from the TWIS give insight of the specific issue.

# Overhead Wire Imaging System (OWIS)

The OWIS operates similarly to the Driver View Imaging System (DVIS), but is directed to produce detailed images of the pantograph, overhead wire, and supporting infrastructure. Just like the DVIS, it has the unique advantage that it is synchronized with all other inspection systems on the vehicle. Additionally, similar to the DVIS, the TWIS is offered with both infrared and visual light options.

## Pantograph Monitoring

The OWIS is a useful system to monitor pantograph interaction with the overhead wire and identify locations of unexpected and undesired conditions. When combined with the Overhead Wire Measurement System (OWMS), the transit is able to pinpoint areas of pantograph distress.

## System Integration

The OWIS is synchronized with all other inspection systems including the Overhead Wire Measurement System (OWMS) to provide images that are correlated with height, stagger, or wire wear defective conditions.

Additionally, the OWIS is synchronized with the Thermal Imaging System (THIS) to identify hot spots in the overhead wire (catenary) to help prevent undesired service interruptions from faulty power infrastructure components.



# Third Rail Imaging System (TRIS)

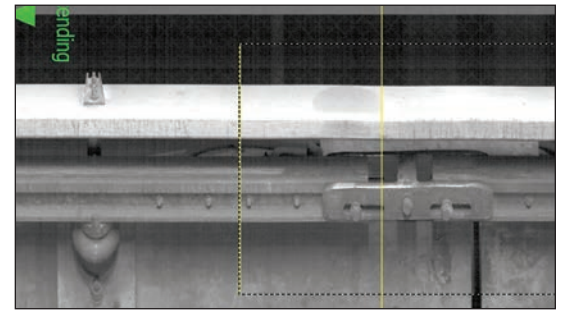


ENSCO's Third Rail Imaging System (TRIS) is the premier method to capture high resolution imagery of the third rail and associated components. The TRIS features high frequency cameras to produce detailed images where ENSCO's industry leading machine vision algorithms can automatically identify components and defective conditions.

## Third Rail Inspection

The third rail and its associated components can be automatically inspected by ENSCO TRIS to look for conditions such as sagging or missing coverboards, battered end ramps, missing or broken fasteners, damaged or shorting isolators, and third rail surface condition.

ENSCO has the unique capability of processing the TRIS imagery into strip chart measurement data. Additionally, the TRIS is synchronized with all other inspection systems. This provides a unique and valuable ability to see Third Rail Measurement System data (position of the third rail relative to the running rail) alongside imagery and strip chart data processed from the images.



## System Integration

A unique capability of the TRIS is to be synchronized with the Thermal Imaging System (THIS) to identify the location of third rail hot spots and have a corresponding image of the location.

# Thermal Imaging System (THIS)



Power infrastructure components that are operating too hot have the risk of interrupting train operations or even have fire risk. Additionally, water leaking in tunnels can cause continued deterioration of the concrete walls. The Thermal Imaging System (THIS) measures the temperature of all power infrastructure, right-of-way, and track components to identify both hot and cold locations.

## Rail Base Corrosion

ENSCO's Thermal Imaging System detects cold spots caused by leaking or pooling water in tunnels. The system's detection is synchronized with our Joint Bar Imaging System to aid in identifying rail base corrosion which, if undetected, can lead to broken rails.

## Tunnel Wall Water Leakage

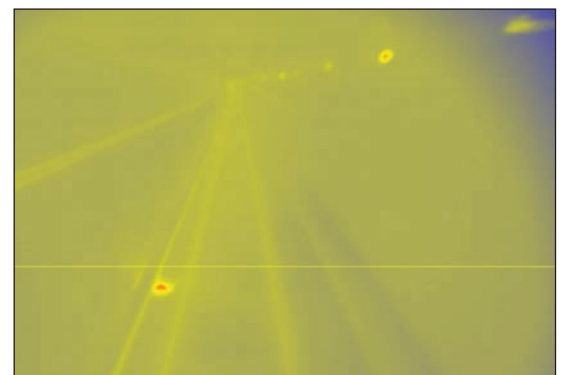
ENSCO's Thermal Imaging System detects cold spots associated to leaking or pooling water. The THIS has the unique ability to be synchronized with other inspection systems such as machine vision to see deteriorating infrastructure conditions.

## Hot Third Rail and Hot Overhead Wire

Both third rail and overhead wire systems can suffer from hot spots that can have potential fire hazard or component failure. ENSCO's Thermal Imaging System captures thermal images and processed with specialty algorithms to accurately identify hot spots.

## Strip Chart Measurements

The ENSCO THIS has patented algorithms to process the thermal imaging data into strip charts. This allow for easy identification of hot and cold locations, correlate with other measurement and imaging systems, and overlay multiple surveys to identify changing thermal conditions.



Example hot third rail detected by ENSCO's Thermal Imaging System (THIS)



# Track Data Management

ENSCO's Data Management Suite provides a fully integrated offering of our data management and analysis software packages. It uses common architecture, data structures, and asset databases to enable cross-communication of the systems to achieve advanced capabilities. The web-based applications, i.e., DTN®, Track/IT®, and AMA, are seamlessly integrated into one user interface.

## Digital Track Notebook® (DTN)



Streamlined track inspections with web-based, paperless record management

## GeoEdit 8



In-depth graphical analysis and reporting of track measurement data

## Virtual Track Walk® (VTW)



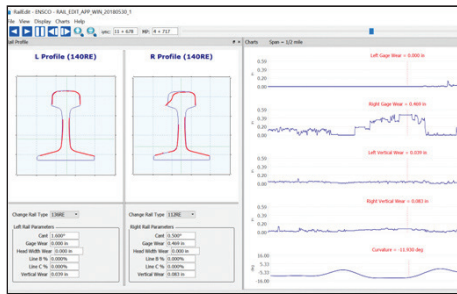
Software enables high-resolution, synchronized track images to be inspected in the office

## Track/IT®



Web-based, track asset and automated inspection data management repository

## RailEdit



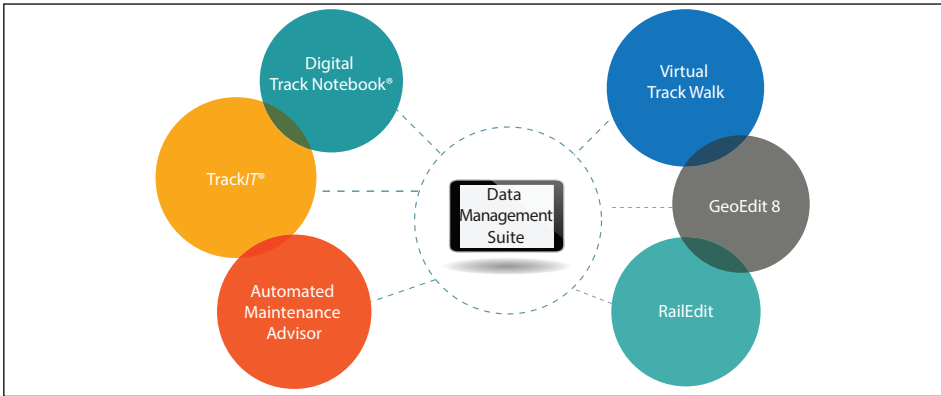
Reprocess rail profile data and identify rail size for inventory generation

## Automated Maintenance Advisor (AMA)



Trend deteriorating conditions and automated identification of prescriptive maintenance tasks

# Track Data Management Suite



ENSCO's Data Management Suite provides a fully integrated offering of our data management and analysis software packages. The suite is comprised of the Digital Track Notebook® (DTN), TrackIT®, Automated Maintenance Advisor (AMA), Virtual Track Walk® (VTW), GeoEdit 8, and VAMPIRE®. ENSCO's Data Management Suite uses common architecture, data structures, and asset databases to enable cross-communication of the systems to achieve advanced capabilities. The web-based applications, i.e., DTN, TrackIT, and AMA, are seamlessly integrated into one user interface. Customers can use ENSCO's software packages individually, or combinations of applications in the Data Management Suite.

## Digital Track Notebook® (DTN)

DTN is a web-based application used by track inspectors to record regulatory and special track inspections.

### Key Suite Features

- DTN defects and measurements identified by a track inspector can be used in AMA deterioration trending and maintenance planning.
- AMA recommended inspection sites can be provided to track inspectors through the DTN to investigate exceptions or deteriorating conditions, and record remedial actions.
- Allows entry of new or updated asset information, including GPS tagging of assets.

## TrackIT®

TrackIT serves as the data repository of the suite accepting automated measurement and asset data. It includes a table query, map and track chart functionality.

### Key Suite Features

- DTN defects and measurements identified by a track inspector can be viewed in TrackIT's map and track chart features.
- Continuous track geometry data can be queried and exported from TrackIT and viewed GeoEdit 8.

## Automated Maintenance Advisor (AMA)

The AMA accepts data from the other systems to create condition-based deterioration trends and recommend maintenance tasks.

### Key Suite Features

- Displays deterioration and maintenance information in TrackIT's map and track chart.
- Accepts measurement and exception data from DTN, TrackIT, & VTW

## Virtual Track Walk® (VTW)

VTW is a workstation-based Windows® software package used to conduct a comprehensive review of imagery from all of ENSCO's machine vision systems, such as the Driver View Imagery System (DVIS) and Track Component Imagery System (TCIS). Within VTW, the user can identify defects and assets.

### Key Suite Features

- Within VTW, the user can automatically push exception data from VTW to TrackIT at the end of the survey review through an Internet connection.
- VTW exceptions can be queried and viewed as cropped images within TrackIT.

## GeoEdit 8 & GeoEdit 8 PLUS

Geoedit 8 is a laptop-based Windows application used to conduct comprehensive review of measurement system data including track geometry and rail profile data. GeoEdit 8 PLUS has enhanced super-user features.

### Key Suite Features

- GeoEdit 8 PLUS can be used to review track geometry exceptions to remove false-positives before importing to TrackIT or AMA.
- GeoEdit 8 PLUS has synchronized viewing with VTW.

## RailEdit

RailEdit is a laptop-based Windows application used for reprocessing of wear data.

### Key Suite Features

- RailEdit can be used to cleanse rail wear data for template errors or data spikes before importing into TrackIT or AMA

# Digital Track Notebook® (DTN) 3.0



ENSCO Rail applied its depth of knowledge of the railroad industry’s regulatory and operational practices to create the Digital Track Notebook® (DTN) 3.0 for mobile track inspection management. The DTN is web-based and complies with the FRA electronic record keeping requirements. Once logged in, users can perform track inspections, locate and record defects, manage inspection schedules, update remedial actions, synchronize all field information from a centralized data management system, and generate reports.

## Web-based Reporting

The DTN’s unique, web-based platform makes it faster and easier to generate critical regulatory and performance reports using a standard Internet browser.

DTN does not require specialized computer hardware platforms. It provides transparent access to a variety of tools and reports with role-based functionality that can be tailored to meet the needs of many users—from track inspection managers to upper level executives. DTN can be used to record track inspections, generate daily inspection reports, or close the loop on track defects. The flexible design can be customized to meet the specific reporting needs of your railroad.

## Paperless Inspection Record Management

The DTN gives wide access to critical data without paper. For example, inspectors can record all aspects of an inspection in a paperless environment using DTN tools

- Denote the properties of the inspection
- Include remarks about inspection, such as weather conditions
- Add a defect to the inspection record
- Upload inspection records to a centralized database
- Automate the distribution of defect records to maintenance personnel

## Compliance With Automated Inspection Scheduling

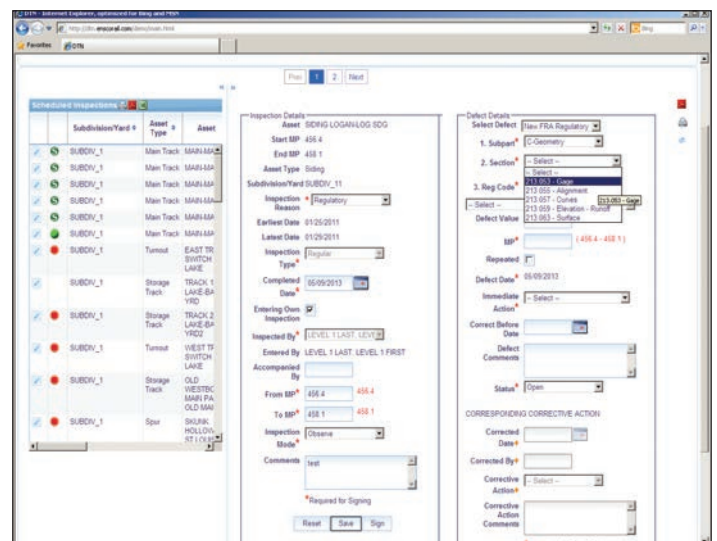
With the DTN, users can automate their approach to meeting regulatory inspection benchmarks. For example, the DTN automates the calculation of the earliest and latest dates that inspections must be performed based on the 49 CFR213 FRA Track Safety Standard. DTN’s color-coded Inspection Priority Indicator makes it easy to prioritize inspections by level of importance.

## Streamlined Maintenance Management

DTN simplifies managing defect status and maintenance records, and provides an organized communication path between track inspectors and maintenance crews. A DTN user can login to a central database to receive inspection and defect reports, or send maintenance reports back to the database. In addition, maintenance and defect repair status can be easily noted.

## Paperless Record Management

DTN tracks defects electronically, and the data can be reviewed in TrackIT®, an ENSCO web-based track infrastructure, maintenance and exception data viewer. TrackIT brings multiple data sources to a central location where the total track health can be comprehensively assessed. ENSCO is a comprehensive service provider offering a full range of solutions for the rail industry.





# Track/IT®



Track/IT® is a comprehensive, enterprise web-based system for track asset management. Produced by ENSCO Rail, it includes a suite of viewing and analytical tools for easy review and analysis of track infrastructure, maintenance and inspection data. Track/IT provides a means to assemble information from a variety of data sources and format it into a central management system that simplifies the storage, analysis and dissemination of critical information.

## Maximum Flexibility

Track/IT is offered in two ways to meet the information technology needs of customers

- A hosted web service
- A site license installed on a corporate network

The technology is compatible with a variety of data communication protocols to facilitate automated data loading and integration with existing information management systems.

End users access the website through a secure login to a variety of viewing and analytical tools that provide information in a selection of graphic formats, including map, tabular and track chart.

Track/IT also provides a means to download data to standard Microsoft Excel® file format, providing users the flexibility to perform custom data analysis.

## Track Chart Management

Track/IT is a flexible tool that can be used for track chart management. It is capable of immediately generating production quality track charts for a subdivision or an entire railroad. The application allows users to customize the track chart content and export it to a PDF track chart book. Track charts are generated at the time of request to ensure up to date content.

## Derailment Investigations

In the event of a derailment, Track/IT users can generate a report of track data for the derailment site in mere moments. Data available for exporting include track charts, track geometry and rail wear test results, video images, ultrasonic rail flaw data, and more.

## Maintenance Planning

Track/IT offers consolidated track chart views that combine displays of track maintenance and inspection results over time, allowing planning departments to assess both the degradation of track and the effectiveness of program maintenance. This

information is valuable to the maintenance planning process. Track/IT can also be used to download the latest track charts, inspection results, strip charts, and GPS waypoint files prior to a trip to the field for verification on the ground.

## Ease of Use

Track/IT is an intuitive, web-based tool that makes it easy for information to be transmitted to authorized users while maintaining secure data storage. It is a flexible tool that can be scaled to meet the needs of an organization. A variety of data loading engines are in place to facilitate the centralization of common industry data types from a variety of suppliers. Reports and graphical outputs are configurable. End user training can be accomplished in less than two hours.

Simplifies enterprise-wide storage, analysis and dissemination of track infrastructure, maintenance and inspection data

## Key Features

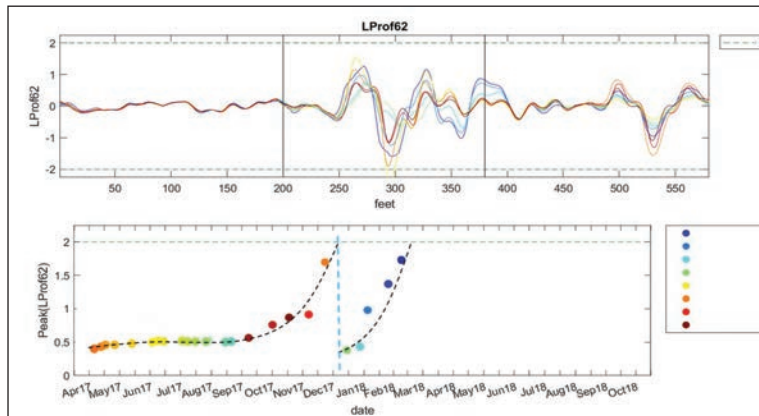
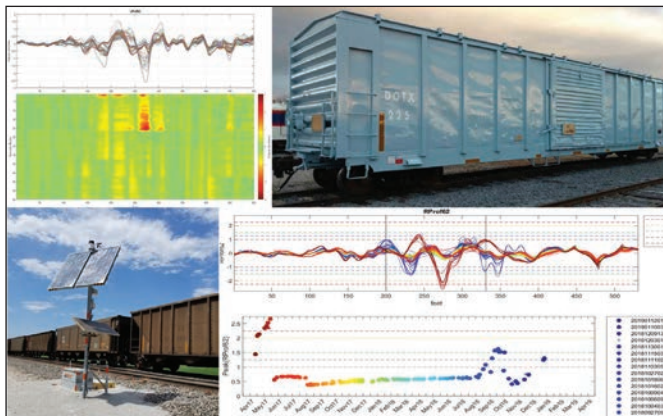
Use Track/IT for data management

- Track geometry measurements
- Rail wear
- Rail corrugation
- Overhead wire anomalies
- Third rail derivation
- Autonomous V/TI and track geometry
- Track charts
- Right of way video recording
- Track bed video recording
- Ultrasonic rail inspection

## ENSCO's Suite of Products

Track/IT complements the use of other ENSCO products including the V/TI Monitor, the Autonomous Track Geometry Measurement System, and the Digital Track Notebook®. Each of these products is designed to interface directly with Track/IT to enhance the reporting capabilities for the end user.

# Automated Maintenance Advisor (AMA)



The ENSCO Automated Maintenance Advisor (AMA) is key to transforming track measurement data into actionable maintenance tasks. Using ENSCO's key knowledge of track condition monitoring and deterioration, the AMA was built to trend deteriorating conditions and recommend remedial maintenance tasks to proactively and scientifically conduct track maintenance.

## Automated and Integrated

The AMA is a web-based application that is fully integrated with ENSCO's Digital Track Notebook® (DTN) and TrackIT® web products. It accepts measurement data from all ENSCO manned and autonomous track measurement systems and can be configured to accept data that is not generated by ENSCO. The AMA recommends maintenance tasks based on the measured track condition. The AMA can also be integrated with Enterprise Resource Planning (ERP) systems, such as SAP or Maximo to execute those maintenance tasks as work orders. The AMA is intended to operate automatically, routinely assessing condition data, and recommending maintenance tasks when applicable.

## Deterioration Trending

The AMA is designed to be fully flexible and configurable by the end user to define deterioration trending settings. The AMA can handle both linear and point assets. For linear assets, the AMA performs dynamic segmentation based on asset characteristics. The user can create user-defined trending parameters, such as custom Track Quality Indices (TQI) or Track Condition Indices (TCI). The AMA can also be integrated with VAMPIRE® to create vehicle/track interaction data to be used in the track deterioration trending.

## Maintenance Identification

Users can define custom rules logic to determine when and where maintenance tasks need to be completed. Alternately, users can use ENSCO's recommended settings defined by our track experts. The AMA can also recommend both repair maintenance, such as tamping, and replacement maintenance, such as undercutting. Rules logic can include cumulative tonnage and component information, such as manufacturer or component type. The final output recommends maintenance tasks with earliest and latest dates, and start and stop mileposts (kilometer posts). If the AMA is integrated with an ERP, the AMA includes a human approval process of maintenance tasks before they are sent to the ERP.

## Data Viewing

The AMA can be configured to operate automatically on the server. The resulting data is viewed in ENSCO's web-based TrackIT map and track chart. Additionally, the user can select specific segments, or point assets to see trend lines over time.

Examples of AMA recommended maintenance tasks

- Rail grinding
- Rail replacement
- Tie replacement
- Tie pad replacement
- Tamping
- Ballast renewal (undercutting)
- Turnout maintenance
- Diamond maintenance

## Benefits

- Increase maintenance efficiency
- Decreases maintenance work not needed
- Condition-based maintenance
- Uses actual measured data to recommend maintenance
- Reduces manual data analysis

## Key Features

- Both Web-based and workstation-based
- Fully automated operation
- Separate "sand-box" instance used for settings optimization
- Recommends maintenance tasks with earliest/latest dates and start/stop mileposts (kilometer posts)
- User customized settings and rules logic
- Flexible to various asset and measurement types
- Integrates with all strip chart and exception data produced by measurement and imaging systems, including automated VAMPIRE.
- Optional application hosting by ENSCO as a service

# GeoEdit 8 and GeoEdit 8 PLUS

Manage your track measurement data effectively



GeoEdit 8 is a Track Measurement Data Management program in a Windows® environment. It can be used to view data, generate reports, assist in maintenance management planning, and exporting data for a range of efforts. It provides quick access to exception, curve and graphical data in a concise and user-friendly format.

## Benefits

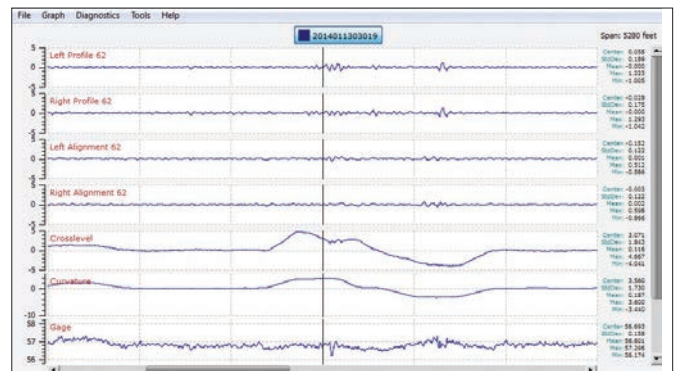
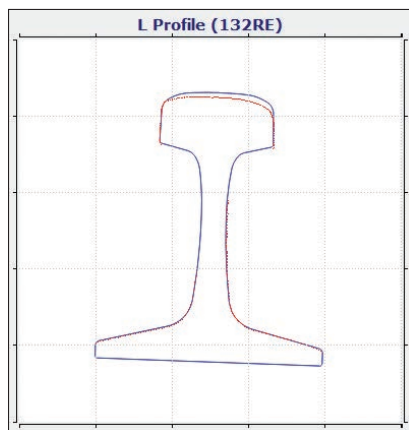
- Supports track geometry, rail profile, ride quality, DGRMS, third rail, and corrugation
- Overlay multiple track measurement survey files
- Plot the difference between channels from different files
- Generate and print reports and plots
- Reverse the direction of the data to accommodate comparison of separate surveys
- Prepare continuous track geometry and rail profile data for vehicle/track interaction modeling
- Export data to various formats, including CSV, VAMPIRE®, and MiniProf
- Better insight and understanding of your data
- Accurate annotation
- Cost efficiency of a paperless environment

## Users

- Track supervisors
- Division engineers
- Track engineers
- Maintenance managers
- Track analysts
- Vehicle dynamicists

## Requirements

Microsoft Windows® 7, 8, or 10; 8 GB RAM, 60 MB hard drive space



## Features

### Exception List

- Scrollable listings of recorded events and calculated exceptions
- Click on defect list to display on strip chart

### Strip Chart Viewing

- Customizable display of multiple track measurement channels
- Click to view rail profile at associated track geometry location
- Synchronized with exceptions and curve lists
- Strip chart measuring tool

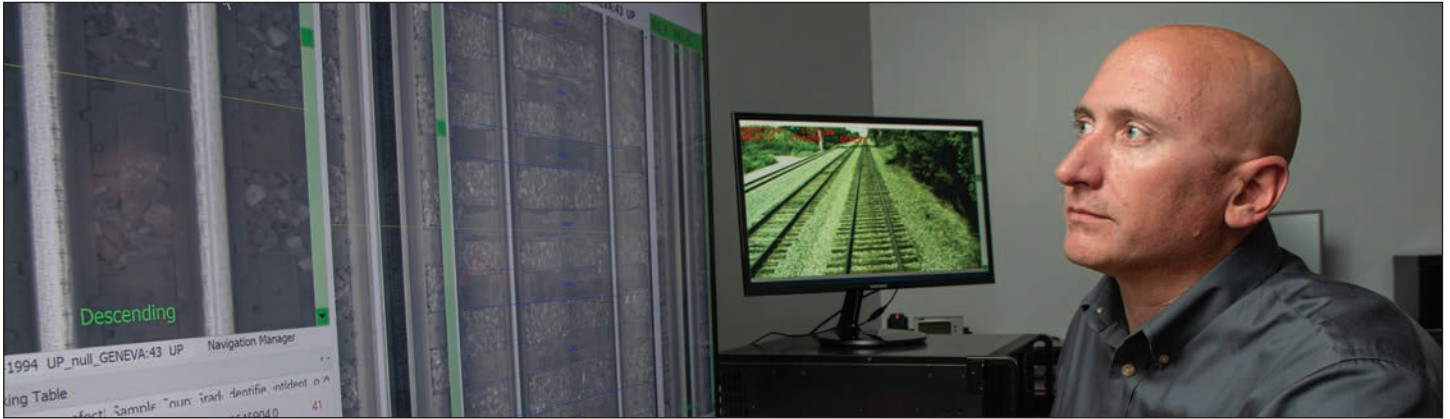
### Rail Profile Viewing

- Display of absolute and relative parameters including cant and wear parameters
- Pan and zoom utilities on rail profile plots
- Slider bar and play button to rapidly view rail profiles throughout survey

### Exports

- PDF reports for exceptions, curve analysis, strip charts, and rail profiles.
- Export continuous track geometry to CSV and VAMPIRE® formats over selectable ranges
- Export rail profiles to MiniProf format

# Virtual Track Walk® (VTW)



ENSCO's Virtual Track Walk® (VTW) software enables high-resolution track images to be inspected in the office. A key feature is the ability to view synchronized images from multiple inspection cameras along with milepost and GPS. When using VTW to inspect track, built-in tools allow the user to mark defects and identify track assets—the software then automatically tags these with milepost numbers and GPS coordinates. Identified defects and assets can be exported to CSV reports.

## Automated and Manual Exception Review

VTW is the key software package for reviewing exceptions identified by automated algorithms. Additionally, VTW can be used to manually identify exceptions as is done in a walking track inspection.

## Optimized Concrete Tie Grading

A key feature of VTW is using it for concrete tie grading. It can be used to confirm automated tie grading algorithms or to conduct manual tie grading. The user can see multiple views of the ties, including zoomed-in views of hairline cracks. The user can manually scroll through ties, or have VTW systematically show each tie or zoomed-in areas of ties. Additionally, the user can see and identify assets, such as mileposts and markings, on the rail web to ensure locational accuracy. Tie grading reports can be exported from VTW. These features allow for rapid and accurate tie grading.

## Asset Location Verification

VTW can also be used for verification of asset locations, such

as signs, signal masts, insulated joints, road crossings, switches, and diamonds. The user can click on any of the multiple views to identify an asset and VTW will automatically determine the milepost and GPS coordinates of the asset. The user can define the type of asset and the name in the details on the asset. Identified assets can be exported to CSV format with milepost, GPS and asset details.

## Supported ENSCO Imagery Systems

- Driver View Imaging System (DVIS)
- Track Component Imaging System (TCIS)
- Joint Bar Inspection System (JBIS)
- Rail Surface Imaging System (RSIS)
- Overhead Wired Imaging System (OWIS)
- Third Rail Imaging System (TRIS)
- Thermal Imaging System (THIS)
- Track View Imaging System (TVIS)
- Tunnel Wall Imaging System (TWIS)
- Rail Component Imaging System (RCIS)

## Key Features

- Simultaneous viewing of images from multiple cameras
- Supports multiple computer monitors
- User customizable viewing and settings
- Move and adjust windows as needed
- All images are synchronized together with milepost (kilometer post or chainage) and GPS coordinates.
- Scroll, zoom and video play features
- User can mark defects
- User can identify assets
- Tie grading
- VTW automatically calculates location and GPS for defect and asset locations.
- Defects and asset data can be exported to CSV format
- Synchronized measurement data viewing with GeoEdit 8 PLUS
- Compare exceptions and assets from previous surveys



5400 Port Royal Rd  
Springfield, VA 22151

1-800-ENSCO-VA (1-800-367-2682) • [rail@ensco.com](mailto:rail@ensco.com)

Visit us at

[ensco.com/rail](http://ensco.com/rail)