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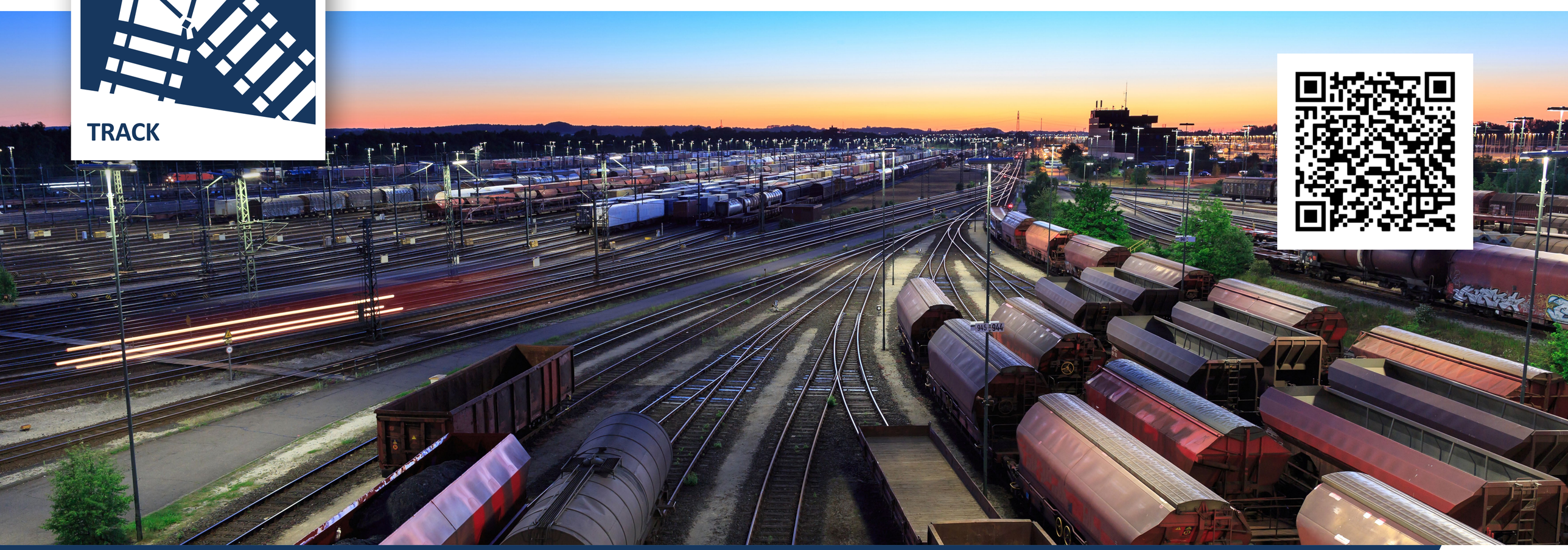


**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $450,000

# Automated Track Change Detection

## PROJECT DESCRIPTION

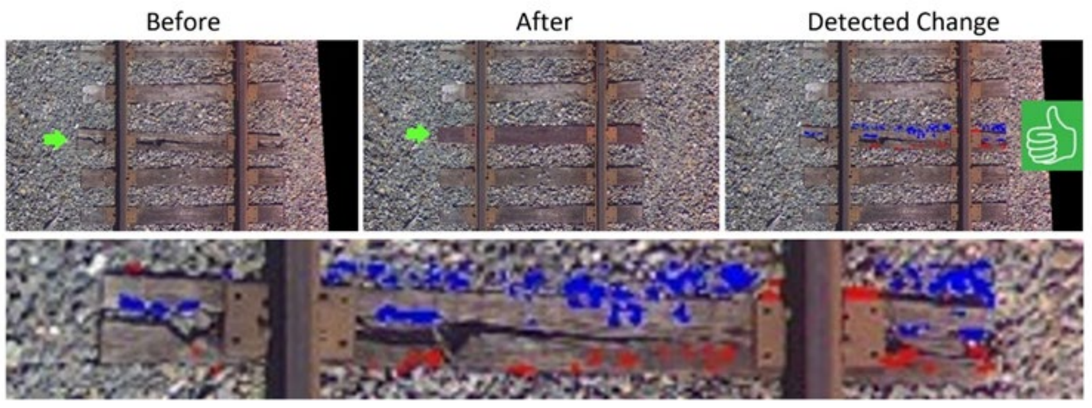
- Develop new technology to automatically detect and report safety-related changes in the track system.
- Leverage advances in laser/camera measurement systems, unmanned aircraft systems (UAS), and artificial intelligence algorithms to develop systems for feasibility testing.
- Develop the technological framework needed to advance change detection technology for track safety assurance applications.

## RAILROAD IMPACT

- Technology identifies safety-related track changes not normally measured by metrology vehicles.
- Automatic data processing delivers important data directly to end users.
- Efficient, generalized algorithms that will detect change in a broad range of track features.

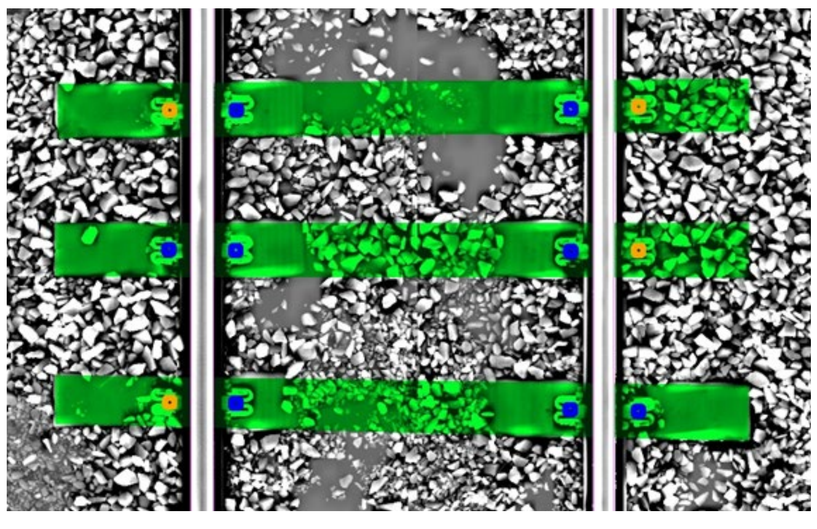
## PROJECT PARTNERS

- Amtrak
- ENSCO, Inc.
- Pavemetrics Systems, Inc.
- Noble Drone Services, LLC
- University of Illinois at Urbana-Champaign (UIUC)
- Transportation Technology Center, Inc. (TTCI)




## PROJECT STATUS

- DOTX-220: Track Component Imaging System
  - Line-scan cameras
- Hi-Rail: Pavemetrics/UIUC/Amtrak/TTCI
  - 3D laser scanning
- UAS: Noble Drone's Small Business Innovative Research (SBIR) Project
  - Consumer-grade, multi-rotor UAS with optical camera



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**FRA PROJECT MANAGERS:**

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Jay Baillargeon (719) 584-7155 jay.baillargeon@dot.gov

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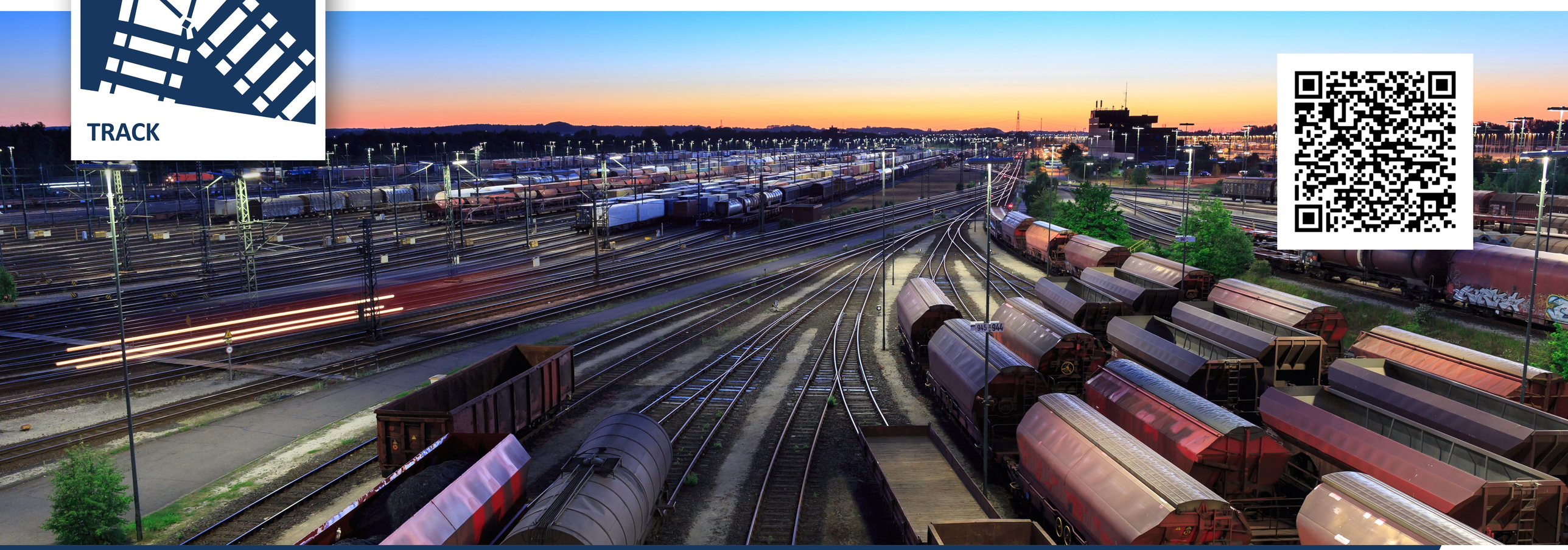


**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $355,388

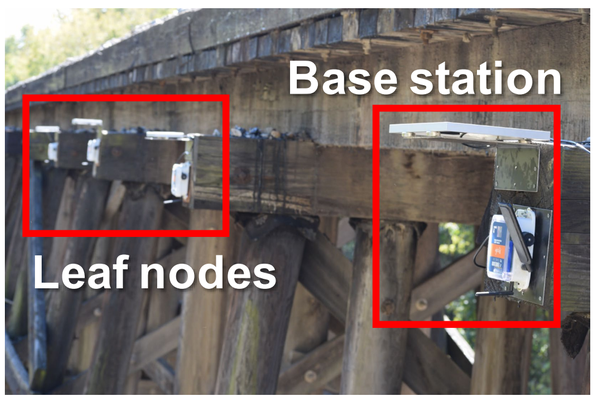
# Condition Assessment of Railroad Bridges Using Wireless Smart Sensors

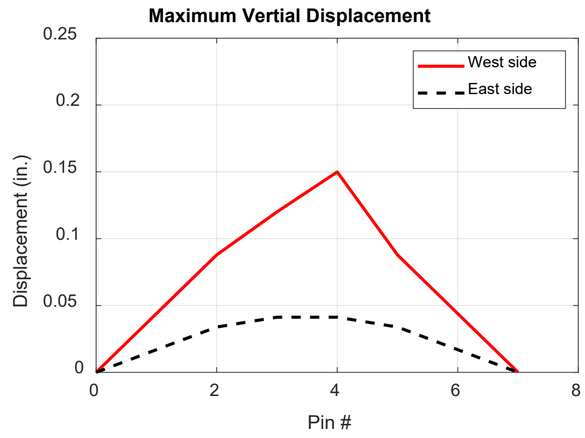
## PROJECT DESCRIPTION

- Develop a wireless smart sensor (WSS) system to automatically assess railroad bridge performance in near real-time under train loads.
- Implement a novel algorithm for on-line, reference-free dynamic displacement estimation.
- Leverage advances in embedded systems technologies to enable rapid anomaly detection and exception reporting to the engineers and decision makers

## PROJECT PARTNERS

- University of Illinois at Urbana-Champaign
- Embedor Technologies
- Canadian National Railway
- Genesee & Wyoming, Inc.



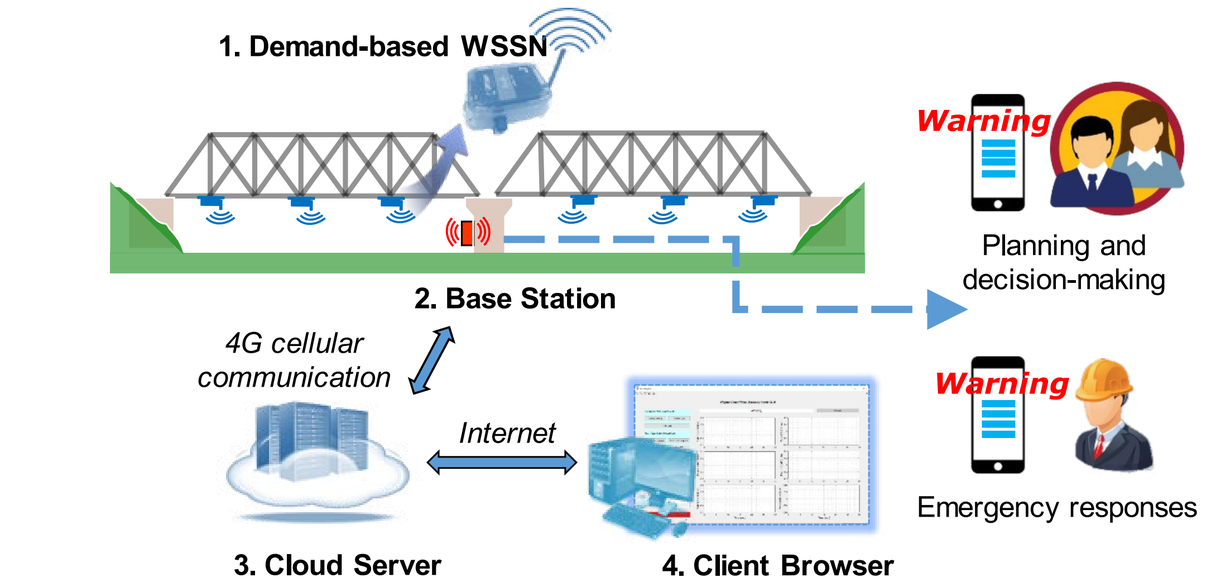



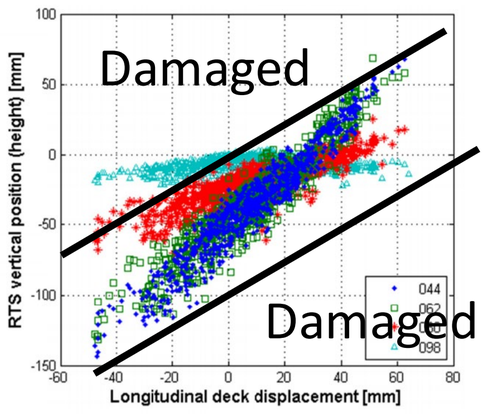

## RAILROAD IMPACT

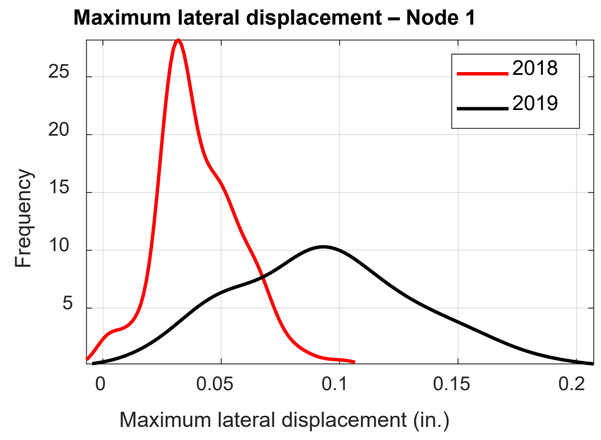
- A reliable, low-cost, WSS-based solution for campaign-type railroad bridge monitoring
- Scalable autonomous monitoring system capable of rapid condition assessment and notification
- Data-based bridge performance guideline from the monitoring campaigns to assist future bridge inspection and performance assessment efforts

## PROJECT STATUS

- Completed WSS hardware and software in 2018.
- In 2019, instrumented and studied:
  - Short-term structural behavior change process on 2 steel and 10 timber railroad bridges
  - Long-term structural behavior change process on 6 timber railroad bridges
- Additional system development and demonstration planned for 2020

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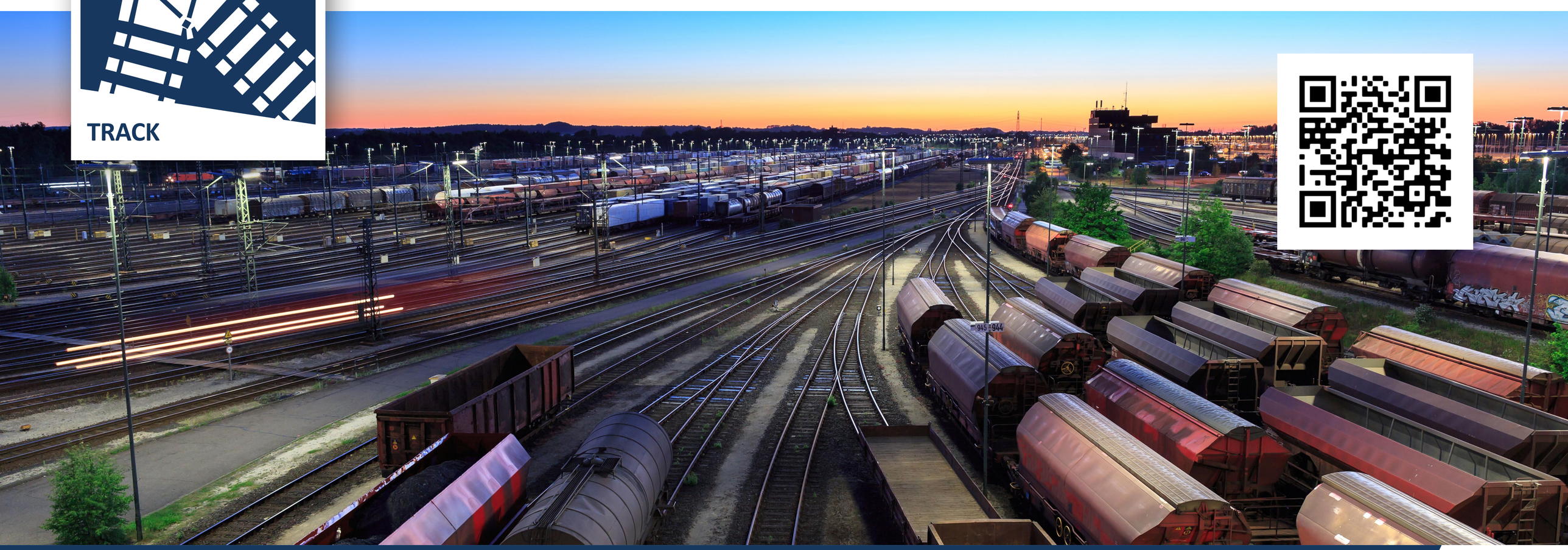


**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $1.09M

# New Industry Standards for Improved Concrete Ties

## PROJECT DESCRIPTION

- Development of new industry recommended practices and standards result from FRA-sponsored concrete tie research:
- AREMA Chapter 30:
  - New testing procedures to ensure effective resistance to end splits (i.e., bursting)
- ASTM A1096/A1096M:
  - New standard defining an experimental procedure to evaluate the bond performance between reinforcements and concrete
- ASTM:
  - New ASTM Standard for Measurement of Key Indented Reinforcement Characteristics

## RAILROAD IMPACT

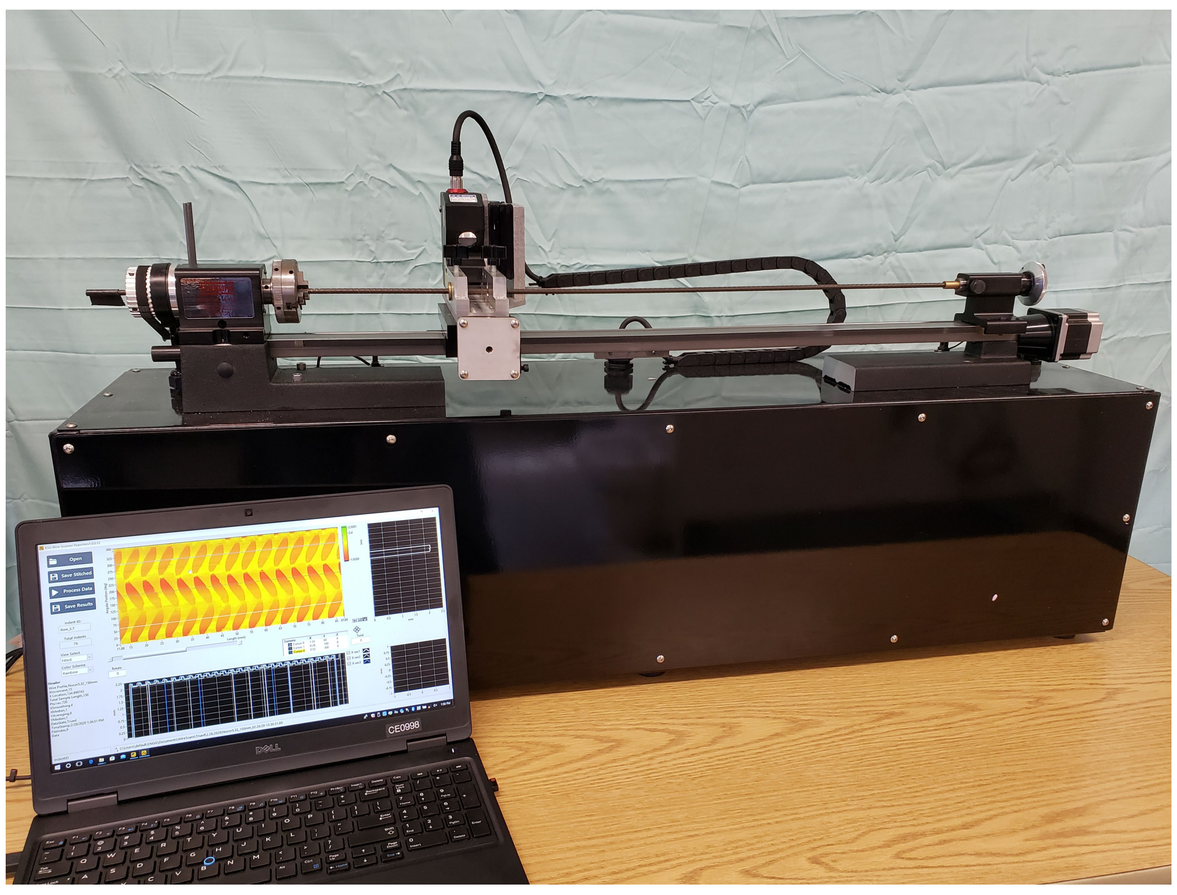
- Better-performing and longer-lasting concrete ties for freight and passenger rail service

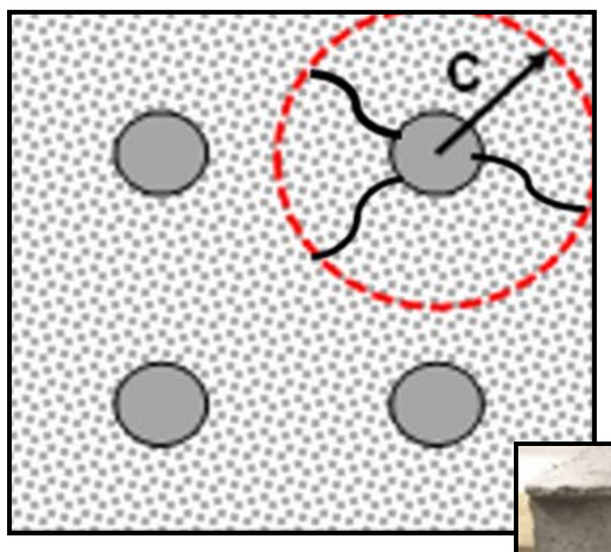
## PROJECT PARTNER

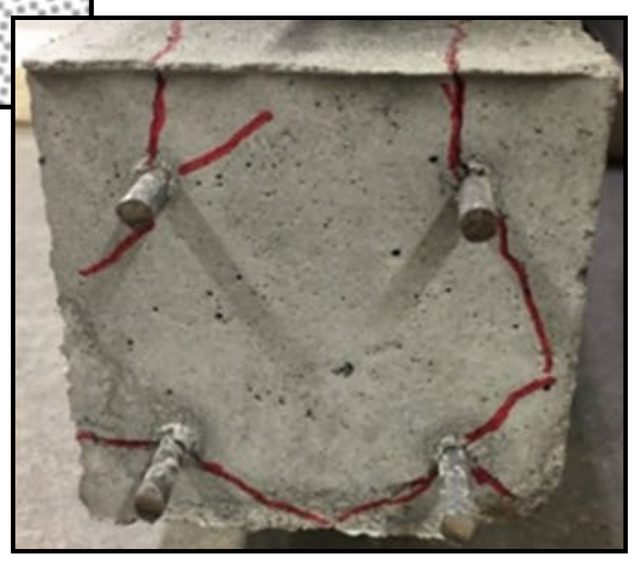
- Kansas State University

## PROJECT STATUS

- AREMA Committee 30 voting is ongoing.
- ASTM A1096/A1096M standard published in 2015.
- New ASTM standard is in development.





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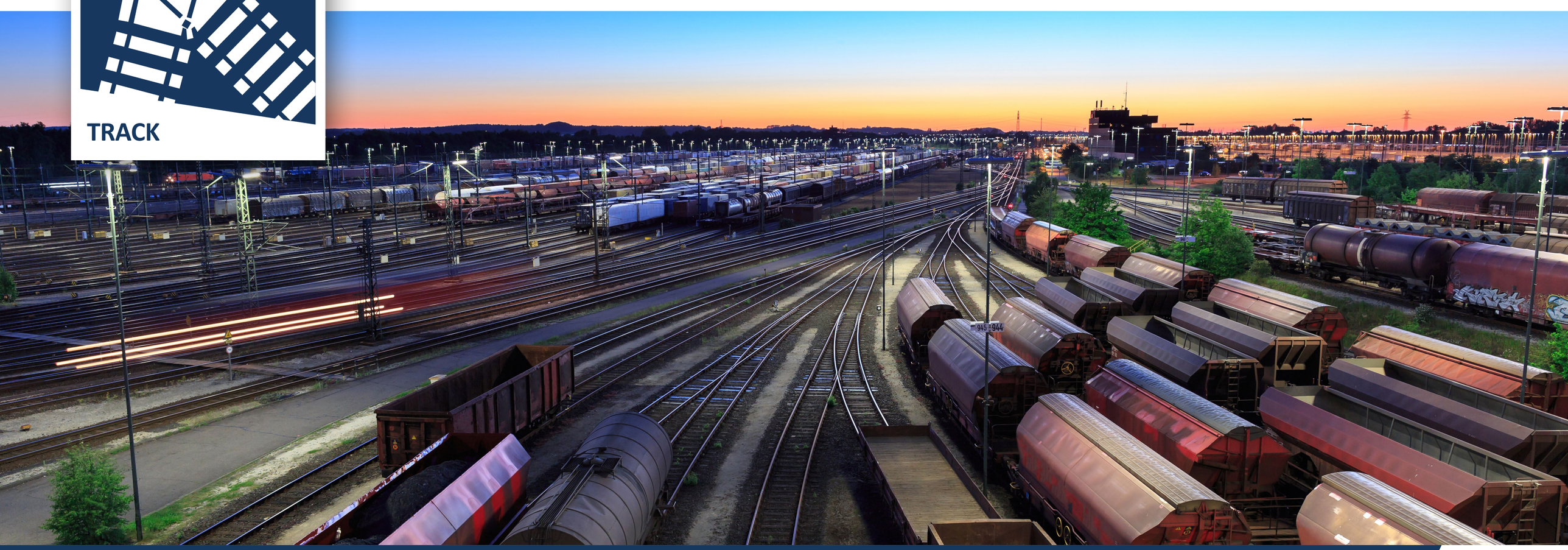


**FOCUS:** DEVELOPMENT | **FRA FUNDING:** $424,000

# High-Speed Rail Inspection by Passive Acoustic Monitoring

## PROJECT DESCRIPTION

- Non-contact acoustic sensors and signal processing algorithms detect internal defects in rails by exploiting the acoustic excitations naturally induced in the rail by the wheels of a moving train.
- Conduct field tests at FRA's Transportation Technology Center (TTC) in December 2019 to assess the feasibility of rail inspection at speeds as high as 80 mph.

## RAILROAD IMPACT

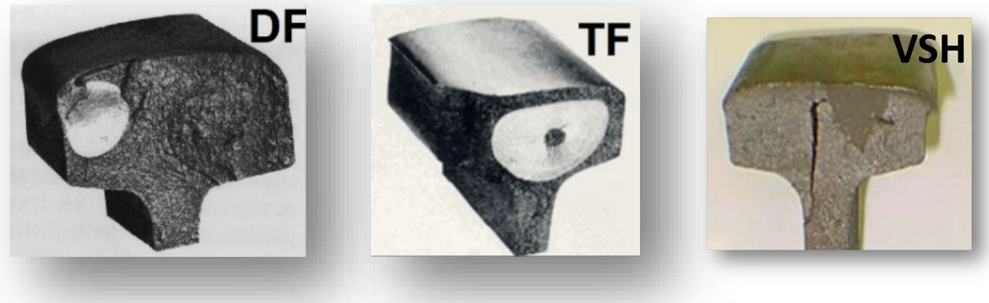
- This passive rail inspection technology would enable higher testing speeds, well beyond the 25 mph maximum speed currently allowed by conventional (e.g., roller search unit-based) rail inspection cars.
- This technology could be installed on regular trains to enable multiple redundant inspections of the same track, thereby improving inspection reliability and, ultimately, overall safety.

## PROJECT PARTNERS

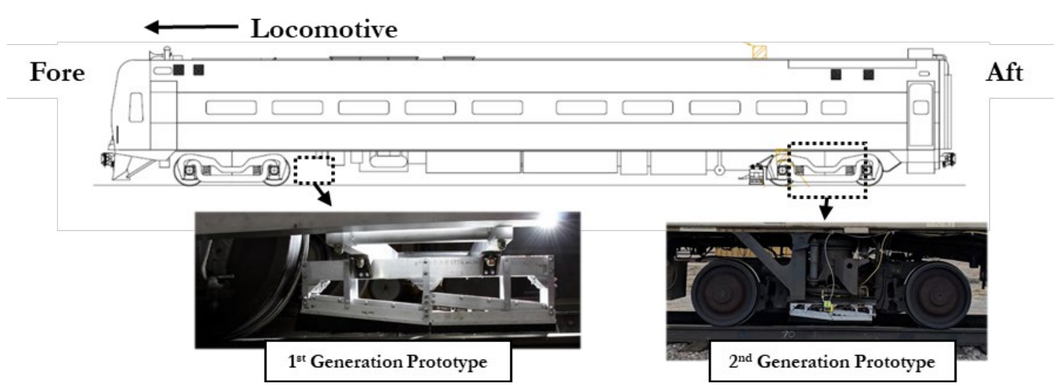
- University of California, San Diego
- Transportation Technology Center, Inc.

## PROJECT STATUS

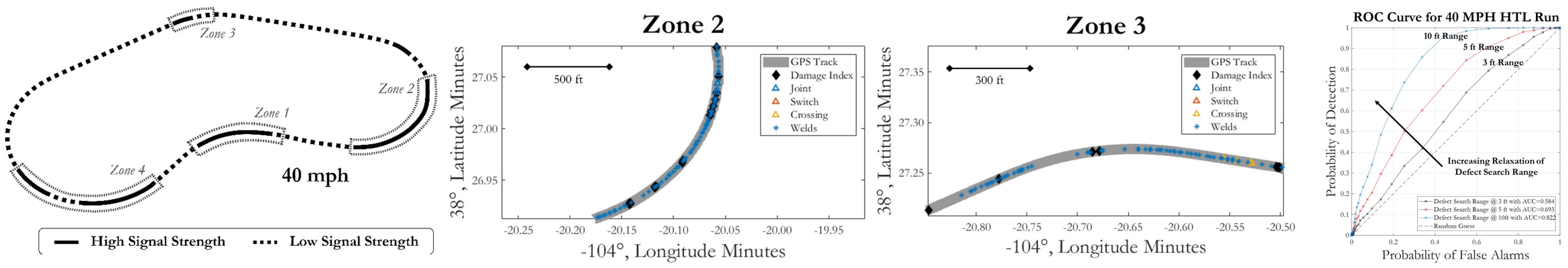
- Data from TTC field tests of second-generation prototype are currently being analyzed.
- Rail inspection feasibility at speeds up to 80 mph is being assessed.




*Examples of Rail Flaws Relevant to Safety (Left to Right: Detail Fracture, Transverse Fissure, and Vertical Split Head)*




*1st Generation Prototype for 2016 Field Test (Left) and 2nd Generation Prototype for 2018 Field Test (Right)*




*Sample of 2018 Field Test Results at 40 mph High Tonnage Loop Test (Left to Right: Acoustic Signal Strength, Zone 2 and 3 Results, Receiver Operating Characteristic Curves)*

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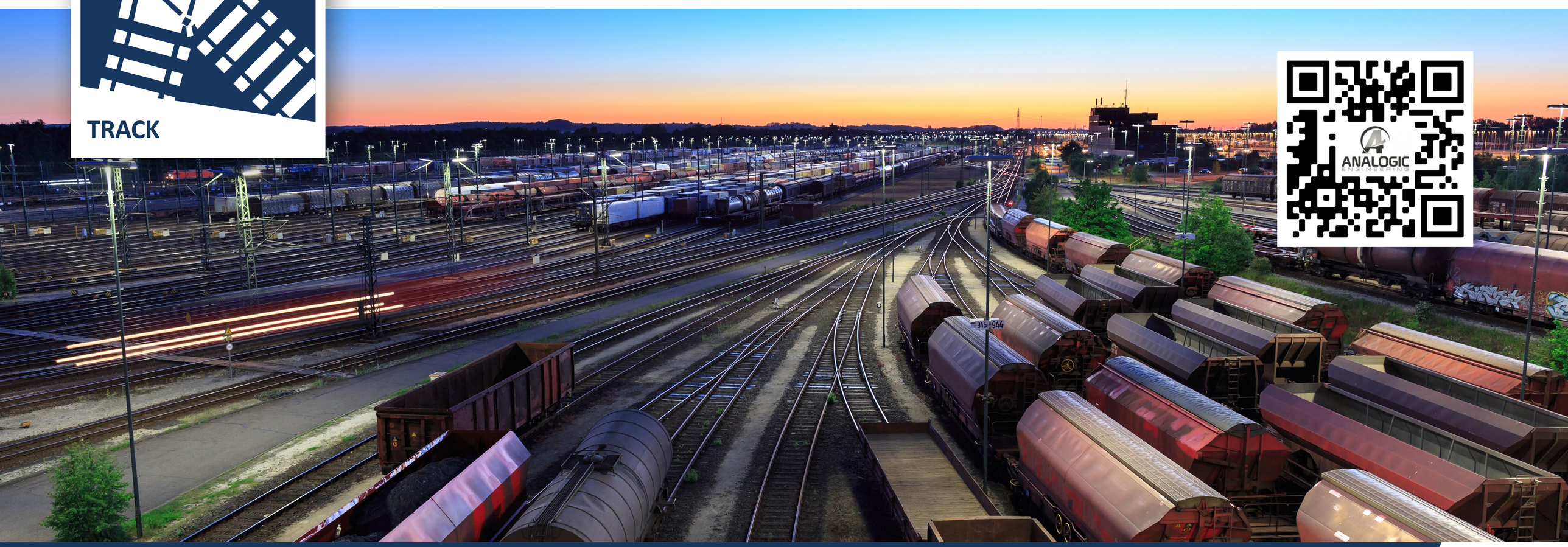


**FOCUS:** DEVELOPMENT | **FRA FUNDING:** $121,608

# Enhanced Acoustic Birefringence Method for Measuring Longitudinal Rail Stress

## PROJECT DESCRIPTION

- Develop portable device for determining rail neutral temperature (RNT) by measuring rail stress using acoustic birefringence (AB). This builds on earlier FRA-funded research that demonstrated a linear relationship between AB and longitudinal rail stress based on a proprietary transducer that can perform accurate, repeatable AB measurements on the complex rail shape. Lab results were consistent with the research goal of RNT error less than 5°F.
- Initial project goal is to verify performance on in-situ rail under field conditions.
- Prototype equipment will then be developed for extended field testing and validation.
- Phase II includes testing additional rail samples to determine if families of calibration constants can be applied to related rail types (e.g., by profile, year, and/or batch) to allow RNT measurements on any rail without needing a prior stress-free reference measurement.

## RAILROAD IMPACT

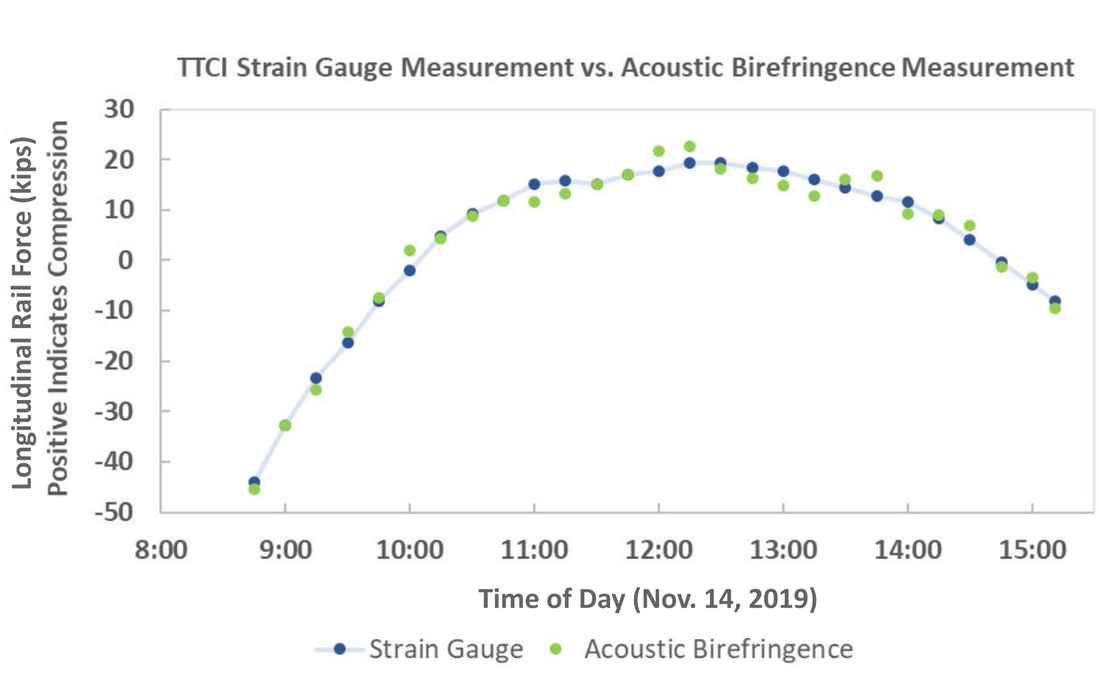
- A portable, non-destructive RNT measurement device would enable better management of RNT – leading to fewer heat buckles and pull-aparts.
- Reducing these rail failures would improve crew and passenger safety and reduce costs due to emergency track repairs, equipment and vehicle damage, environmental remediation, and disruption of revenue traffic.

## PROJECT PARTNERS

- Analogic Engineering, Inc.
- Robert Erikson, Ph.D. (Engineering Consultant)
- Transportation Technology Center, Inc.

## PROJECT STATUS

- Testing at FRA's Transportation Technology Center has verified the linear relationship between AB and rail stress for in-situ rail. After calibration, the rail stress measured using AB tracked with strain gauge data throughout the day within an average error of 1.9 kips, equivalent to an RNT error of 0.7°F.

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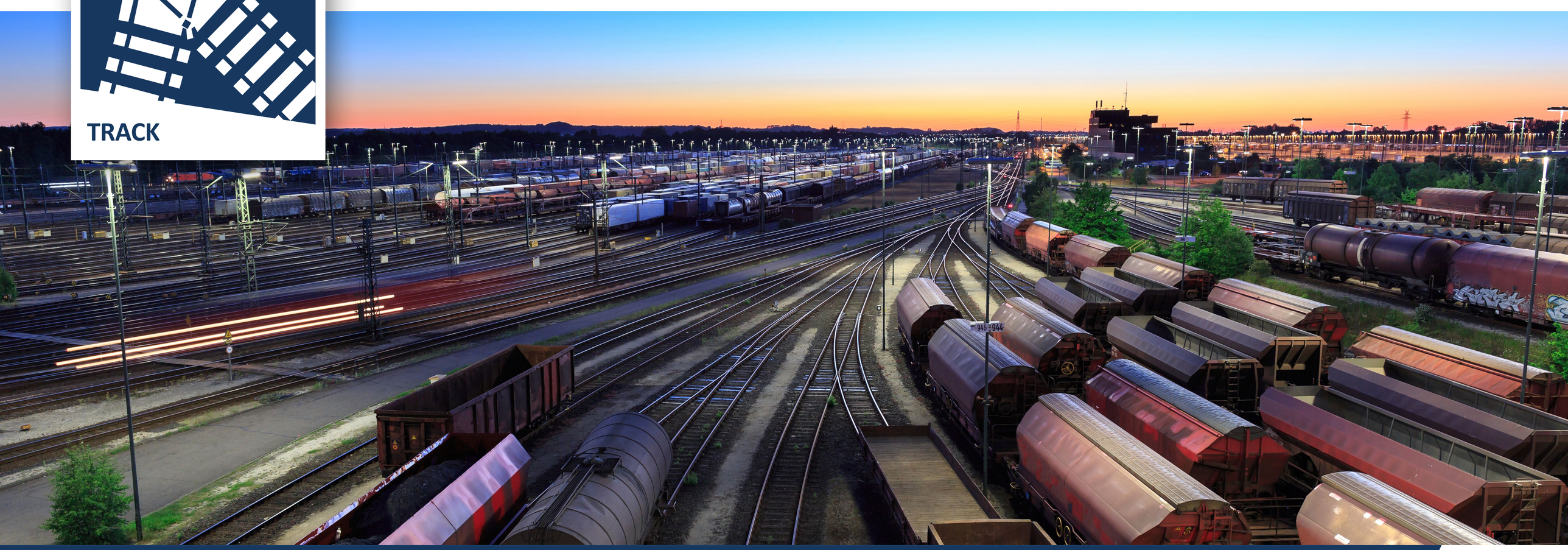


**FOCUS:** DEVELOPMENT | **FRA FUNDING:** $139,000

# From Rail Flaw Imaging to Remaining Life Estimation

## PROJECT DESCRIPTION

- Continuing development of a non-destructive evaluation tool to image internal rail flaws in quasi real-time for objective identification of defect size and orientation.
- Utilizes an improved synthetic aperture focus technique for quasi real-time ultrasonic imaging.
- A fracture mechanics task will estimate the remaining life of flawed rails in service.

## RAILROAD IMPACT

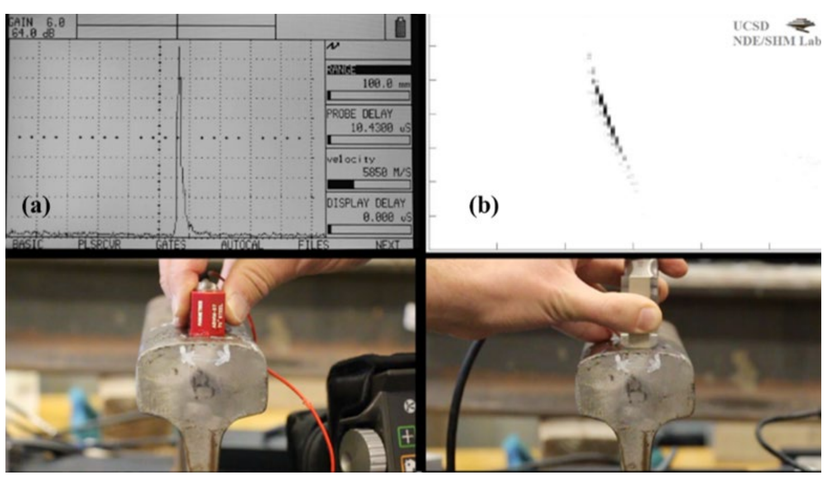
- Improved current hand verification techniques (A-scan system) for robust rail flaw sizing
- Increased safety through objective sizing of rail flaws for accurate defect severity categorization
- Reduced maintenance cost from well-informed decision making in response to flaw severity

## PROJECT PARTNERS

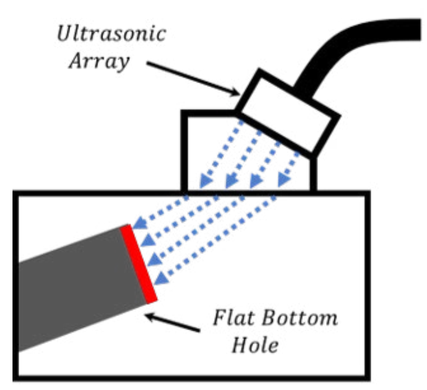
- University of California, San Diego
- Transportation Technology Center, Inc.

## PROJECT STATUS

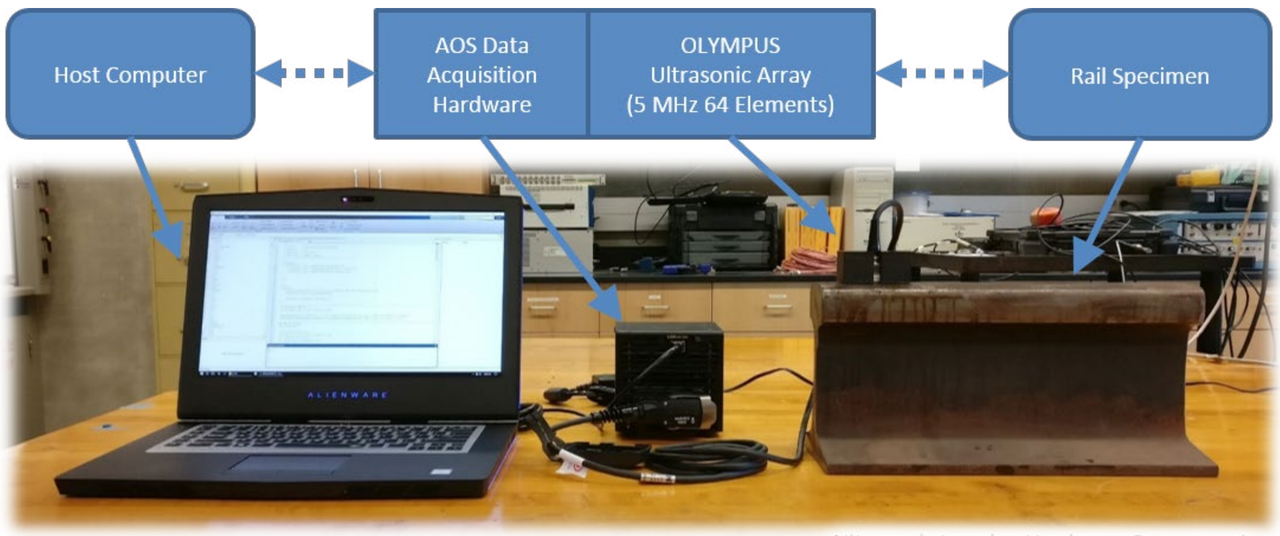
- Two-dimensional flaw imaging demonstrated in real-time on man-made and natural rail flaws.
- Ongoing work to add 3D rail flaw imaging and automatic flaw sizing capabilities.
- Requirements being developed for a field-deployable prototype.



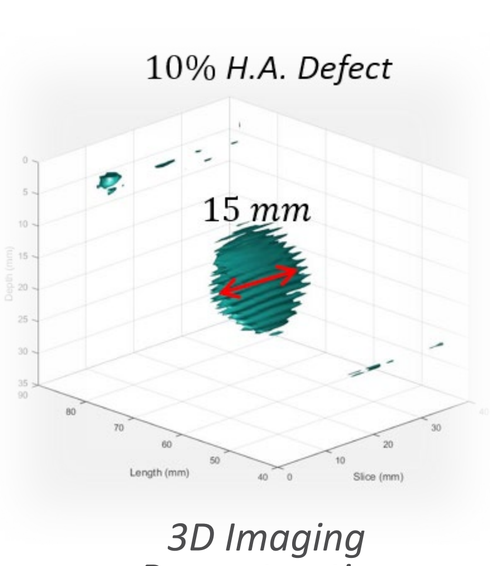

*(a) Traditional Ultrasonic A-Scan System and (b) Ultrasonic Imaging System*




*Imaging Schematic*




*Ultrasonic Imaging Hardware Components*




*3D Imaging Reconstruction*


*Rail Flaws to Image: Transverse Fissure*

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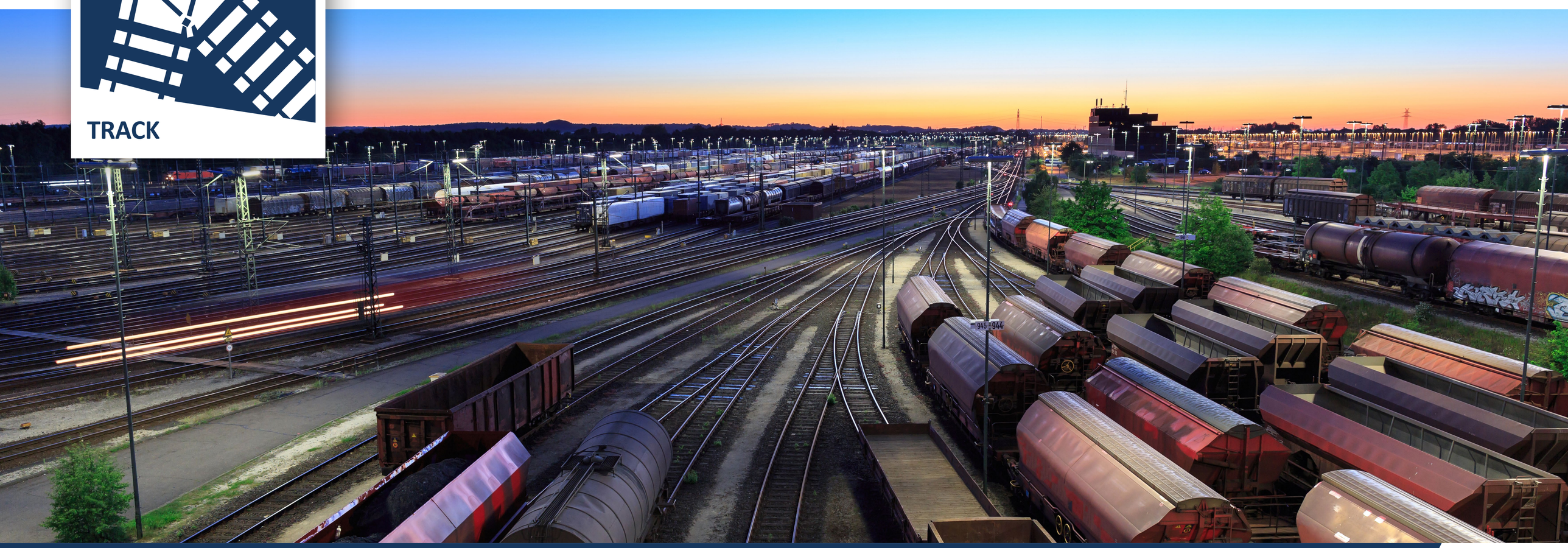


**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $123,895

# Field Testing of Welding Repair of Railhead Defects

## PROJECT DESCRIPTION

- A new technology based on multi-pass gas metal arc weld for in-situ repair of railhead defects will increase weld efficiency and durability.
- Identify suitable welding wire composition and optimize the welding parameters, including the flow rate, heat input, preheat, and cooling rates.
- Aim to achieve a defect-free welded section and confirm it through nondestructive and destructive evaluation.
- Control the microstructure to avoid the formation of undesirable phases such as martensite and bainite in the heat-affected zone.

## RAILROAD IMPACT

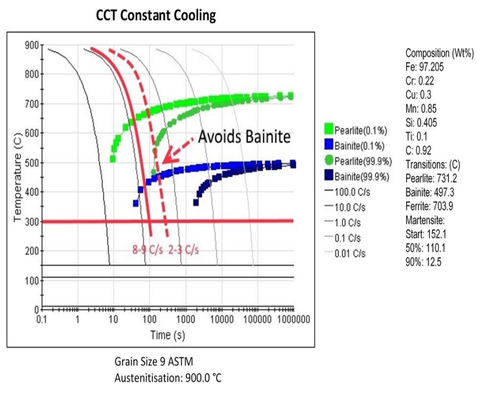
- This technology would improve the quality of welded railhead repairs and enhance their durability.
- Improve overall rail transportation safety.

## PROJECT PARTNERS

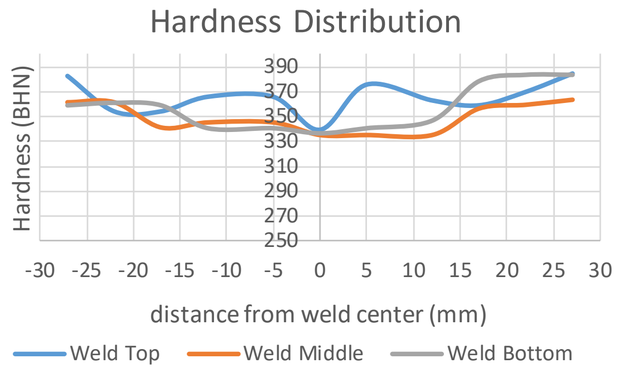
- Tuskegee University
- Transportation Technology Center, Inc.

## PROJECT STATUS

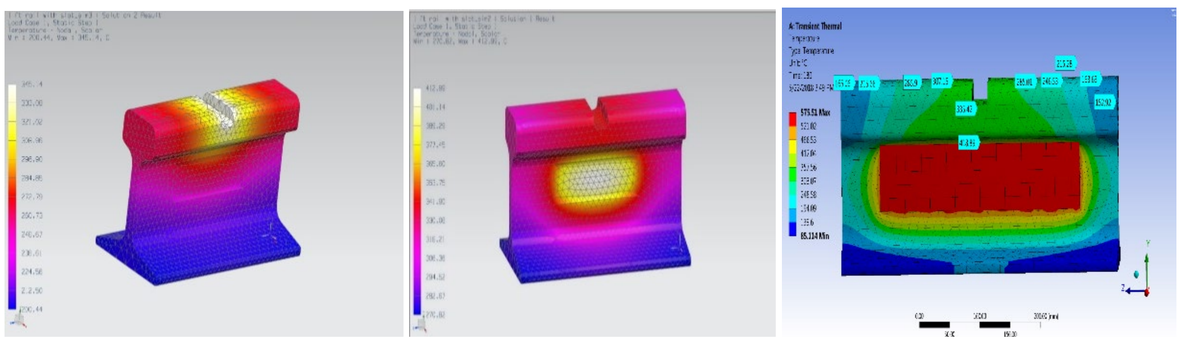
- POSTALLOY® 2892 SPL welding wire achieved adequate hardness, modulus of rupture (i.e., resistance against bending), and ductility.
- Welding parameters have been optimized to obtain desired microstructure and a porosity-free weld.
- Testing and validation are in progress to obtain approval for field testing at FRA's Transportation Technology Center.



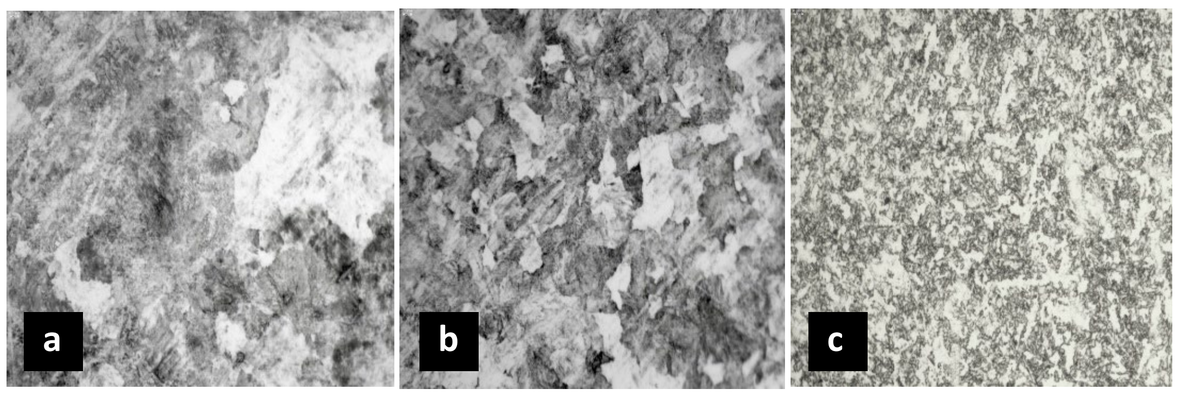

*Application of CCT curve to avoid bainite phase formation*




*Hardness profile of welds using POSTALLOY® 2892 SPL filler wire at a constant voltage of 28V and wire speeds of 390 inches/minute*



*Finite element analysis establishes an equilibrium distribution of preheat temperature adjacent to the slot to be welded.*




*Optical micrographs of the (a) parent, (b) HAZ, and (c) welded regions taken at 50X magnification show no evidence of bainite formation.*

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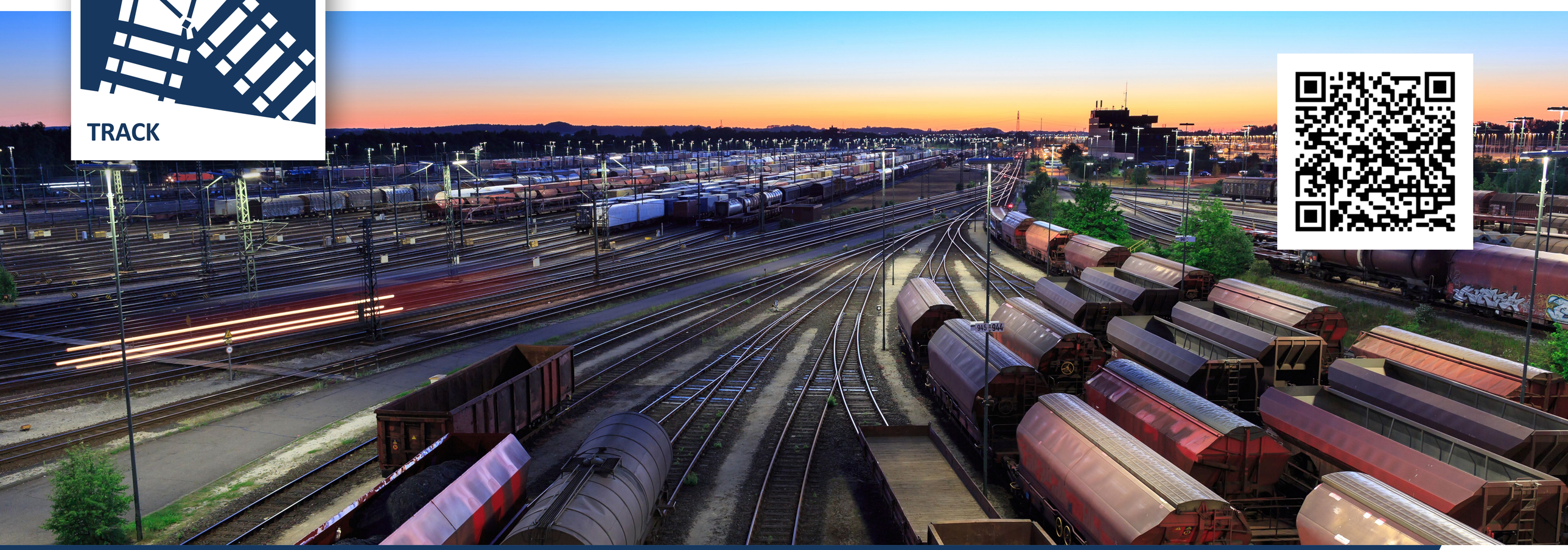


**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $123,895

# Improved Signal Wire Attachment Method

## PROJECT DESCRIPTION

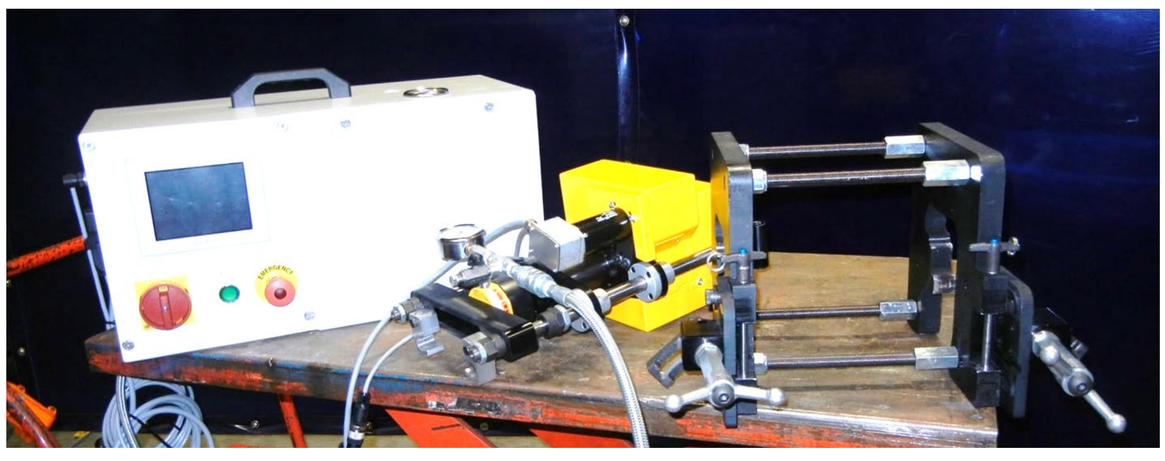
- Develop an improved method to attach signal wires to rail:
  - Develop a solid-state friction welding process.
  - Eliminate weak martensite formation and liquid metal embrittlement in rail steel resulting from exothermic welding processes.
  - Permit easy removal/reinstallation of wire to ease track maintenance.
  - Improve joint quality and consistency with a portable, automated system and process.

## RAILROAD IMPACT

- Eliminates risk of rail break derailments due to improper wire attachment
- Decreases maintenance requirements for millions of attachment points in the U.S. rail network

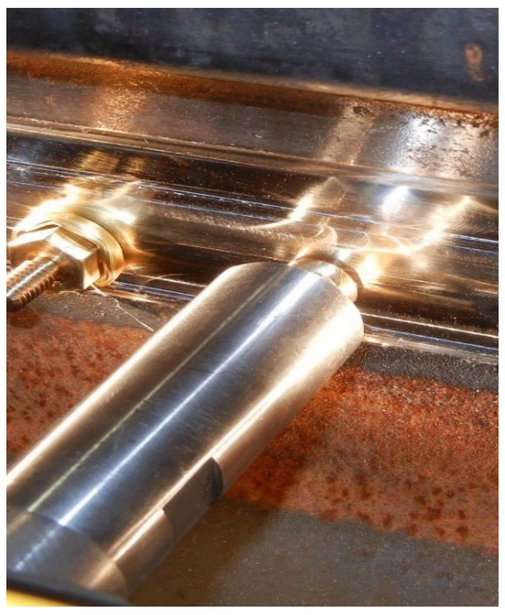
## PROJECT PARTNERS

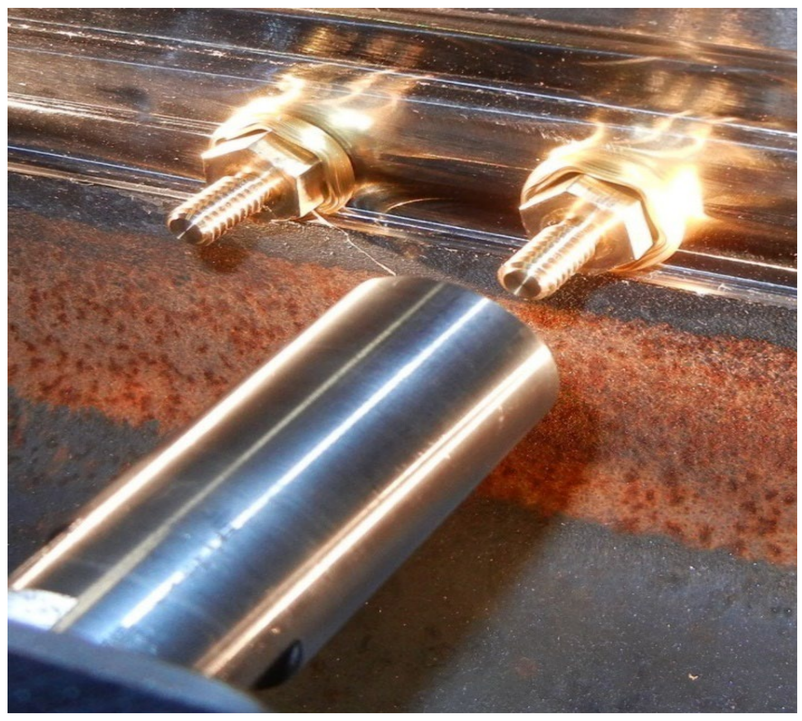
- Edison Welding Institute
- Transportation Technology Center, Inc.



## PROJECT STATUS

- Technical Report of proof of concept and laboratory testing is available on FRA eLibrary.
- Pre-production prototype development and in-track testing is underway at TTC.
- ***SEE THIS NEW TECHNOLOGY DURING THE TRACK WALK ON WEDNESDAY!***





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**FRA PROJECT MANAGER:**

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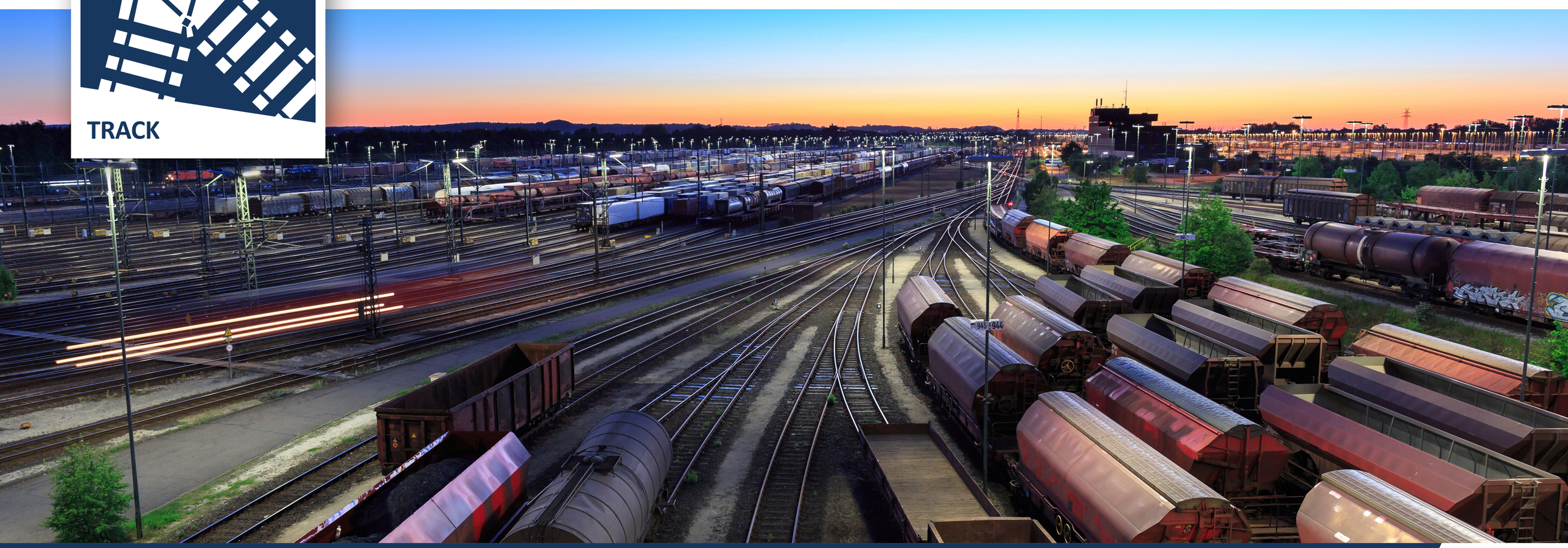


**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $600,000

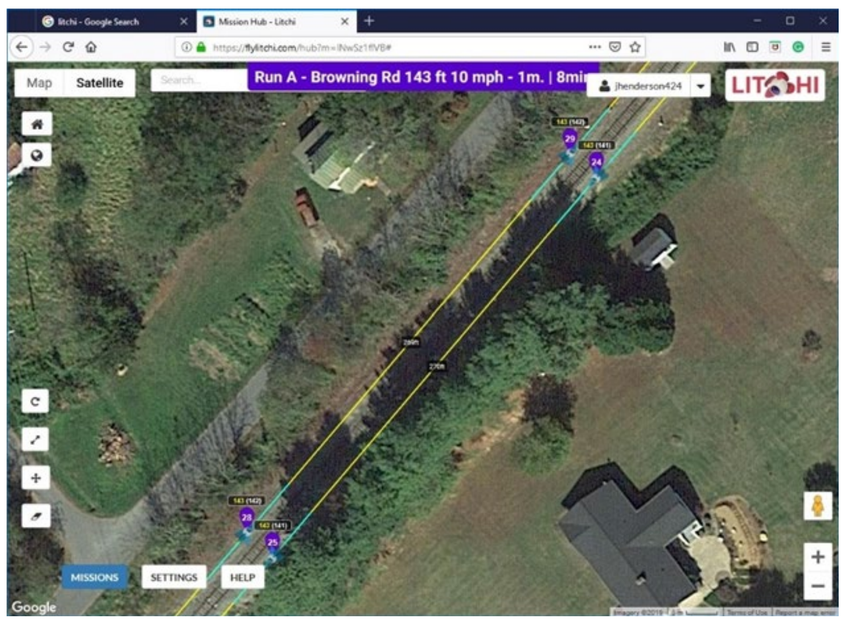
# Leveraging Unmanned Aircraft Systems (UAS) for Improved Safety

## PROJECT DESCRIPTION

- Explore innovative ways to utilize UAS to improve rail transportation safety.
- Enhance UAS-related research opportunities and facilities.

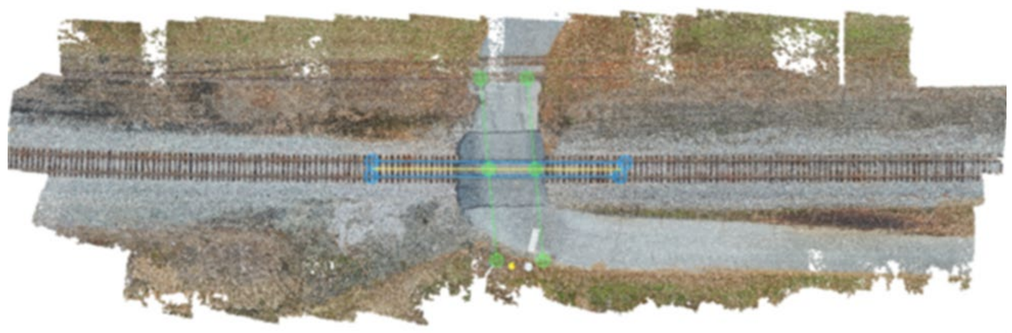

## RAILROAD IMPACT

- Improve safety: Remove personnel from hazardous areas (e.g., track, bridges, and derailments).
- Save time: More efficient data collection (e.g., surveying and 3D reconstruction)
- Reduce cost: Mobile deployable technology, which reduces equipment requirements.



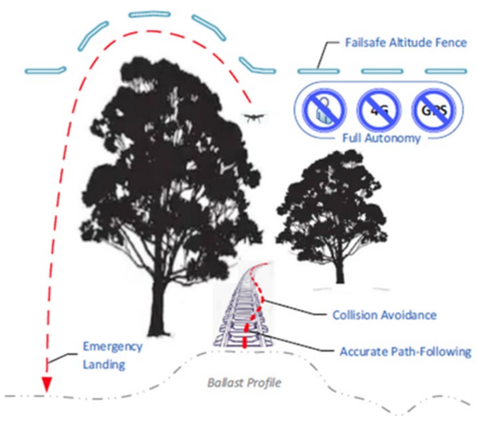

## PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Volpe National Transportation Systems Center
- Brunswick (Maine) Police Department
- Florida Department of Transportation
- Noble Drone Services, LLC
- Michigan Tech Research Institute, Inc.
- VisoStack, Inc.
- Federal Aviation Administration



## PROJECT STATUS

- Ongoing applied research for trespasser detection and prevention
- Investigating grade crossing surveying for humped conditions and safety appliances
- Developing UAS-based track change detection technology
- Developing technologies necessary for beyond visual line of sight (BVLOS) operation on railroads




U.S. Department of Transportation

**Federal Railroad Administration**

**FRA PROJECT MANAGER:**

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ROLLING STOCK

FEDERAL RAILROAD ADMINISTRATION

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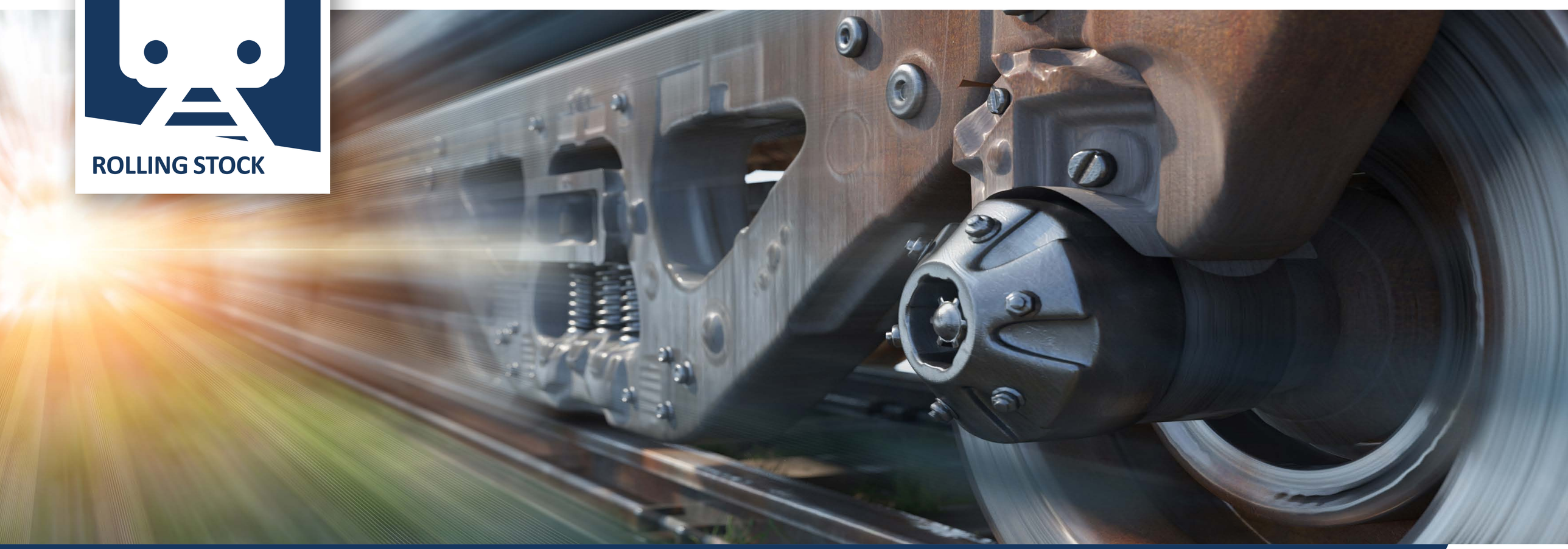

**FOCUS:** COMPONENT SAFETY | **FRA FUNDING:** $858,000

# Diagnosis of Bearing Grease Degradation and Water Ingress Prevention

## PROJECT DESCRIPTION

- Investigate the properties of grease degradation related to bearing performance.
- Develop a methodology for sampling grease from roller bearings.
- Determine if it is possible to identify the grease metrics associated with bearing failure modes using state-of-the-art statistical methods.
- Determine how rubbing lip seals and frictionless seals perform in preventing water ingress over the life of the bearing.
- Determine if water ingress will occur through environmental conditions.
- Develop recommendations to correctly identify fretting corrosion, as differentiated from water damage, and mitigate it in revenue service.

## RAILROAD IMPACT

- Develop methods and capabilities to understand bearing failure modes through grease sampling and analysis.
- Reduce accidents by proposing methods to diagnose bearing defects through grease analysis.
- Determine whether bearing seal testing standards are adequate to limit bearing degradation for the railroad industry.

## PROJECT STATUS

- Identified a robust methodology for sampling grease from roller bearings
- Collecting grease samples from various wheel and bearing shops
- Conducting bearing water-tightness testing on water spray bearing rig
- Testing bearing seals in environmental conditions in humidity chamber

## PROJECT PARTNER

- Transportation Technology Center, Inc.

*Humidity Chamber, Water Spray Test Touch-up, Grease Sampling*

U.S. Department of Transportation

**Federal Railroad Administration**


**FRA PROJECT MANAGER:**

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ROLLING STOCK

FEDERAL RAILROAD ADMINISTRATION

OFFICE OF RESEARCH, DEVELOPMENT & TECHNOLOGY

**FOCUS:** COMPONENT SAFETY | **FRA FUNDING:** $858,000

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*Humidity Chamber, Water Spray Test Touch-Up, Grease Sampling*

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**FRA PROJECT MANAGER:**

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**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $198,474

# Locomotive Crashworthiness and Occupant Protection

## PROJECT DESCRIPTION

- Project objective is to develop and analyze a passive system to protect an engineer from secondary impact injuries that might be experienced due to impact with the cab console.
- The primary requirement for the system was the ability to compartmentalize and limit the injury indices for a 95th percentile anthropomorphic test device (ATD).
- A baseline console was modified with an airbag and a crushable knee bolster to meet this objective. A computer model of an ATD impacting the cab console was validated using results from component-level tests.
- Modeling results indicate that the engineer protection system is capable of meeting the performance requirements.

## RAILROAD IMPACT

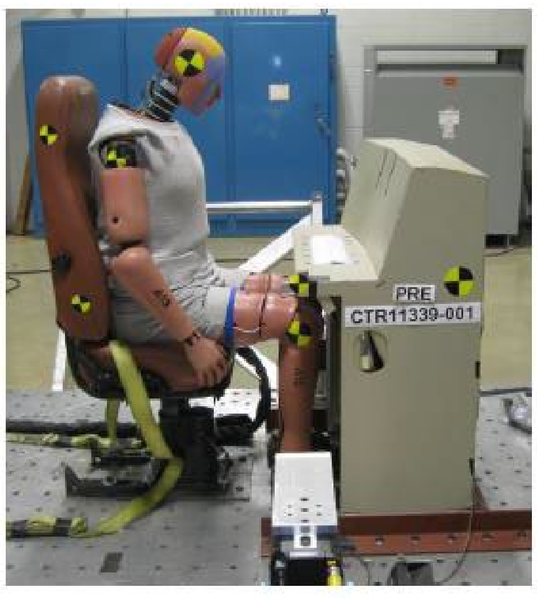
- Reduce fatalities and injuries to train crews in head-on collisions.

## PROJECT PARTNER

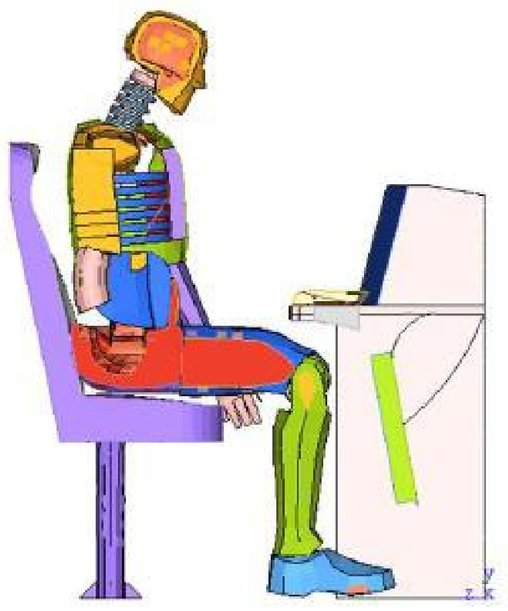
- Sharma & Associates, Inc.

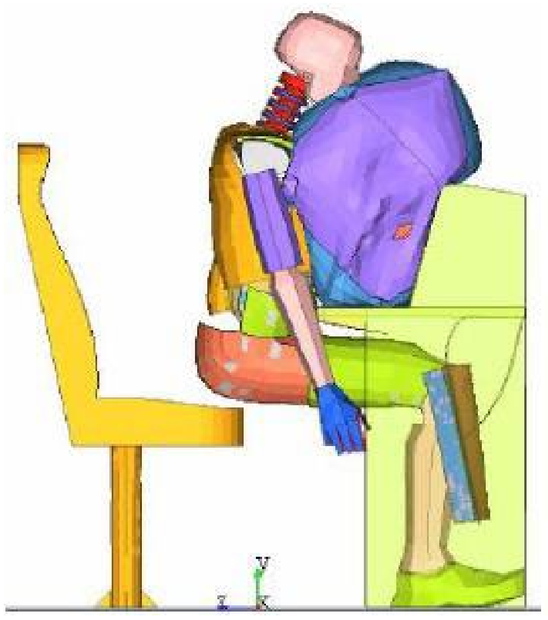
## PROJECT STATUS

- Preliminary dynamic sled testing has been completed.
- Nearly all injury criteria have been met, with the exception of two due to airbag failure.
- Additional testing is underway with modified airbag to demonstrate full compliance.









U.S. Department of Transportation

**Federal Railroad Administration**

**FRA PROJECT MANAGER:**

Jeff Gordon (617) 564-8095 jeffrey.gordon@dot.gov

ROLLING STOCK

# FEDERAL RAILROAD ADMINISTRATION

OFFICE OF RESEARCH, DEVELOPMENT & TECHNOLOGY

**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $772,037

# Locomotive Crashworthiness and Occupant Protection

## PROJECT DESCRIPTION

- Design, fabricate, and test two crash energy management (CEM) components for retrofit onto the forward end of a locomotive:
  - (1) Deformable anti-climber (DAC)
  - (2) Push-back coupler (PBC)
- Detailed designs for these components were developed, and the performance of each design evaluated through large deformation dynamic finite element analysis.
- Two test articles were fabricated and individually dynamically tested to verify performance characteristics.
- Full-scale, vehicle-to-vehicle impact testing is ongoing as described in the table below to demonstrate that the components work in tandem to minimize override in collisions.

## RAILROAD IMPACT

- Reduce fatalities and injuries to train crews and occupants of leading vehicles due to override in collisions.

## PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Transportation Technology Center, Inc.

## PROJECT STATUS

- Conventional and CEM coupling tests have been completed to develop data on expected coupler forces.
- The first vehicle-to-vehicle test has been performed (January 23, 2019); the second test planned for March 2020 has been delayed due to COVID-19 travel restrictions.
- Full-scale, train-to-train demonstration will be in late 2020.

| Test Description | Critical Measurements |
|---|---|
| Conventional Coupling Tests | • Maximum non-destructive coupling speed<br>• Dynamic impact forces<br>• Impact accelerations<br>• Displacements |
| CEM Coupling Tests | • Maximum non-destructive coupling speed<br>• Dynamic crush forces<br>• Impact accelerations<br>• Displacements<br>• Effectiveness of PBC |
| Vehicle-To-Vehicle Tests | • Dynamic crush forces<br>• Accelerations<br>• Displacements<br>• Effectiveness of PBC and DAC working as a system |
| Train-To-Train Test | • Effectiveness of crashworthy components at managing load path<br>• Effectiveness of crashworthy components in inhibiting override and lateral buckling |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**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $265,108

# Compliance Testing for Locomotive LED Sample Fixtures Phase III and IV

## PROJECT DESCRIPTION

- The railroad industry is beginning to introduce LED lighting for locomotive headlights.
- This project is intended to set test procedures for the evaluation of new locomotive LED headlights and auxiliary lights.
- Light fixture samples that satisfied requirements set forth in Phase I and II LED sample testing were evaluated further.
- The focus of Phase III testing is a subjective evaluation of LED headlamp performance under dynamic field testing conditions.
- Phase IV environmental testing will evaluate the performance of LED headlamps in the presence of freezing rain & ice accumulation.

## RAILROAD IMPACT

- Phase III and IV LED testing will provide AAR's Headlight-Auxiliary Light Standard Technical Advisory Group with a better understanding of LED headlamp performance in revenue service.
- This effort will also help support AAR in updating locomotive headlight standards and recommended practices.

## PROJECT PARTNERS

- Association of American Railroads
- ENSCO, Inc.
- Engineering Systems, Inc.
- Norfolk Southern Railway
- Union Pacific Railroad
- Transportation Technology Center, Inc.


## PROJECT STATUS

- Phase III dynamic testing was completed at FRA's Transportation Technology Center in November 2019 using an SD70-series locomotive.
- Phase IV environmental testing was completed in January 2020 using a wind tunnel to simulate blowing snow and freezing rain conditions.
- Analysis of the sample lamps' performance under various test conditions is expected in Spring 2020.

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**Federal Railroad Administration**

**FRA PROJECT MANAGER:**

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ROLLING STOCK

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**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $300,000

# Locomotive Waste Heat Recovery System Integration, Safety, and Field Demonstration

## PROJECT DESCRIPTION

- Validate safety and reliability performance of ThermaDynamics Rail, LLC, locomotive waste heat recovery system (L-WHRS) retrofitted onto a locomotive and analyzed during on-the-road operations.
- Conduct locomotive static and field tests to validate assumptions, performance, and adequacy of the high-pressure heat exchanger (HiPHEX) equipping the L-WHRS to convert wasted locomotive thermal energy from the exhaust gases into conditioned electrical power.

## RAILROAD IMPACT

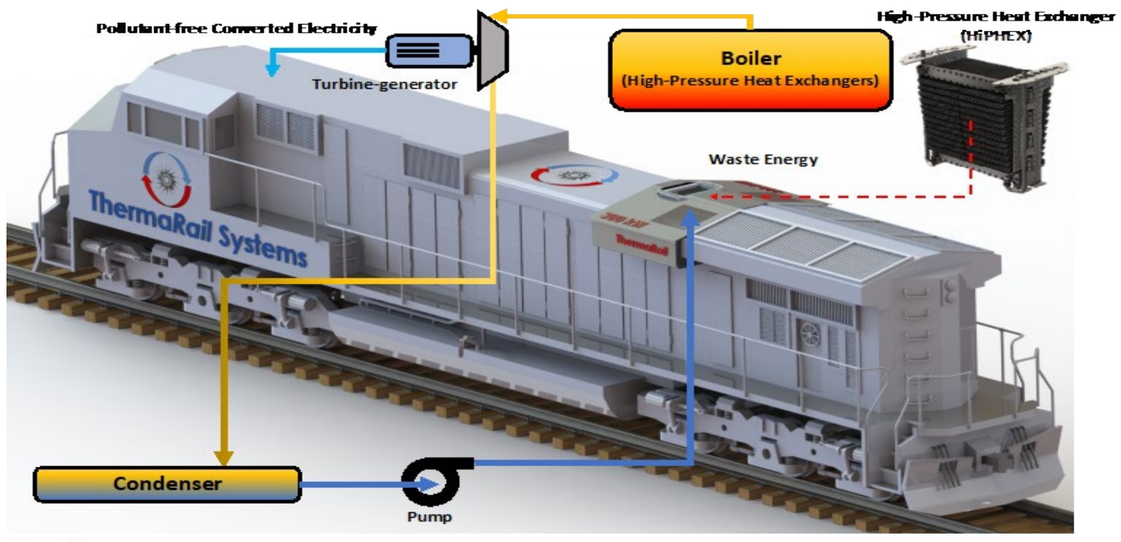
- **Reduced Locomotive Operating Costs**
  Locomotives retrofitted with the L-WHRS augment their electric power supply. The electricity produced from waste thermal energy enables locomotives to achieve the same propulsion power with decreased fuel consumption and pollutant emissions. Fuel savings leads to reduced operating cost.
- **Reduced Thermal and Pollutant Emissions**
  Thermal rejection to the environment is reduced as the HiPHEX extracts energy from the exhaust gases prior to venting to the atmosphere. The HiPHEX further supports exhaust gas recirculation pollutant reduction technologies.

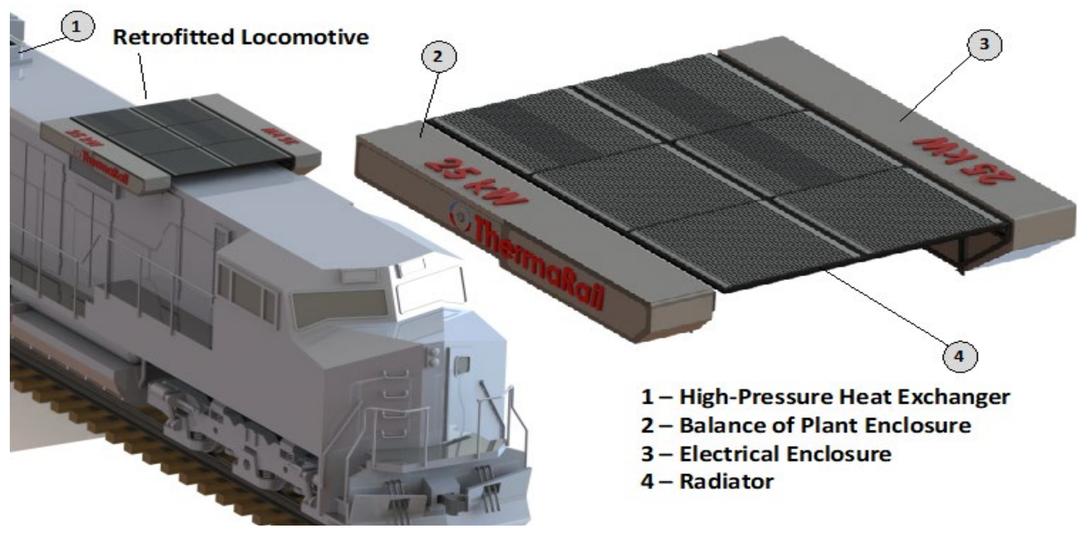
## PROJECT PARTNERS

- Norfolk Southern Railway
- ThermaDynamics Rail, LLC

## PROJECT STATUS

- The project is nearing completion under its developmental Phase IV. In this final phase of the project, the electrical energy recovered from the exhaust gases is conditioned to supply electric power to selected locomotive electrical loads and to energy storage systems to execute “load-following” functions via distribution to the locomotive electric bus. Retrofitting the L-WHRS is non-invasive and executed through enclosures mechanically coupled to the locomotive lifting lugs.

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**FRA PROJECT MANAGER:**
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ROLLING STOCK

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**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $176,966

# Passenger Car Glazing Integrity

## PROJECT DESCRIPTION

- Passenger ejection through openings created by dislodged windows during derailment events has resulted in numerous fatalities and injuries.
- Accident data, global standards, and other literature were reviewed to identify the modes of glazing failure under derailment conditions, and the resulting potential for passenger fatalities and injuries.
- Based on other engineering and practical considerations, several concepts for improved glazing performance were developed.

## RAILROAD IMPACT

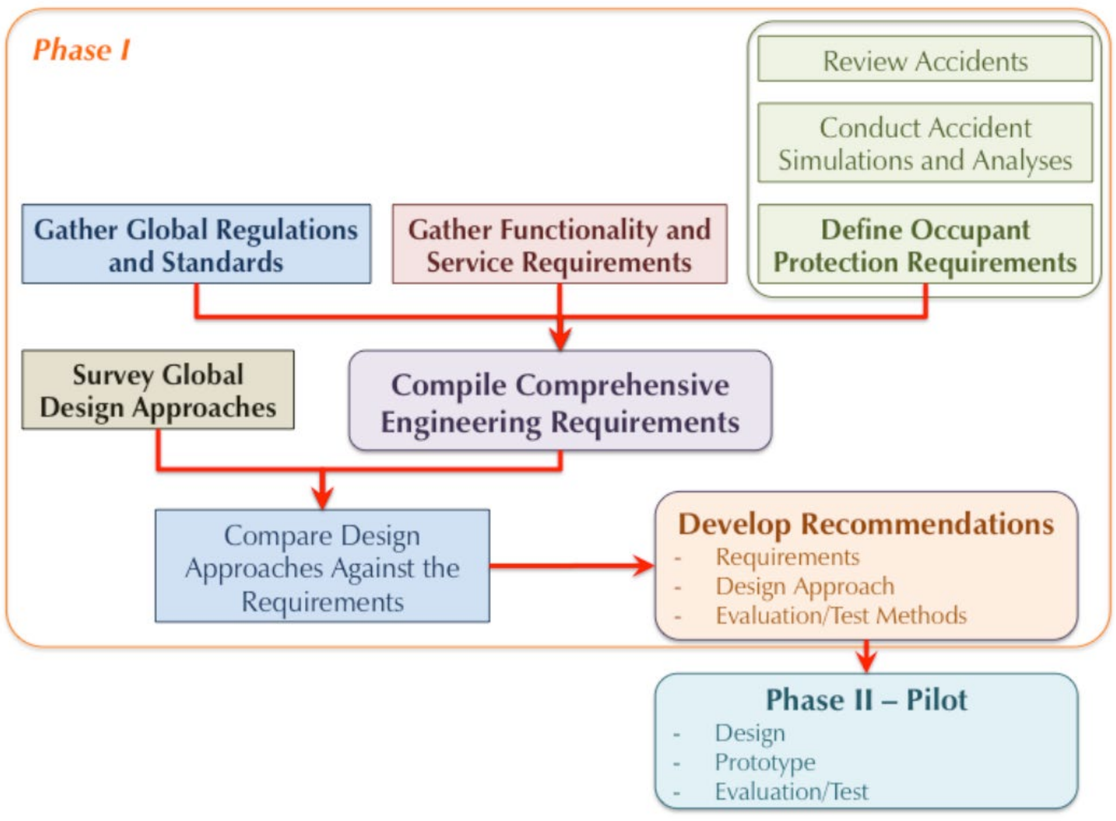
- Successful development of prototype glazing protection methods will reduce the number and severity of passenger injuries in derailment events.

## PROJECT PARTNER

- Sharma & Associates, Inc.

## PROJECT STATUS

- Phase I (as outlined below) is complete.
- Current focus is on the evaluation of these concepts, along with a base case, through a series of tests and analysis.
- Test fixtures are under development to perform physical testing of baseline and up to two design options to demonstrate potential for improved glazing retention under the following test conditions:
    - Gasket edge prying test
    - Normal force retention test
    - Ballast drag test

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**FRA PROJECT MANAGER:**

Jeff Gordon (617) 564-8095 jeffrey.gordon@dot.gov

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OFFICE OF RESEARCH, DEVELOPMENT & TECHNOLOGY

**FOCUS:** WHEELS | **FRA FUNDING:** $279,350

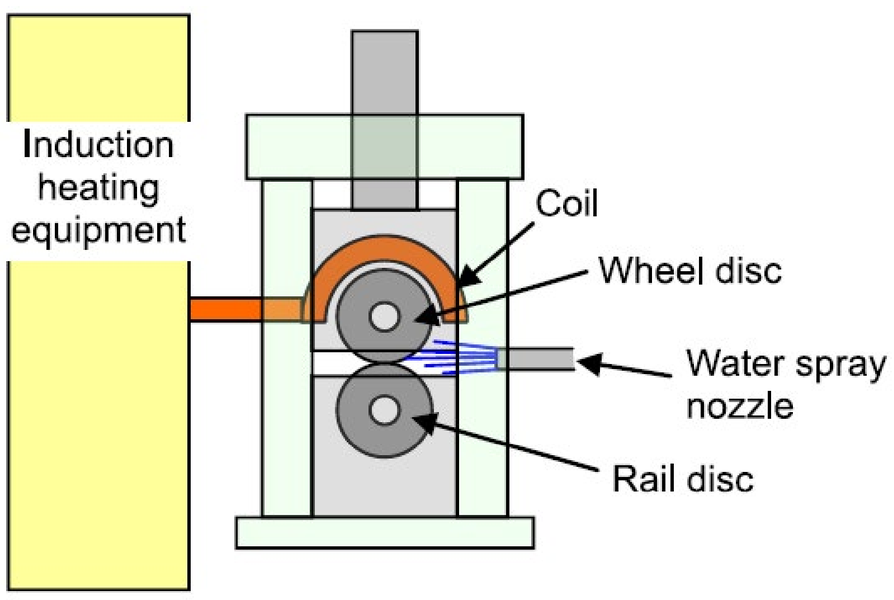
# Effects of Temperature on Wheel Spalling

## PROJECT DESCRIPTION

- High-impact wheels are often characterized by the spalling (i.e., rolling contact fatigue) that occurs due to sliding of the wheels, causing high temperature and martensite formation, which in turn leads to wheel tread discontinuities.
- Investigate how temperatures at the wheel-rail interface can affect wheel surface performance under various loading conditions.
- Test wheel specimens under a range of realistic temperatures and slip ratios representing various braking conditions, using a twin-disc testing machine.

## RAILROAD IMPACT

- Prevention of high-impact wheels caused by wheel spalling due to elevated temperature from wheel sliding, which can lead to improved train operation safety and reduced stress state to track infrastructure and rolling stock components.



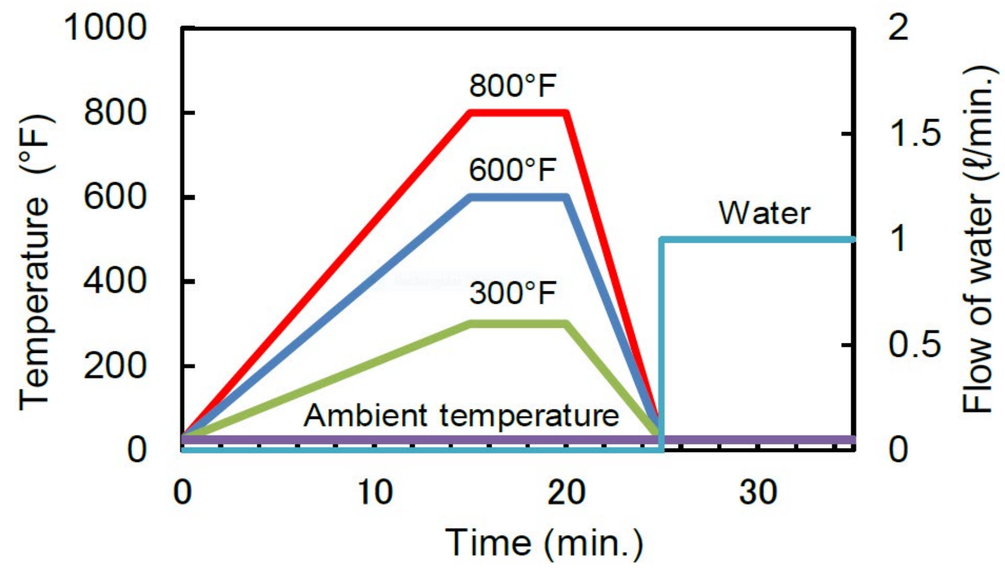

*Testing Machine Used to Study Thermal Effects on Wheel Spalling*

## PROJECT PARTNERS

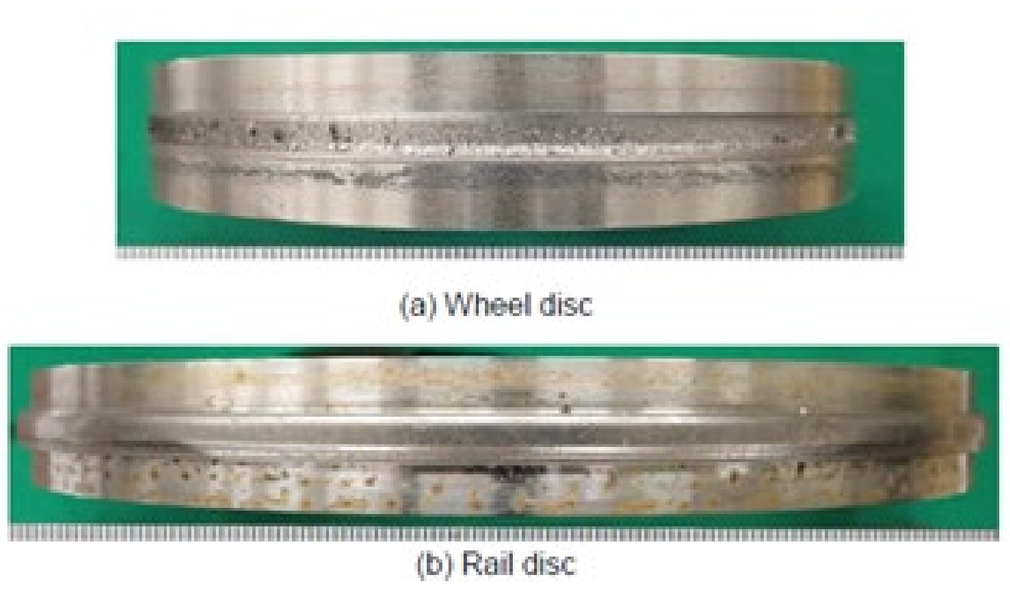
- Transportation Technology Center, Inc.
- Nippon Steel Technology Co., Ltd

## PROJECT STATUS

- Project completed: A total of 32 tests, covering two wheel materials (cast and forged), 4 wheel temperatures (ambient to 800°F), 4 slip ratios (0 to 0.75%), and various traction coefficients as a ratio of longitudinal and vertical wheel/rail contact forces




*Thermal Cycles for Twin-Disc Testing*




*Surface Conditions of Wheel and Rail Discs after a Test*

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**Federal Railroad Administration**

**FRA PROJECT MANAGER:**
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HUMAN FACTORS


**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $1,000,000

# Augmented Reality (AR) Head-Up Display (HUD)

## PROJECT DESCRIPTION

- Purpose: Investigate HUD technology for use in locomotives.
- HUDs are used in other transportation domains but have not yet been utilized in the rail industry.
- Develop a prototype AR-HUD in FRA's Cab Technology Integration Laboratory (CTIL) simulated environment to:
  - Enhance situational awareness, reduce the need for multiple system displays for locomotive operations, and serve as a platform for warnings and communications symbology.

## RAILROAD IMPACT

- Fewer in-cab display systems and associated costs, reduced risk of distraction, enhanced situational awareness, and general reduction in risk of operational human error
- "Eyes-out" design focus enables crew to continue to operate head-up without looking down at a new display.


## PROJECT PARTNERS

- Massachusetts Institute of Technology's (MIT) Human Systems Lab and General Electric's (GE) Global Research teamed to respond to an FRA Broad Agency Announcement solicitation for proposals related to display design research.
- Both partners are leaders in display and locomotive software design.
- MIT brings human factors expertise while GE brings locomotive design and operations expertise to the table.

## PROJECT STATUS

- Completed first of the 2-year period of performance for the project.
- Completed development of prototype HUD conformal display design. Now working to integrate display with CTIL simulator for system demonstration and prep for system evaluation activity.
- If the CTIL evaluation is successful, then the next step is to install, demonstrate, and evaluate the display in an actual crewed locomotive.
- GE has generated a patent for HUD display-related symbols.

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HUMAN FACTORS


**FOCUS:** APPLIED RESEARCH | **FRA FUNDING:** $100,567

# Monitoring Engineer Fatigue (MEFA)

## PROJECT DESCRIPTION

- Purpose: Determine the feasibility of using artificial intelligence (AI) technology to autonomously monitor and combat locomotive engineer fatigue.
- Specifically, research determined the plausibility of identifying fatigue through physiological cues through a variety of non-invasive detection sensors.

## RAILROAD IMPACT

- Use AI technology to detect operator fatigue and then automate systems to take action prior to an accident or incident to reduce fatigue-related accidents.


## PROJECT PARTNERS

- Boeing/Aurora Flight Sciences brings expertise in artificial intelligence, autonomy and robotics to transportation system development.
- Massachusetts Institute of Technology's Human Systems Lab has expertise in human factors research, knowledge of locomotive operations, and utilization of the FRA's simulator research lab, the Cab Technology Integration Laboratory (CTIL).

## PROJECT STATUS

- Initial system was designed and AI algorithms were developed.
- An engineer monitoring system was configured to capture fatigued behavior through motion capture and eye and facial tracking sensors.
- Next steps include validation of the system through human-in-the-loop testing in CTIL.

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**Federal Railroad Administration**

**FRA PROJECT MANAGER:**

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