RAIL

MOVING AMERICA FORWARD

FRA Office of Research, Development, and Technology

Current Research Projects

U.S. Department of Transportation
Federal Railroad Administration

December 21, 2022

1. Track
2. Rolling Stock
3. Train Control & Communication
4. Human Factors

RESEARCH SECTIONS

SECTION ONE

TRACK

Experimental Evaluation of Wheel/Rail Contact, Third Body Layer, and Surface Finish on Risk of Derailment (Phase II)

PROJECT DESCRIPTION

- Extend the studies that have been performed on the Virginia Tech-FRA roller rig during Phase I and Phase II to provide a better understanding of the fundamentals of wheel-rail contact mechanics and dynamics.
- Evaluate additive agents that influence the wheel-rail traction by either decreasing (such as leaf residue and flange grease) or increasing (such as aluminum and iron oxides) for better on-demand management of motive and braking power.
- Evaluate the effect of wheel flanging on wheel-rail contact profile and pressure distribution.
- Evaluate the effect of wheel flange contact on longitudinal and lateral traction under various two-point and conformal contact conditions.

RAILROAD IMPACT

- Understanding the complex mechanics and dynamics that occur at the wheel-rail interface is critical for improving railway operational safety and efficiency.
- Scientifically evaluating additive agents that affect contact forces, traction, and wheel-rail wear, but cannot be evaluated accurately in the field due to the naturally-varied conditions.
- Providing a better understanding of wheel-rail flange contact that can significantly increase wheel-rail wear and affect railroad safety.
- Using the roller rig's test results to provide a guideline to the industry practitioners for improving rail safety and cost efficiency.

PROJECT PARTNERS

- Virginia Polytechnic Institute and State University
- Norfolk Southern Railway
- Standard Steel, LLC

COST & SCHEDULE

- Funding, FY22: $249,680
- Project Duration: September 2022 – September 2024

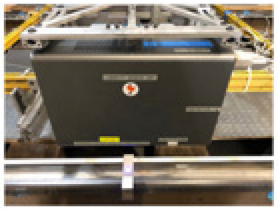
U.S. Department of Transportation
Federal Railroad Administration

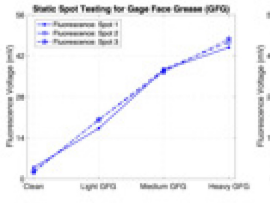
FRA PROJECT MANAGER: Alexandra Baginski • (202) 578-6218 • alexandra.baginski@dot.gov

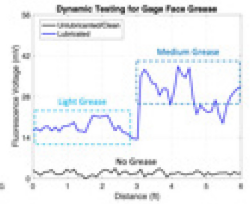
Non-contact Detection and Qualitative Evaluation of Rail Gage Face Lubricant Using Optical Sensing Methods

PROJECT DESCRIPTION

- Determine the efficacy of non-contact sensing devices for identifying the state of gage face lubrication, specifically whether it is lubricated.
- Develop an easily-deployable onboard optical system for use in revenue service.
- Prove the effectiveness and any shortcomings of the developed system through extensive testing, initially in the lab and eventually in the field.
- Provide recommendations on whether non-contact sensing devices can effectively be deployed in revenue service for gage face lubrication detection.







1st Generation (2016)

2nd Generation (2018)

3rd Generation (2020)

RAILROAD IMPACT

- Advancing maintenance of way practices and improving rail operation safety
- Providing a reliable solution for effectively detecting the presence and adequacy of gage face lubricants
- Reducing wheel and rail wear due to flanging under high friction conditions in curves
- Decreasing wheel climb derailments in curves
- Improving rail operation efficiency by enabling better maintenance scheduling
- Providing cost saving by reducing wheel/rail wear and reducing derailments in curves

PROJECT PARTNERS

- Virginia Polytechnic Institute and State University
- Norfolk Southern Railway

COST & SCHEDULE

- Funding, FY22: $185,556
- Project Duration: September 2022 – September 2024

FRA PROJECT MANAGER: Alexandra Baginski • (202) 578-6218 • alexandra.baginski@dot.gov

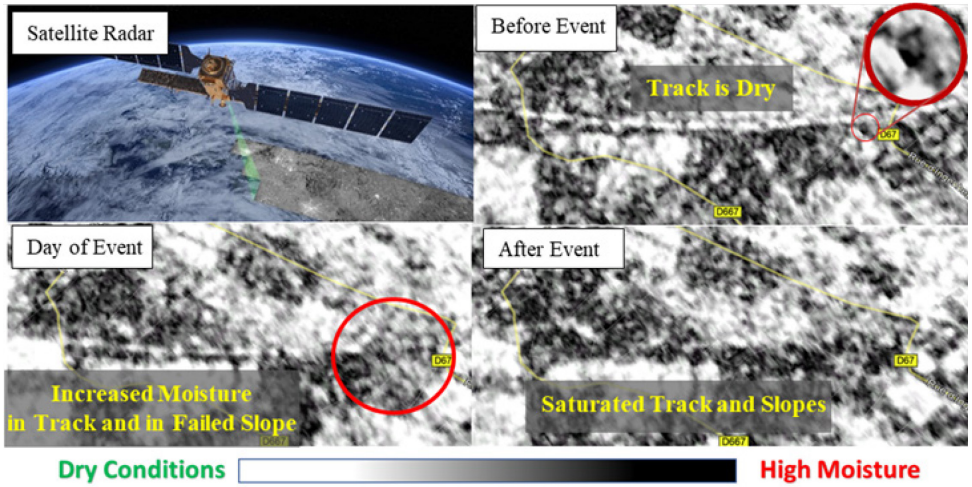
Satellite Radar Imagery for Ground Hazard Risk Monitoring in Railway Track and Slopes

PROJECT DESCRIPTION

- Develop, qualify, and implement an intelligent monitoring system that uses satellite radar images and AI to detect precursors to events that trigger ground hazards in the railway ROW by quantifying and monitoring soil moisture content changes and slow rate ground surface mobilization.
- Phase 1: System validation and qualification
- Phase 2: Automation and Implementation

RAILROAD IMPACT

- Improve rail safety through the timely automated detection of failure conditions.
- Facilitates the mitigation of the ground hazard risk
- Network-wide real-time monitoring and detection
- On-demand real-time monitoring of high-risk areas
- Accident investigation to identify possible contributing track condition changes.
- Ability to integrate data with information acquired by other track-sensing technologies.



PROJECT PARTNERS

- University of South Carolina
- L3Harris Geospatial
- CSX

COST & SCHEDULE

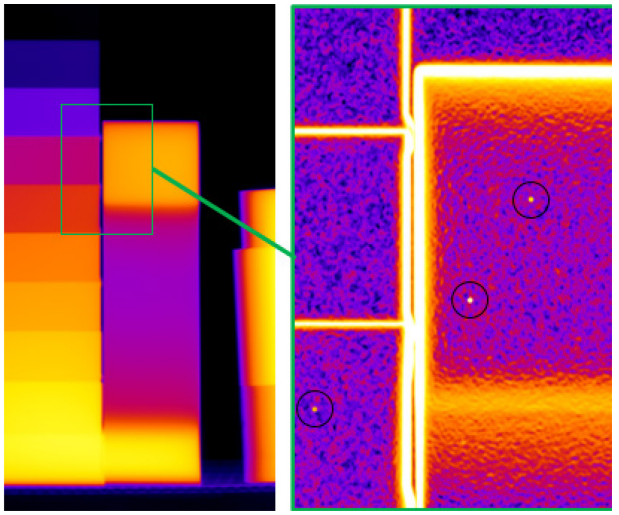
- Funding, FY21: $310, 819
- Project Duration: June 2021 – June 2023

FRA PROJECT MANAGER: Alexandra Baginski • (202) 578-6218 • alexandra.baginski@dot.gov

Radiographic Inspection of Rail Welds

PROJECT DESCRIPTION

- Detect and locate both voids and solid impurity defect nucleation sites within rail welds.
- Apply cutting-edge x-ray source and detector technologies.
- Research high-resolution, high dynamic range, and dual-energy X-ray inspection capabilities.
- Create a database of rail weld images for data-driven regulatory guidance of weld inspection.
- Create a reference design for a rail weld inspection system.



RAILROAD IMPACT

- Create a path for radiographic inspection of rail welds.
- Reduce rail weld failures and improve infrastructure by performing robust radiographic NDT on rail welds.

PROJECT PARTNER

- University of Tennessee Knoxville Nuclear and Radiological Engineering Department

COST & SCHEDULE

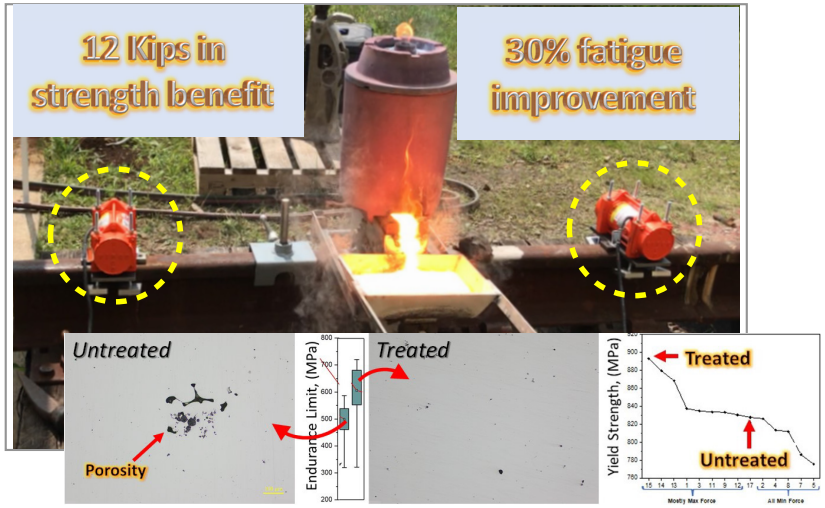
- Funding, FY22: $246,995
- Project Duration: September 2022 – September 2024

FRA PROJECT MANAGER: Alexandra Baginski • (202) 578-6218 • alexandra.baginski@dot.gov

An In-Track Apparatus to Improve Thermite Weld and Rail Integrity

PROJECT DESCRIPTION

- Extend rail life through improvements of thermite welds with higher strength and fatigue performance.
- Minimize thermite weld porosity and refine grains by mechanical vibration during weld casting.
- Develop a prototype instrumented thermite weld treatment device for in-track use.
- Perform full-scale AREMA bend weld test and tensile test.
- Determine tensile, fatigue, fracture toughness, and wear properties under laboratory conditions.
- Test in track at Union Pacific.



RAILROAD IMPACT

- Extend rail life and improve track safety through significant enhancement of thermite weld strength and fatigue life.
- Decrease track delays and labor costs from new methods to cast thermite welds.
- Development of an FRA/AREMA suitable device for easy in-track implementation

PROJECT PARTNERS

- University of Houston
- Orgo-Thermit, Inc.
- Union Pacific Railroad
- A&K Railroad and Materials Inc.

COST & SCHEDULE

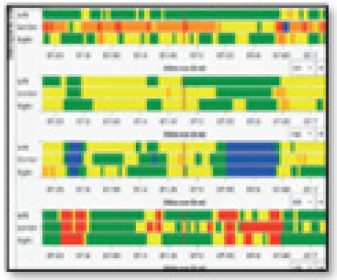
- Funding, FY22: $202,114
- Project Duration: September 2022 – September 2024

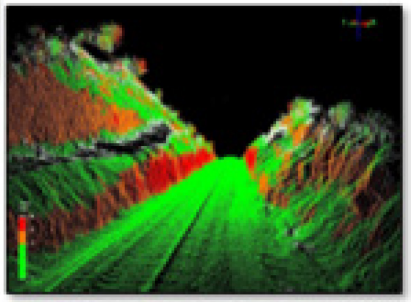
FRA PROJECT MANAGER: Alexandra Baginski • (202) 578-6218 • alexandra.baginski@dot.gov

Ground Hazard Database and Warning System

PROJECT DESCRIPTION

- Create Advanced Ground Hazard Database.
- Populate database using trackbed surveys, remote sensing data, and various imagery, e.g., LiDAR, thermal, optical, moisture, etc.
- Real-time hazard warning system for slope movement
- Final deliverables – user-friendly ground hazard database and real-time change detection system for ground hazards with traffic light alert levels to categorize changes on revenue service corridors.





RAILROAD IMPACT

- Easier, quicker, and more reliable means for assessing ground hazards instead of human inspection to remote areas.
- Increased safety, reliability, and revenue due to less disruption of service
- New web-based ground hazard database to allow real-time change detection.

PROJECT PARTNERS

- University of Illinois at Urbana-Champaign
- Sixense, Inc.
- BNSF

COST & SCHEDULE

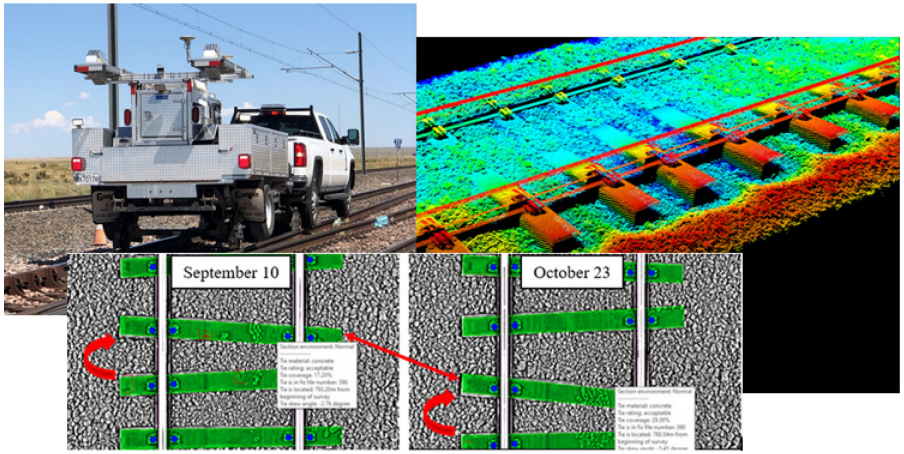
- Funding, FY21: $485,336
- Project Duration: September 2021 – September 2024

FRA PROJECT MANAGER: Alexandra Baginski • (202) 578-6218 • alexandra.baginski@dot.gov

Automated Track Change Detection (ATCD)

PROJECT DESCRIPTION

- This project develops and demonstrates new technology to augment human track inspection activities. The research adapts commercially available 3D scanning sensors and artificial intelligence technologies to identify and classify track features and to compare the changes in these features over time. Understanding how track conditions change in response to loads provides valuable insight into track degradation rates as well as maintenance effectiveness.



RAILROAD IMPACT

- Advance technology-augmented human inspection capabilities to yield improved track condition awareness and safety.
- Provide data required to modernize CFR 213 Subpart F track inspection regulations.
- Provide value-added inspection data to existing geometry car inspection systems in operating conditions that include both:
- Locations without a priori knowledge (e.g., the first inspection of a given route)
- A posteriori (e.g., a repeat inspection of a route) inspection scenarios

PROJECT PARTNERS

- University of Illinois at Urbana-Champaign
- Pavemetrics Systems, Inc.
- CSX
- Union Pacific Railroad
- Volpe National Transportation Systems Center

COST & SCHEDULE

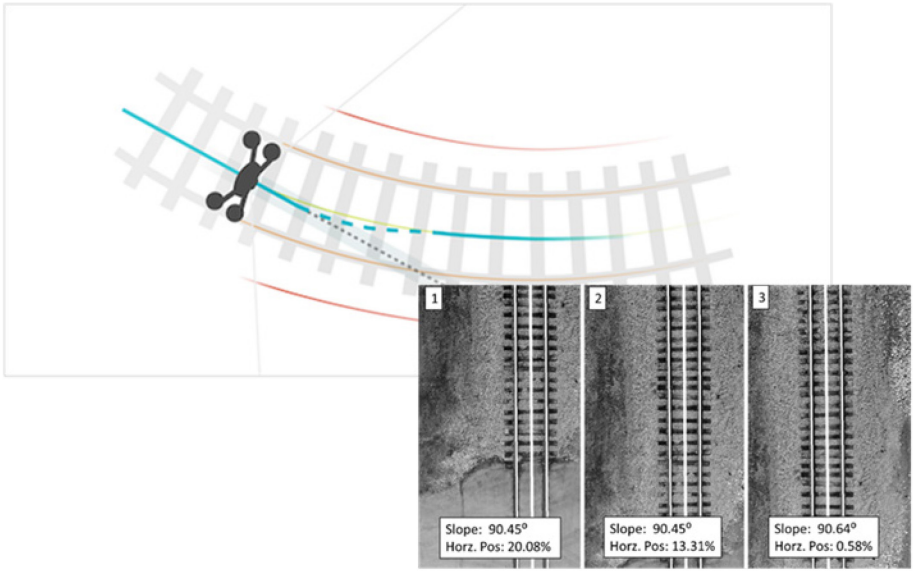
- Funding, FY21: $485,336
- Project Duration: September 2021 – September 2024

FRA PROJECT MANAGER: Alexandra Baginski • (202) 578-6218 • alexandra.baginski@dot.gov

Drone-based Track Inspection: Automated Track Centerline Detection and Flight Automation

PROJECT DESCRIPTION

Unmanned aerial vehicles, or drones, are potentially beneficial technologies for railroad inspection operations. This project conducts research and development of technologies that enable drones to fly autonomously over railroad track. The unique characteristics of railroad track provide an opportunity to guide aircraft via machine vision methods and may help to partially support the safety case for FAA beyond visual line-of-sight (LOS) flight authorization.



RAILROAD IMPACT

- Current drone operations are limited by LOS operations and in GPS enabled regions.
- This system (licensed API) would allow railroads to inspect larger sections of track at one time, speeding up crossing inspections while allowing for the inspection of additional features or anomalies.
- Using drones can limit time spent on track by personnel, which in turn improves the safety of railway workers.
- Several railroads are currently working toward automating regulatory track inspections; this system would complement these efforts, saving users both time and money.

PROJECT PARTNERS

- VisioStack, Inc.
- CSX
- Florida East Coast Railway

COST & SCHEDULE

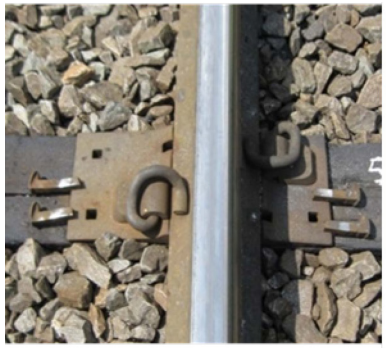
- Funding: $313,074
- Project Duration: September 2021 – September 2023

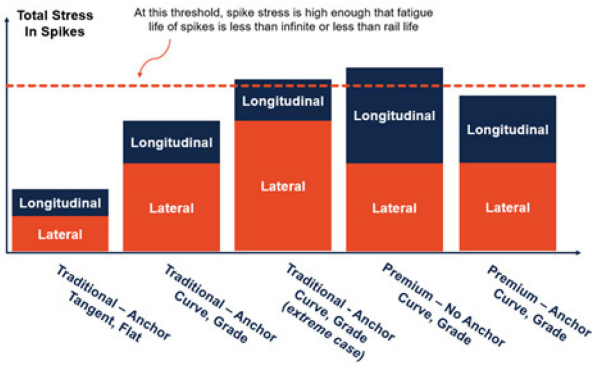
FRA PROJECT MANAGER: Cameron Stuart • (202) 306-5326 • cameron.stuart@dot.gov

Spike Failure Mitigation

PROJECT DESCRIPTION

Spike failures are identified as the root causes of recent derailments. FRA research has identified spike failures in wood ties with elastic fastening systems resulting from overloading conditions. Additional research has demonstrated the critical role that friction plays in the load path. This project will identify, test, and recommend methods to provide and maintain plate-to-tie friction in elastic fastening systems installed on wood ties.





RAILROAD IMPACT

- Spike fasteners are a critical connection between the rail and crosstie. Spike failures have result in derailments. The objective of this project is to identify, test, and demonstrate methods to ensure proper friction is maintained between ties and tie plates in elastic fastening systems. This friction will reduce the loads on spikes and will help to mitigate spike failures in track.
- Improve system safety and reliability and reduce life cycle infrastructure costs.
- Improve spike design and system arrangements.
- Reduce risk of derailments due to fastener failures.

PROJECT PARTNERS

- University of Illinois at Urbana-Champaign
- Progress Rail Services
- Advanced Rail Management
- voestalpine Nortrak
- Norfolk Southern Railway
- Vossloh AG
- Lewis Nut & Bolt
- Pandrol

COST & SCHEDULE

- Funding: $859,000
- Project Duration: April 2018 – September 2024

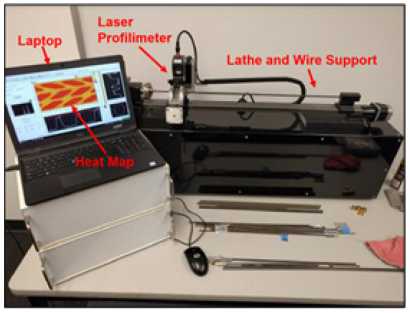
FRA PROJECT MANAGER: Cameron Stuart • (202) 306-5326 • cameron.stuart@dot.gov

Machine Vision Technology for Pre-Stressing Wire Quality Control

PROJECT DESCRIPTION

- Ensuring a proper bond between concrete and indented wire reinforcements is critical to the performance of concrete railroad ties. This project continues FRA-sponsored development of an automated wire scanning technology and deploys the system in a wire manufacturing plant for wire quality control monitoring.
- Partner with Technology Development Institute to deploy existing technology into Nucor-LMP prestressing wire manufacturing facility to enable indented wires to consistently meet product specifications

In-Plant
Wire Indent Scanning



Reduce In-Track Failures

RAILROAD IMPACT

- This project develops advanced technology to improve the quality of concrete crossties. The object is to improve the state-of-good repair of railroads, improve operational safety, and reduce the economic burden of track maintenance.
- Deploy technology previously developed under FRA-funded research to ensure a more-consistent wire product.
- Improve safety by reducing risk of in-track failures due to nonconforming wire indentations.
- Ability to make in-production adjustments to indent roller setup and ensure specifications are being met.

PROJECT PARTNERS

- Kansas State University
- Nucor-LMP

COST & SCHEDULE

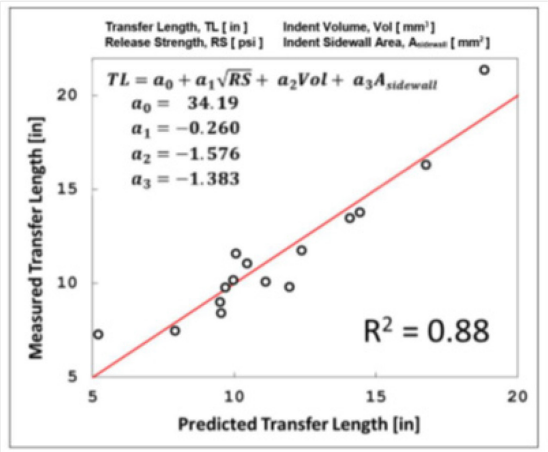
- Funding: $100,000
- Project Duration: July 2021 – December 2023

FRA PROJECT MANAGER: Cameron Stuart • (202) 306-5326 • cameron.stuart@dot.gov

Transfer Lengths of Large-Diameter Prestressing Tendons

PROJECT DESCRIPTION

- Ensuring a proper bond between concrete and indented wire reinforcements is critical to the performance of concrete railroad ties. This project conducts research to determine the pre-stress transfer lengths of large-diameter reinforcements using a variety of concrete properties. The research applies techniques (ASTM1096, automated wire scanner) developed in prior FRA research studying smaller reinforcements.
- Industry is moving to larger indented wire types: 7mm, 8mm, and 10.5mm – versus 5.32mm.
- Project goal is to empirically establish performance correlations between larger diameter wires and existing bond performance tests:
  - ASTM 1096 (un-tensioned pull-out test)
  - Wire indent geometric characteristics relationship to concrete tie transfer lengths



RAILROAD IMPACT

- This project develops advanced technology to improve the quality of concrete crossties. The object is to improve the state-of-good repair of railroads, improve operational safety, and reduce the economic burden of track maintenance. The project advances the state of knowledge with respect to concrete tie reinforcements.
- The bond relationship between pre-stressing wire and concrete is critical to managing concrete tie design and performance.
- Results will help eliminate concrete tie bursting failures.
- Project results will be disseminated throughout the industry and may results in adjustments to industry standards.

PROJECT PARTNERS

- RJ Pereman and Associates
- Nucor-LMP
- PCM RailOne AG
- voestalpine Nortrak

COST & SCHEDULE

- Funding: $167,936
- Project Duration: September 2020 – March 2023

FRA PROJECT MANAGER: Cameron Stuart • (202) 306-5326 • cameron.stuart@dot.gov

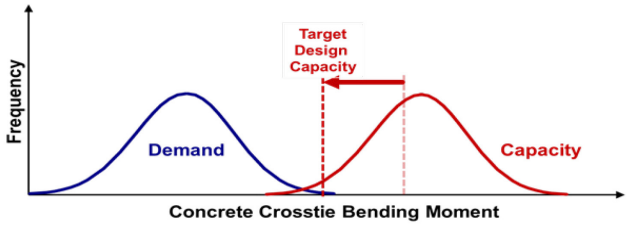
Advancing Concrete Crosstie Design

PROJECT DESCRIPTION

Concrete crossties are an essential element of railroad track structure. This project collects and summarizes industry research on concrete tie design and performance over the past decade into a single report. This report will serve as an educational tool for future academics, students, practitioners, and regulators.

RAILROAD IMPACT

The proper design and manufacture of concrete crossties is critical to the state of good repair of the U.S. railroads. The objective of this research is to collect the key research findings from recent concrete tie research into a single, easy-to-access report for use by students and industry personnel.



PROJECT PARTNERS

- University of Illinois at Urbana-Champaign
- Kansas State University
- University of South Carolina
- voestalpine Nortrak
- Vossloh AG

COST & SCHEDULE

- Funding: $1250,000
- Project Duration: May 2021 – November 2023

FRA PROJECT MANAGER: Cameron Stuart • (202) 306-5326 • cameron.stuart@dot.gov

Autonomous Power-Efficient Track Inspection System (APTIS)

PROJECT DESCRIPTION

Machine vision and artificial intelligence technologies are maturing rapidly in many industries. This project conducts research to adapt these technologies for use as an efficient, effective method to inspect track conditions. The project goal is to develop and test a modular, field-deployable system combining edge computing with advanced artificial intelligence processing to detect and classify track features from a moving platform in near-real-time

RAILROAD IMPACT

- The objective of this project is to research and apply advanced technologies to the task of track inspection. Machine vision and artificial intelligence technologies offer an opportunity to improve track inspection efficiency and increase the level of automation in these traditionally manual tasks.
- Track inspection and change detection capability in a cell-phone-sized package will expand the use of advance technologies to all field personnel.
- Real-time data products to assist in timely decision-making activities.
- Adaptable to many platforms – hand-held, hi-rail, full-sized rail vehicle

PROJECT PARTNERS

- University of South Carolina
- CFD Research Corp.
- CSX

COST & SCHEDULE

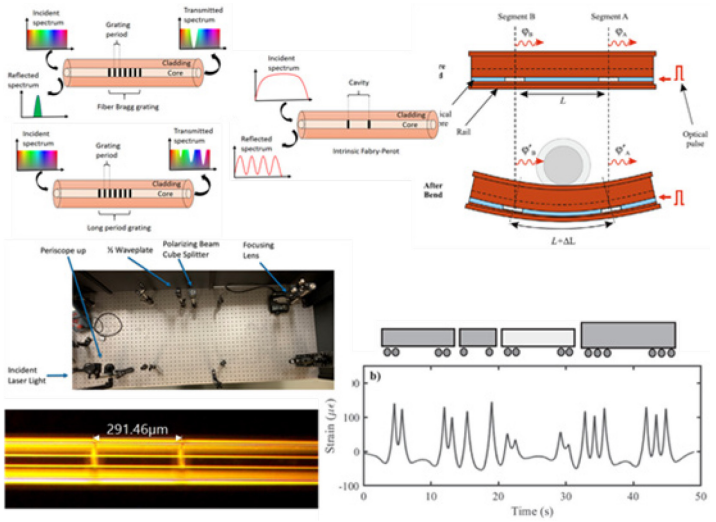
- Funding: $282,899 (Phases 1 & 2)
- Project Duration: September 2021 – September 2024

FRA PROJECT MANAGER: Cameron Stuart • (202) 306-5326 • cameron.stuart@dot.gov

Intelligent Track Transitions Using Optical Fiber Sensors

PROJECT DESCRIPTION

- Optical fiber technologies are finding new applications in many industries for presence detection and load measurements. This project researches optical fiber sensors for continuous, automated monitoring of track – especially track transitions. This technology development effort focuses on measuring the load distribution characteristics and load-deflection behavior of track.
- Three different optical fiber sensor technologies will be implemented: FBG, LPG, and IF-P.
- Field testing at the Transportation Technology Center (in collaboration with ENSCO, Inc.)
- Data being collected will include wheel counts, wheel load magnitudes, tie reaction forces, rail temperatures, and rail deflections.



RAILROAD IMPACT

- The objective of this research is to explore the utility of fiber-optic sensing technologies toward continuous monitoring of the track structure. The work represents a significant advancement over traditional single point and series measurement techniques.
- Research findings will pave the path for future utilization of existing fiber-optic cable network for railroad track condition monitoring (distributed sensing).

PROJECT PARTNERS

- Oklahoma State University
- HNTB Corp.
- ENSCO, Inc.
- Amtrak
- US Army COE ERDC

COST & SCHEDULE

- Funding: $169,141 (Phase 1)
- Project Duration: September 2022 – September 2025

FRA PROJECT MANAGER: Cameron Stuart • (202) 306-5326 • cameron.stuart@dot.gov

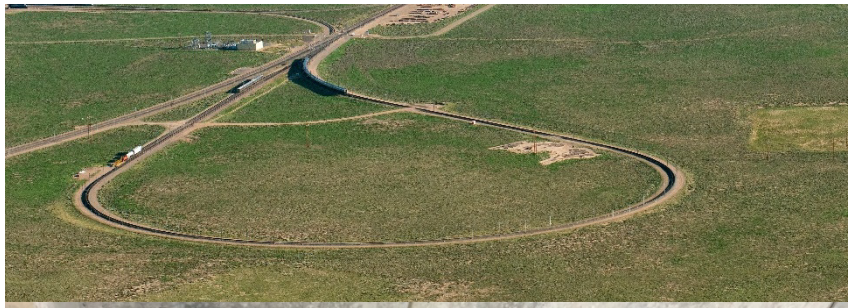
Advancement in Rail Integrity Inspection

PROJECT DESCRIPTION

- Continue ongoing effort on rail integrity at the Transportation Technology Center (TTC).
- Collect naturally occurring rail flaws (unbroken) from FAST, TTC, and North American railroads.
- Evaluate, maintain, and support activities related to the FRA Rail Flaw Library.
- Support third-party rail integrity testing at TTC.
- Research current Phased Array Ultrasonic Testing unit options and accessories and recommend best option for FRA needs at TTC.
- Develop a conceptual plan for a high-speed, non-contact rail flaw test facility at TTC.

RAILROAD IMPACT

- Support future research to evaluate and improve the performance of current and future rail inspection technologies.
- Achieve higher reliability of NDE inspection and procedures for complete rail flaw detection and characterization.
- Provide realistic rail flaw samples to researchers to validate their work on rail inspection technologies.
- Improve rail integrity research capabilities at TTC



PROJECT PARTNER

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $ 149,318
- Project Duration: October 2022 – September 2023

FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

Advancement of CWR Management

PROJECT DESCRIPTION

- Provide a well-diversified research portfolio to advance longitudinal rail force technologies and management.
- Develop a conceptual plan for a realistic RNT test bed/facility to facilitate all types of RNT testing.
- Provide continuous in-situ RNT monitoring.
- Support of third-party CWR management-related testing at the Transportation Technology Center.
- Investigate the effect of curve movement on RNT.
- Evaluate longitudinal track resistance under special conditions, including curve rail/break mechanics.
- Improvements in CWR destressing

RAILROAD IMPACT

- Increase track buckling safety through improved CWR management practices.
- Provide more accurate input and parameters for rail break theory implementations.
- Provide a RNT testing capabilities attractive for researchers, industry professionals, and universities from across the country.
- Support development of measurement equipment for rail longitudinal force in a realistic environment.
- Gain more understanding of curve movement management and rail break mechanics in curves.

PROJECT PARTNERS

- ENSCO, Inc.
- Kandrew Inc.

COST & SCHEDULE

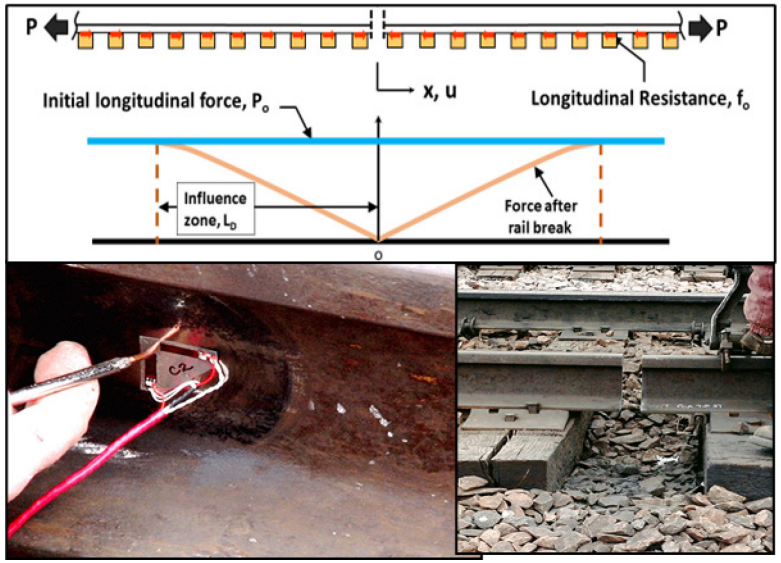
- Funding, FY23: $149,345 – Funded
  - FY24: $204,360 – Option
- Project Duration: October 2022 – September 2024

FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

Development of Low-Cost Rail Stress and RNT Management Technology

PROJECT DESCRIPTION

- Develop, construct, and demonstrate prototype low-cost rail stress and RNT management technology (RSMT) consisting of a disposable measurement coupon bonded to the rail and a hand-held data reader.
- Coupon will contain a strain-gauge circuit coupled with a rail temperature sensor to measure RNT.
- Design a low-power circuit board for sensor integration and communication.
- Perform testing in laboratory setting.
- Develop improved bonding methods.
- Fabricate prototype and conduct long-term field testing under controlled conditions.



RAILROAD IMPACT

- Provides direct knowledge of RNT profiles, enabling maintainers to perform and document rail adjustments in all scenarios
- Improves CWR procedures for RNT management and facilitates compliance with FRA CWR safety standards
- Enhances quality control for panel installations, joint removals, and crossing renewals
- Monitors RNT changes in curves
- Supports research and advancement of rail break theory by enabling feasible field experiments in revenue service

PROJECT PARTNERS

- ENSCO, Inc.
- Kandrew Inc.
- Instrumentation Services, Inc.

COST & SCHEDULE

- Funding, FY23: $163,651 – Funded
  - FY24: $222,816 – Option
- Project Duration: August 2022 – August 2024

FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

Rail Force Management Technology Implementation and Transfer

PROJECT DESCRIPTION

- Host, maintain, and improve rail force management software packages (CWR SAFE, RNT Restore, Rail Temperature and Buckling Application)
- Implement rail stress adjustment methodology for special cases into RNT Restore.
- Develop and implement a roadmap for rail force management software transfer to hosting by FRA.
- Convert CWR-SAFE core modules from FORTRAN to modern programming language.
- Support for rail force management software applications, including user documentation and training webinars.

RAILROAD IMPACT

- Provide industry and academia with a set of new and upgraded rail force management applications on a centralized platform that can assist with CWR management, guidance development, and future research.
- Establish better awareness and tools of proper rail stress management methodologies for field personnel.
- Create a platform to disseminate the results of FRA research in the area of longitudinal rail stress and CWR management to industry, academia, and regulators.

PROJECT PARTNERS

- ENSCO, Inc.
- Kandrew Inc.

COST & SCHEDULE

- Funding: $819,967
- Project Duration: September 2020 – December 2024

FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

Technical Support for FRA Office of Railroad Safety

PROJECT DESCRIPTION

- Assist FRA Office of Research, Development, and Technology in conducting tests, detailed analyses, and technical reviews on behalf of the Office of Railroad Safety to ensure the safety of the U.S. railroad network.
- Efforts can include analyses to ensure appropriate and justifiable regulations as well as support for efforts focused on railway infrastructure, passenger safety, and freight accident prevention.
- Provide support and training for safety-related issues including continuous welded rail (CWR) maintenance practices.

RAILROAD IMPACT

- Task provides for quick response instrumentation, testing, and analytical support to resolve safety-related problems and emergencies, determine causal factors, and reduce future problems.
- Supports data gathering for high-speed/high-cant deficiency qualification and revised safety standards, reflecting sound science and engineering expertise
- Facilitates ongoing technical evaluation required for demonstration and deployment of new technologies for improved safety and operational efficiency
- Training material for CWR management developed under this task will serve as a resource for the rail industry.

PROJECT PARTNERS

- ENSCO, Inc.
- Kandrew Inc.

COST & SCHEDULE

- Funding: $149,952
- Project Duration: March 2023 – October 2024

FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

Fatigue Crack Growth Rate Material Characterization of Targeted Microstructures of Welded Rail

PROJECT DESCRIPTION

- Subside specimens (railhead) of rails welded by flash-butt procedure and full-scale specimens of rails welded by the thermite process will be prepared.
- Metallographic analysis and hardness maps will be conducted for each process to determine the different regions of the microstructure in which the fatigue crack will be targeted for FCGR testing.
- Mechanical testing, including cross-weld tensile and fracture testing will be performed, targeting the specific microstructural regions of the weld and HAZ
- Crack growth rate testing will be done on the weld, the CGHAZ region (directly adjacent to fused region), and the SCHAZ region (typically defined as the region directly adjacent to the visible HAZ).
- Statistical analysis will be done to determine whether crack growth is due to differences in microstructure and/or to different load ratios.
- Modeling of crack growth will be done.

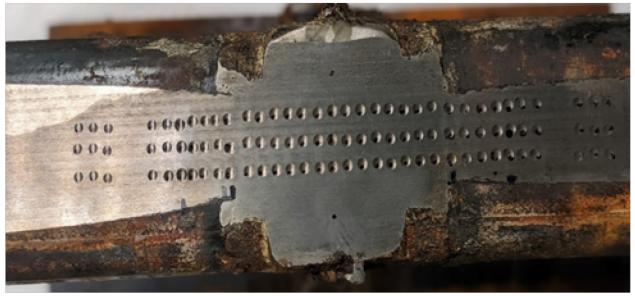
RAILROAD IMPACT

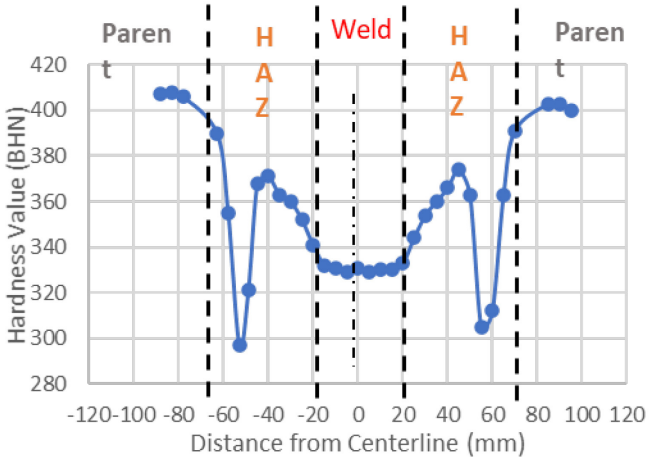
- Improve rail safety
- Better understand fatigue damage of welded rail joints
- Develop predictive model for crack growth in welded rail joints
- More accurately assess the inspection intervals and replacement schedules

PROJECT PARTNERS

- Tuskegee University
- EWI
- Thornton Tomasetti
- Steel Dynamics, Inc.
- Nucor Corp.

Thermite Weld Hardness Mapping





COST & SCHEDULE

- Funding, FY21: $179,613 – Funded
  - FY22: $173,834 – Funded
  - FY23: $146,553 – Option
- Project Duration: September 2021 – September 2024

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

Parameters Influencing Track Longitudinal Stiffness and Its Implications for Rail Adjustment Procedures

PROJECT DESCRIPTION

Overview

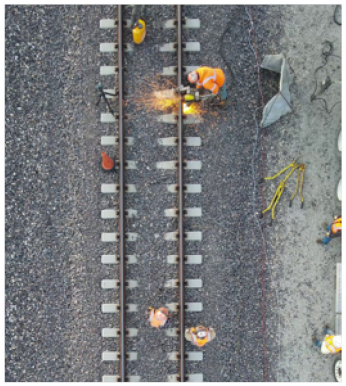
Provide quantitative assessment of variables influencing axial stress influence zones and guide future rail stress adjustment practices.

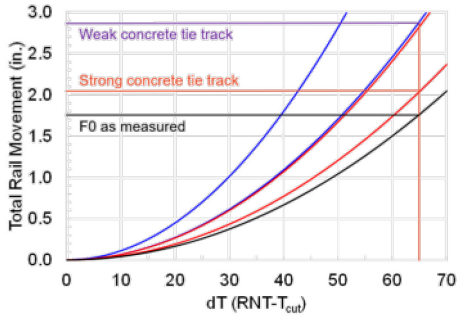
Methods:

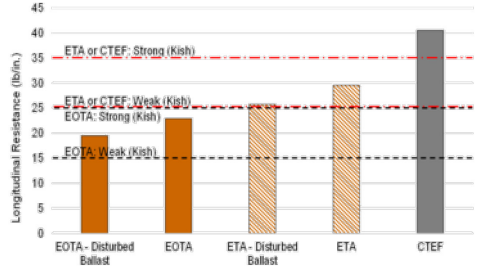
- Laboratory Experimentation: Quantify and control fastener and ballast stiffness; to be conducted at University of Illinois.
- Finite Element Modeling: Develop and advance model that is properly validated based on lab and field data collected in this project.
- Field Experimentation: Quantify impact of various parameters on longitudinal resistance to augment existing research on partner railroads.

Phase 1

Phases 2 & 3







RAILROAD IMPACT

- Improved rail integrity and maintenance guidance for unclipping rail during rail destressing
- Improved understanding of longitudinal rail stress transfer and its influence on changes in rail neutral temperature (RNT) as a function of time/tonnage.
- Improved quantification of how rail gap size and influence zone are influenced by:
  - Fastening system characteristics
  - Rail tension/compression
  - Ballast (track) longitudinal stiffness

PROJECT PARTNERS

- University of Illinois at Urbana-Champaign
- Amtrak, BNSF, Union Pacific Railroad
- Kandrew Consulting, Inc.

COST & SCHEDULE

- Funding: $420,000 (to date)
- Project Duration: September 2020 – September 2024

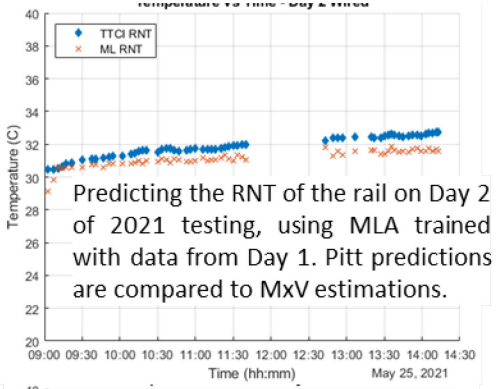
FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

Image Processing and Machine Learning Algorithms To Measure Axial Stress In Rails

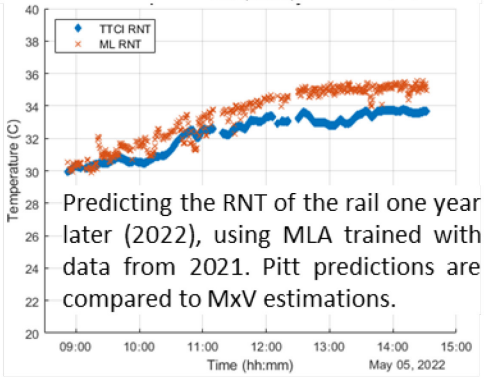
PROJECT DESCRIPTION

- Develop a new technology to determine the rail neutral temperature (RNT) of continuous welded rail.
- The original scope was based on the non-contact detection of rail vibrations induced by impact hammer using high-speed, high-resolution video-cameras. The videos were to be processed to extract the modal characteristics of rail, and link such characteristics to a machine learning algorithm trained with finite element data.
- **Three field tests were performed: Fall 2020, Spring 2021, and Spring 2022** in Pueblo, CO.
- The two most relevant results of these field tests were: (1) the setup can be greatly simplified and made more economical; (2) and the RNT predictions agree very well with the RNT estimated by TTC using conventional strain gages.

Close-up view of the instrumentation used during the latest field test



Predicting the RNT of the rail on Day 2 of 2021 testing, using MLA trained with data from Day 1. Pitt predictions are compared to MxV estimations.



Predicting the RNT of the rail one year later (2022), using MLA trained with data from 2021. Pitt predictions are compared to MxV estimations.

RAILROAD IMPACT

- Reliable technology able to determine axial stress and neutral temperature would reduce drastically the risk of buckling during warm days or rail fracture during the cold season.
- The proposed technology is conceived to be minimally invasive, cost-effective, and practical. It is minimally invasive and practical because it would require only a very few measurements to be conducted at any time of the day and at any time of the year.

PROJECT PARTNERS

- University of Pittsburgh
- MxV Rail (formerly Transportation Technology Center, Inc.)

COST & SCHEDULE

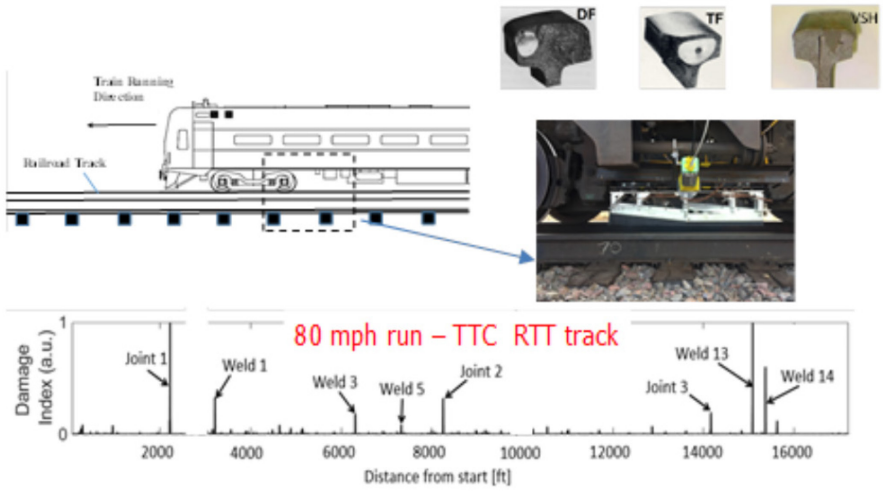
- Funding: $333,449
- Project Duration: July 2019 – February 2023

FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

High-Speed, Non-Contact Rail Inspection System

PROJECT DESCRIPTION

- FRA aimed to develop a rail inspection capability for internal flaws at test speeds comparable to revenue speeds.
- Significant prior experience of the University of California, San Diego, in design, construction, and testing of non-contact ultrasonic rail inspection systems leveraged for the development of a high-speed rail inspection capability.
- Already performed four field tests at TTC at speeds up to 80 mph with good feasibility results for the detection of joints, welds, and internal flaws.
- Recent work aimed at bringing the POD and the PFA for internal rail flaws to acceptable levels.
- Most recent field test in June 2022 up to 40 mph (max allowed on HTL loop) demonstrated effectiveness of controlled acoustic source and low-cost sensors.



UCSD high-speed rail inspection prototype and a test run at 80 mph at TTC (RTT track)

RAILROAD IMPACT

- High-speed rail inspection technology would enable extremely high testing speeds, well beyond the ~ 25 mph maximum speed currently allowed by conventional (e.g., RSU-based) rail inspection cars.
- Inspecting the rail at regular train speeds would simplify scheduling of rail inspections around normal traffic.
- "Smart train" approach: This technology could be used on regular trains to enable multiple, redundant inspections of the same track, thereby improving the inspection reliability and, ultimately, transportation safety.

PROJECT PARTNERS

- University of California, San Diego
- BNSF Railway and Union Pacific Railroad
- Transportation Technology Center, Inc.

COST & SCHEDULE

- Year 1 (funded): $256,925
- Year 2 (funded): $229,542
- Project Duration: September 2020 – March 2023

FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

Rail Neutral Temperature Estimation Using Local Rail Vibration Measurements and Machine Learning

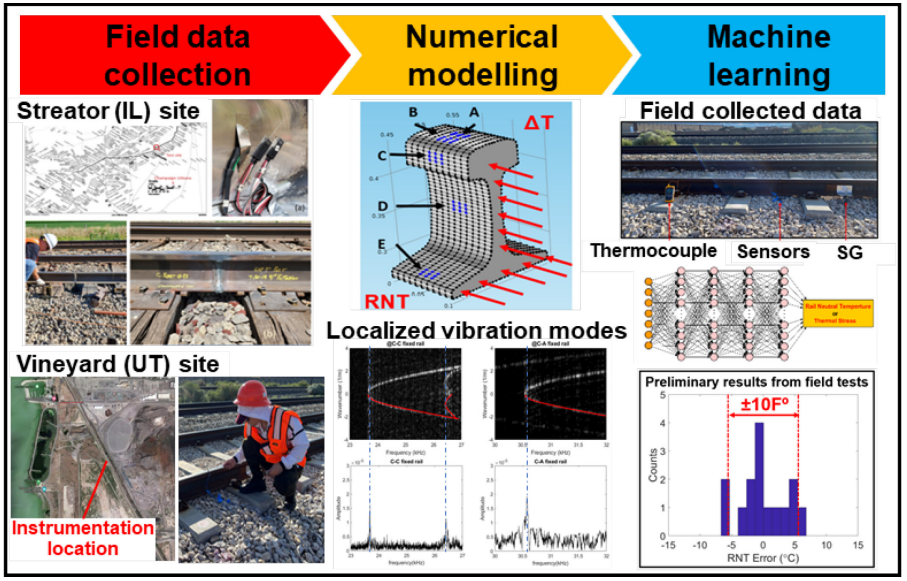
PROJECT DESCRIPTION

Overview

The objective of this project is to develop and evaluate a system to measure, non-destructively, rail neutral temperature (RNT) of in-place continuous welded rail (CWR) to an accuracy of ± 5 ˚F.

Methods:

- Collect local rail vibration data from two different instrumented revenue-service rail test sites.
- Study fundamental relationships between local rail vibration data and RNT, rail temperature, longitudinal load, rail structure, and support conditions.
- Develop supervised machine learning algorithms to determine RNT in situ without need for reference measurements, disruption to traffic, nor modification to track structure.
- Perform technology evaluation with unfamiliar data.



RAILROAD IMPACT

Improve track safety and reliability by minimizing the risks of track buckling through technology that:

- Predicts in-place RNT with an accuracy of ±5ºF
- Does not disrupt or modify track structure
- Does not require baseline reference data
- Is insensitive support condition, temperature, and residual stress variations
- Is applicable to all rail and train traffic conditions

PROJECT PARTNERS

- University of Illinois at Urbana-Champaign; University of Utah
- BNSF
- Utah Transit Authority

COST & SCHEDULE

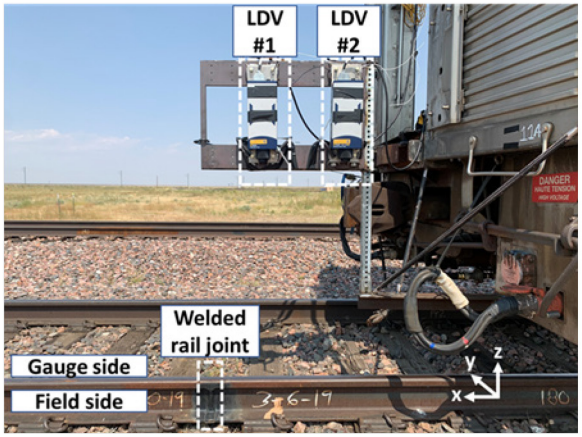
- Funding: $209,377 (to date)
- Project Duration: September 2021 – March 2023

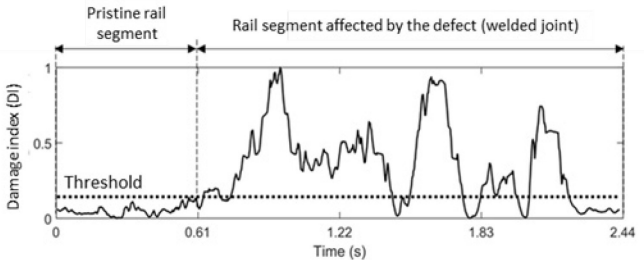
FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

Rail Defect Detection By Noncontact Measurements

PROJECT DESCRIPTION

- The goal of this project is to develop a non-contact technology for identifying defects in rails.
- Laser Doppler vibrometer (LDV) measurements are proposed to analyze rail vibrations induced by wheel-rail contact.
- A numerical framework was developed to simulate the damage detection system while laboratory tests were performed to investigate speckle noise observed in moving LDV measurements.
- Advanced system identification algorithms integrated with noise reduction and damage detection techniques were evaluated to identify rail defects, including internal defects and missing fasteners.
- Field tests were carried out at the Transportation Technology Center to evaluate the performance of the proposed system to identify a welded rail joint and missing fastener.
- Additional field tests will be performed in Cleburne, TX, in collaboration with BNSF.





RAILROAD IMPACT

- A non-contact rail integrity inspection system to detect rail flaws including internal flaws using rail vibrations induced by railcar wheels.
- Implementation of a new generation infrared-based laser Doppler vibrometer in order to maximize the signal-to-noise ratio in the measurement signals.
- Ability to carry out inspections at operation rail car speeds.

PROJECT PARTNERS

- University of Texas at Austin (UTA)
- Transportation Technology Center, Inc.
- BNSF
- Polytec, Inc.
- Texas Innovation Center at UTA

COST & SCHEDULE

- Funded: $515,000
- Period of Performance: May 2019 – August 2023

FRA PROJECT MANAGER: Robert Wilson• (617) 999-0061 • robert.wilson@dot.gov

Longitudinal Stress Measurement Using Ultrasound, Phase II

PROJECT DESCRIPTION

During Phase 1 and 2a of the Longitudinal Stress Measurement Using Ultrasound project, the following were achieved:

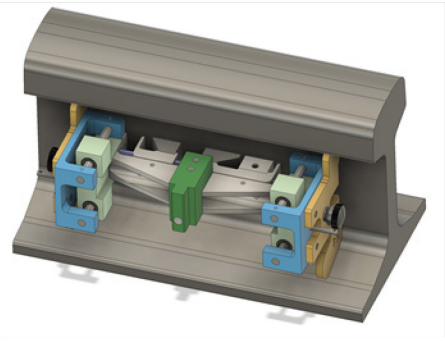
- Fabricated device for measuring rail stress using ultrasound (Direct (*Method A*) and Angled (*Method B*))
- Conducted laboratory calibration tests to determine the elastic constants of UK & US rail steel (*Method A*)
- Achieved a NRT accuracy of 2.9 ksi/15.3 °F (*Method A*)
- Conducted laboratory and track trials on U.K. rails to validate *Method B*
- Achieved linear, consistent, and more accurate measurements by combining Methods A and B (*Hybrid*)

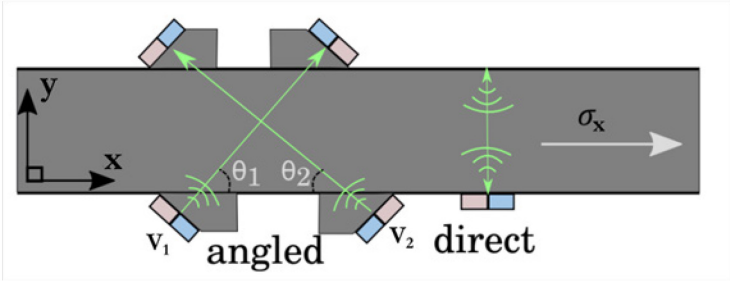
Phase 2b of work will consist of:

- Refining *Method B* to achieve high consistency and accuracy
- Improving the data processing and automation algorithm
- Validating *Method B* through laboratory testing on U.K. rail specimens and track trials on both U.K. and U.S. rails

Outcome:

- An ultrasonic-based, calibration-free NRT measurement method – independent of material properties





RAILROAD IMPACT

- Extension of rail lifetime, enhancement of railroad safety and reduction of track downtimes by minimizing occurrences of bucking/pull-apart.
- Simplification and cost reduction of rail NRT maintenance through a fast, non-destructive ultrasonic-based NRT measurement system.
- Project outcomes could be developed into a portable NRT measurement device for non-specialist operator.

PROJECT PARTNER

- University of Sheffield, U.K.

COST & SCHEDULE

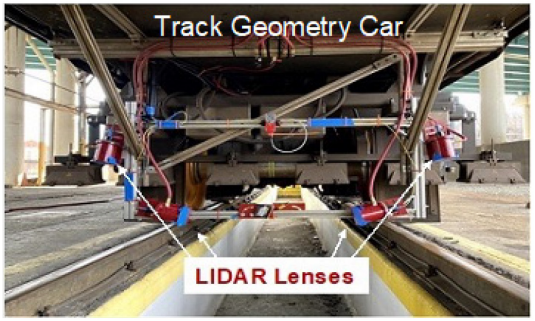
- Funding: FY21 $150,120 – Funded
  - FY22: $150,120 – Funded
  - Cost Sharing total: $120,000
- Project Duration: September 2021 – September 2023

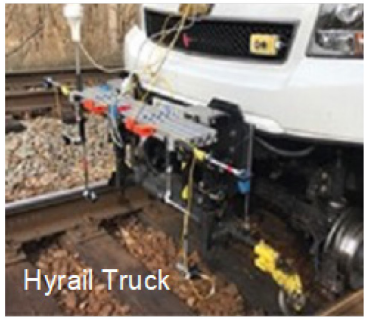
FRA PROJECT MANAGER: Robert Wilson• (617) 999-0061 • robert.wilson@dot.gov

Advanced, Non-Contact Detection of Lateral Track Strength

PROJECT DESCRIPTION

- Evaluate the applicability of non-contact Doppler LiDAR sensors to detect lateral track and crosstie motions/vibrations as they relate to rail movement and buckling under rolling wheel loads.
- Evaluate the applicability of non-contact sensors for in situ detection of lateral track strength.
- Determine the effectiveness of Doppler LiDAR systems or similar non-contact sensors (eddy current, etc.)
- Develop advanced data analytics methods that can provide efficient, accurate, and autonomous post-processing means for the large volume of data that results from the revenue service and test track testing.
- Provide recommendations for the use of non-contact sensors for detecting weak track strength.





RAILROAD IMPACT

- Providing improved systems for rail stability detection with far better timeliness than currently possible
- Developing data analytics methods for semi/fully-automated processing of a large volume of data
- Advancing railroad operational safety and maintenance efficiency
- Improving the FRA and Class I railroads' ability to perform autonomous track inspection to determine lateral track strength, far beyond the available methods

PROJECT PARTNERS

- Virginia Polytechnic Institute and State University
- Norfolk Southern Railway

COST & SCHEDULE

- Funding:
  - Year 1 budget: $195,496
  - Year 2 budget: $204,495 - Option - Unfunded
- Project Duration: August 2022 – August 2024

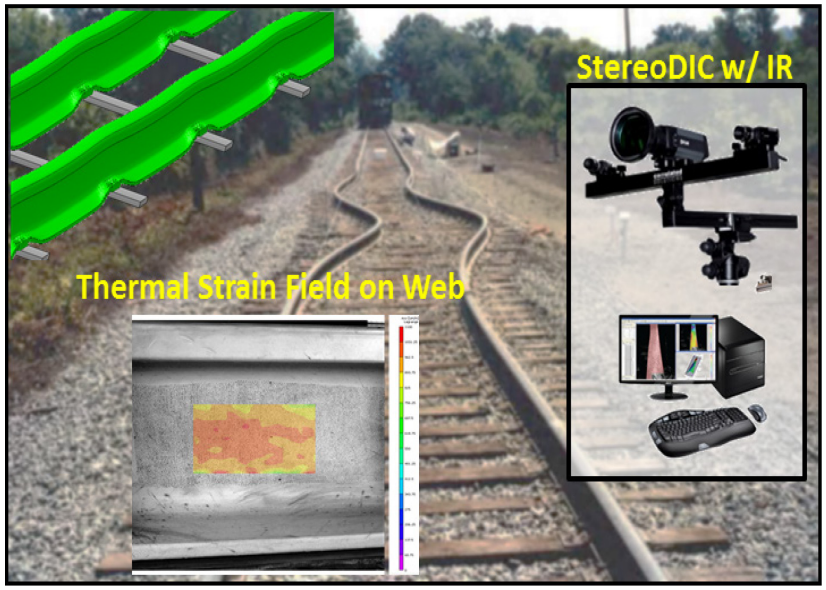
FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

Non-Contacting System for Longitudinal Rail Stress Measurements: Field Deployment and Validation

PROJECT DESCRIPTION

Following the success of previous FRA-sponsored research, this project explores the field deployment, optimization, testing, and qualification of the next generation system for RNT and rail longitudinal stress measurements.

- The system hardware is a portable, non-contacting DAQ system based on stereo vision and/or 3D laser scanner technology for full field deformation measurements of rail.
- The system software implements a reference-free, novel algorithm for data processing of a series of measured rail deformation fields within a thermal cycle.
- The next generation system will be deployed, tested, validated, and demonstrated in the field under various track and operating conditions and acquisition modes.



RAILROAD IMPACT

- Improve safety due to early detection of potential rail failure.
- Facilitate effective management of thermal stresses.
- In-situ, non-destructive, reference-free testing; does not disrupt service
- Simple, easy-to-use, accurate, and cost-effective technology deployed on a routine basis or on-demand.
- Ability to integrate data with information acquired by other track sensing technologies.

PROJECT PARTNERS

- University of South Carolina
- Correlated Solutions Inc.
- CSX Transportation

COST & SCHEDULE

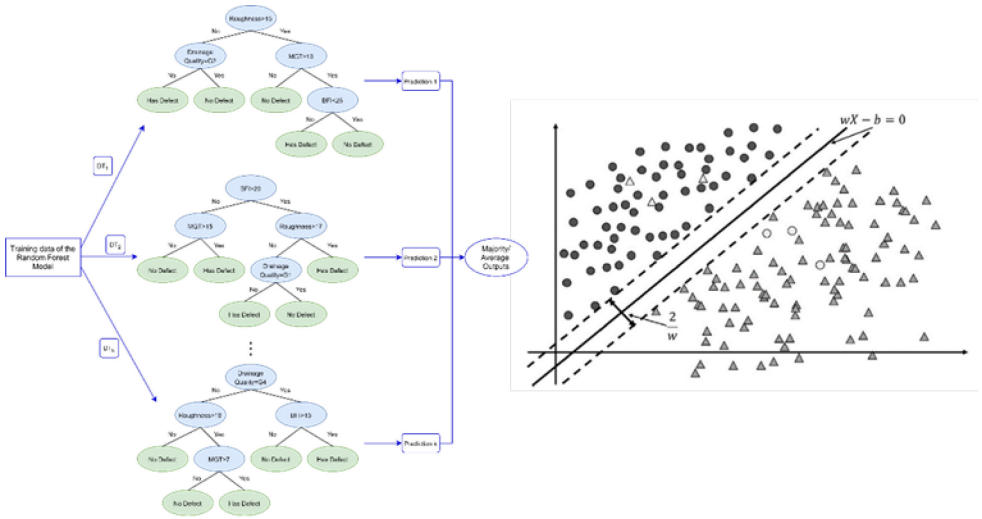
- Funding:
  - $164,077 (FY21 – Funded)
  - $166,170 (FY22 - Funded)
  - $122,961 (FY23 - Option)
- Project Duration: September 2021 – September 2024

FRA PROJECT MANAGER: Robert Wilson • (617) 999-0061 • robert.wilson@dot.gov

Machine Learning-based Analysis of the Need for Railway Track Maintenance

PROJECT DESCRIPTION

- The effect of drainage quality, BFI, previous geometry data, and MGT on track degradation rate will be investigated using large datasets.
- At least two machine learning-based methods, namely, random forest and support vector machine will be employed to predict the mileage of geometry defects.
- A new dataset from another track will be utilized to check the accuracy of proposed models.



RAILROAD IMPACT

- Improving track performance as geometry defects are predicted and maintained before they surpass certain thresholds
- Valuable information regarding the effect of drainage quality on track degradation rate will be provided, which helps in making key decisions on maintaining or improving the drainage in order to decrease track degradation rate.
- Reducing the carbon footprint associated with track maintenance

PROJECT PARTNERS

- University of Massachusetts Amherst
- Loram Technologies, Inc.
- HNTB Corp.

COST & SCHEDULE

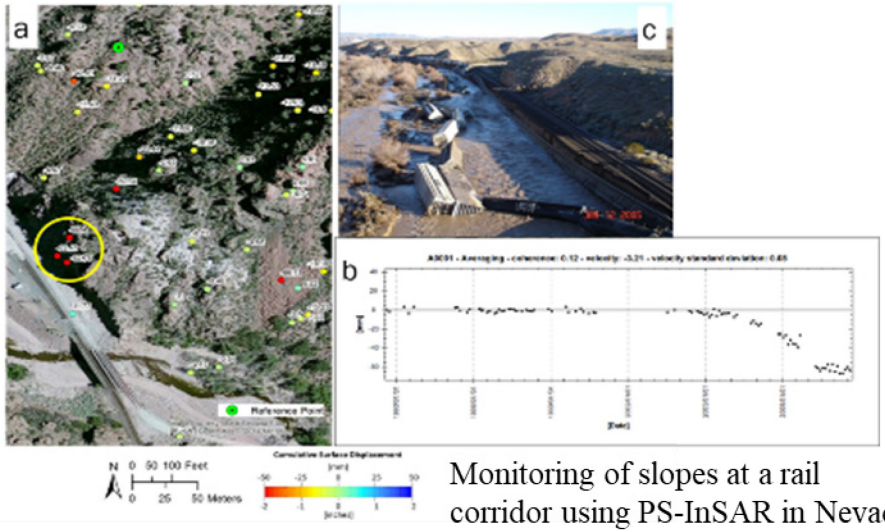
- Funding: $315,623
- Project Duration: July 2021 – July 2023

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Integrated, Automated Decision Support System for Ground Hazard Risk Mitigation for Railways Using Remote Sensing and Traditional Condition Monitoring Data

PROJECT DESCRIPTION

- Establish a geospatial database and decision support system of railway ground hazard locations and failures.
- Develop and monitor high ground hazard segments of the rail corridor by integrating real-time environmental data, satellite, unmanned aerial vehicle, and railcar-mounted remote sensing technologies with traditional condition monitoring data.
- Use automated change detection and a smartphone-based data entry portal as a tool for incident reporting, using field photographs to validate remote-sensing-based ground hazard and the condition of the rail infrastructure and the right-of-way in (ROW) high ground hazard zones.
- Ground-truth the automated change detection and develop a decision support system based on the triggering levels of ground hazard obtained from historic data.



Monitoring of slopes at a rail corridor using PS-InSAR in Nevada

RAILROAD IMPACT

- Geospatial database and decision support system for integrating ground hazard information with traditional condition monitoring data.
- Proactively locate, monitor, and mitigate ground hazard risks along the ROW.
- Enhance the safety and reliability along corridors prone to ground hazard risks.
- Reduce geohazard-based operational disruptions and safety risks through predictive evaluation and monitoring.

PROJECT PARTNERS

- Loram Technologies, Inc.
- BNSF
- Wisconsin & Southern Railroad
- Michigan DOT

COST & SCHEDULE

- Funding: $606,922
- Project Duration: October 2021 – 2024

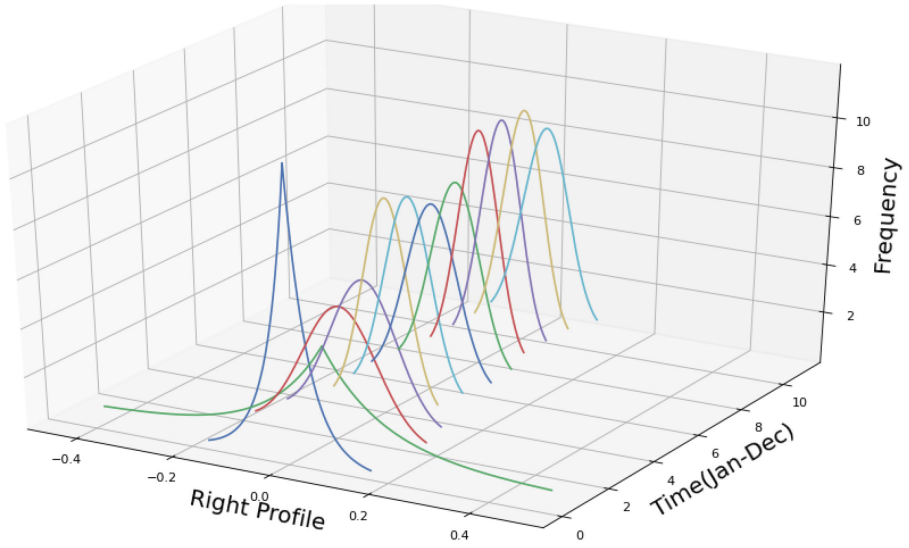
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Development of a Multi-Dimensional Track Quality Index (TQI) and Defect Risk Model in Support of Autonomous Track Geometry Inspection

PROJECT DESCRIPTION

- Develop 3D track geometry running surface growth model based on densely gathered inspection data.
- Develop AI model to determine growth rate probabilities and projected time to defect development.
- Develop AI model to determine probability of defect/exception development.
- Provide for identification of track locations with potential for track geometry defect development with a focus on safety-related defects that can result in geometry-related derailments.
- Develop analysis algorithm(s) to create multi-dimensional TQI with time/MGT component.
- Validate the algorithms.



RAILROAD IMPACT

- Increased inspection car frequency and autonomous inspection vehicle data provide additional information about condition and adequacy of the track geometry.
- Ability to use this additional data to better understand degradation and defect occurrence is valuable tool for railroads and FRA.
  - Provide additional information on where high-risk track geometry defects could develop.
  - Provide prioritized maintenance through new TQI.
- Fewer severe geometry defects and associated derailments

PROJECT PARTNERS

- University of Delaware, Railroad Engineering and Safety Program
- Amtrak

COST & SCHEDULE

- Funding, FY20: $238,551
- Project Duration: September 2020 – December 2023

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Quantitative Assessment of the Influence of Drainage on Track Support

PROJECT DESCRIPTION

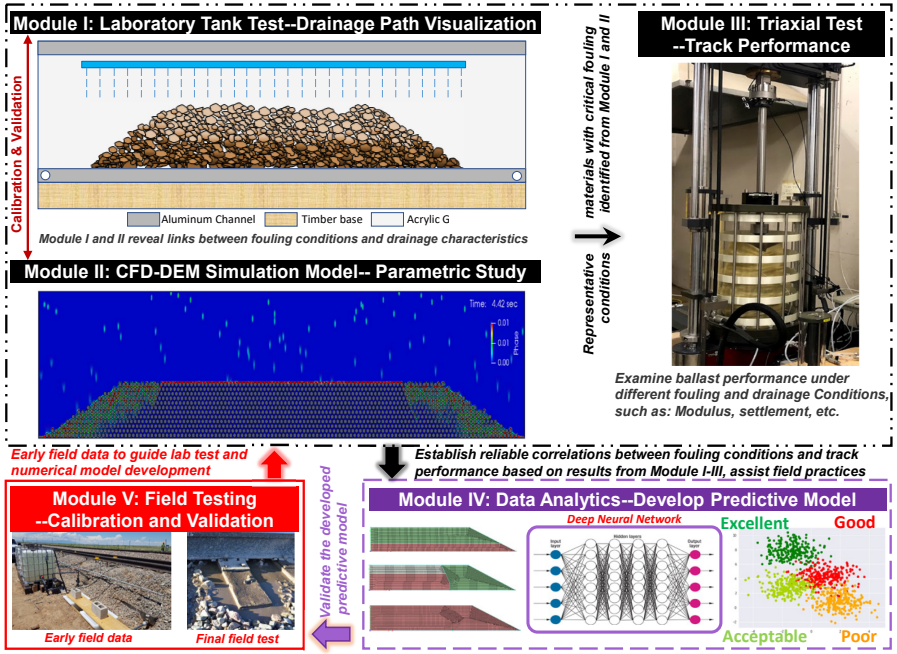
- Quantitatively study the ballast drainage characteristics under different fouling levels and fouling materials.
- Establish accurate correlations between ballast fouling conditions, drainage characteristics, and track performance.
- Examine the effectiveness of popular track maintenance methods, such as shoulder cleaning, track lifting, undercutting.
- Develop a practical predictive model to assist in field track maintenance decision making.

PROJECT PARTNERS

- University of South Carolina
- CSX Transportation
- M×V Rail
- BNSF
- Loram Technologies, Inc.
- RTS Corp.
- HNTB Corp.

COST & SCHEDULE

- Funding: $385,000
- Project Duration: August 2021 – August 2024



RAILROAD IMPACT

- Use a practical numerical predictive model to assist field track maintenance decision making.
- Provide guideline for selecting the best maintenance method according to specific track conditions.
- Provide reference information to help to make cost-effective maintenance schedule.
- Assist to condition-based track maintenance and improve track safety and operation efficiency.

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

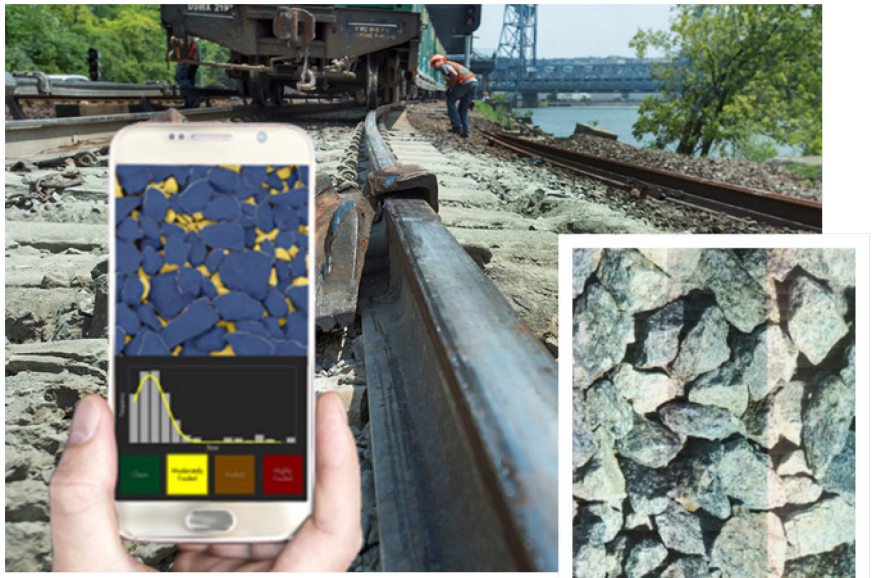
Crushed Aggregate Gradation Evaluation System

PROJECT DESCRIPTION

- Develop a portable, scalable machine vision-based aggregate inspection technology.
- Utilize deep learning computer vision techniques to analyze aggregate particle size grading and derive a fouling index in real time.
- Enhance prototype smartphone system for ballast assessment and develop subsurface imaging (probe) component.

RAILROAD IMPACT

- Development of an objective, quantitative system for railroads and FRA inspectors to characterize fouled ballast conditions in the field in real-time.
- Improved railroad safety and maintenance operations
- Broaden the application of innovative technologies to detect degraded track conditions.



Subsurface probe image

PROJECT PARTNER

- Oceanit

COST & SCHEDULE

- Funding: $300,000
- Project Duration: July 2021 – June 2023

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Comprehensive Asset Mapping Survey of Test Loops and Associated Tracks at the Transportation Technology Center

PROJECT DESCRIPTION

- Undertake a Railway Asset SCanning (RASC®) survey of the test loops, Chemical Depot line, and yard tracks at the Transportation Technology Center, Pueblo, CO, utilizing a suite of sensors including ground- penetrating radar, linescan camera imaging, 3D panoramic camera and mobile terrestrial laser scanning.
- Process the integrated datasets to provide a comprehensive asset mapping survey of the various test tracks.
- Provide a suite of asset mapping parameters, including but not limited to: track centerline, mileposts, structures (bridges, crossings, signage) ballast volume, insulated joint location, and catenary (mast locations and OLE height and stagger).

RAILROAD IMPACT

- Provide a baseline asset survey of the test tracks at TTC at the point of handover to the new operator.

PROJECT PARTNERS

- Rhomberg Sersa USA, Inc.
- Zetica Rail

COST & SCHEDULE

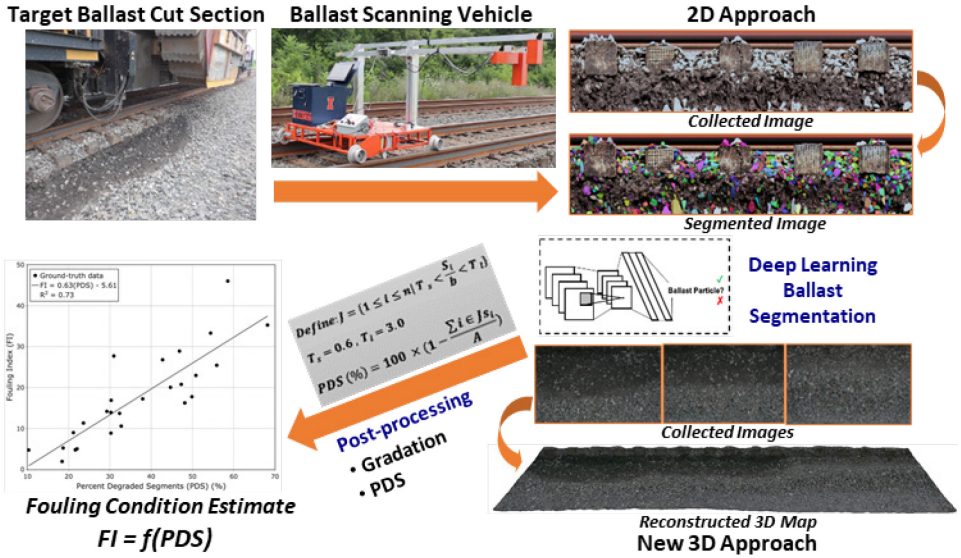
- Funding: $109,039
- Project Duration: April 2022 – September 2023

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Automated, Machine Vision-Based Ballast Scanning System

PROJECT DESCRIPTION

- Develop and demonstrate implementation of a computer-vision-based ballast inspection system mounted on an automated rail vehicle.
- Portable and efficient method for acquiring continuous longitudinal scans and depth profiles from ballast shoulder and crib sections
- Rapid and automated inspection approach, capable of quantifying ballast condition along the track without sampling
- Percent degraded segments extracted from images linked to Selig's fouling index.



PROJECT PARTNERS

- Loram Technologies, Inc.
- BNSF
- Canadian National Railway
- Amtrak

COST & SCHEDULE

- Funding: $398,694

RAILROAD IMPACT

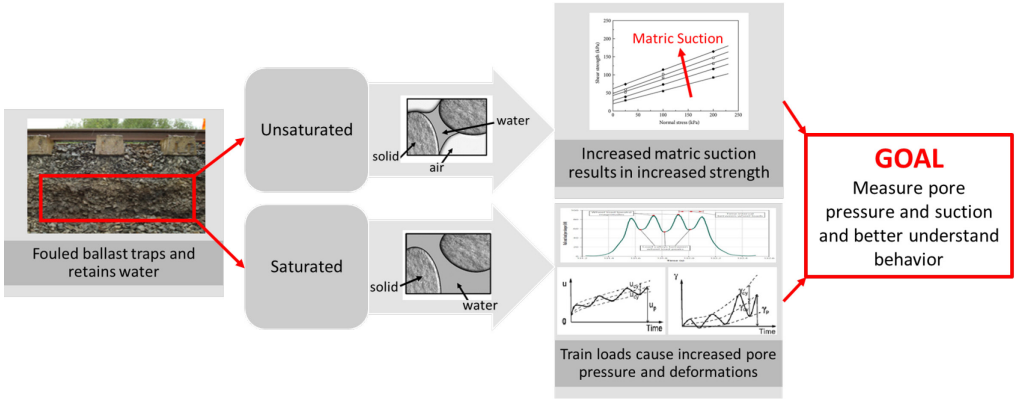
- Real-time (or near-real-time) detection and/or prediction of ballast anomalies and degradation using deep learning techniques.
- Automated, consistent, and objective imaging-based evaluation of ballast condition.
- Investigative tool for geotechnical analysis at trouble spots
- Can be paired with other automated GPR and track settlement data to establish correlations and provide ground truth
- Improve rail network safety and reliability.

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Development and Assessment of a Pore Water Pressure and Matric Suction Sensor: Laboratory Strength Testing and Field Substructure Monitoring

PROJECT DESCRIPTION

- Trapped and retained moisture can have varying effects on ballast strength and track deformation. A system of sensors capable of measuring localized pore water pressure and matric suction is needed to better describe the overall behavior of fouled ballast. We will:
  - Develop a laboratory pore pressure and matric suction sensor system capable of localized measurements within the specimen;
  - Modify the laboratory system for field implementation;
  - Develop a particle-based wireless sensor system capable of localized measurements of strain, particle motion, pore pressure, suction, temperature, barometric pressure, and humidity.



PROJECT PARTNER

- BNSF

COST & SCHEDULE

- Funding, FY22: $104,576; 24-month total: $204,856
- Project Duration: September 2022 – September 2024

RAILROAD IMPACT

- Improves understanding of the role of pore water pressure and suction in laboratory and field conditions
- Improves understanding of ballast strength degradation with increased fouling and moisture
- Improves understanding of overall ballast behavior (i.e., strength and deformation) under train-induced loads
- Increases safety and efficiency for rail industry
- Improves nondestructive detection of fouled ballast using traditional and novel technologies

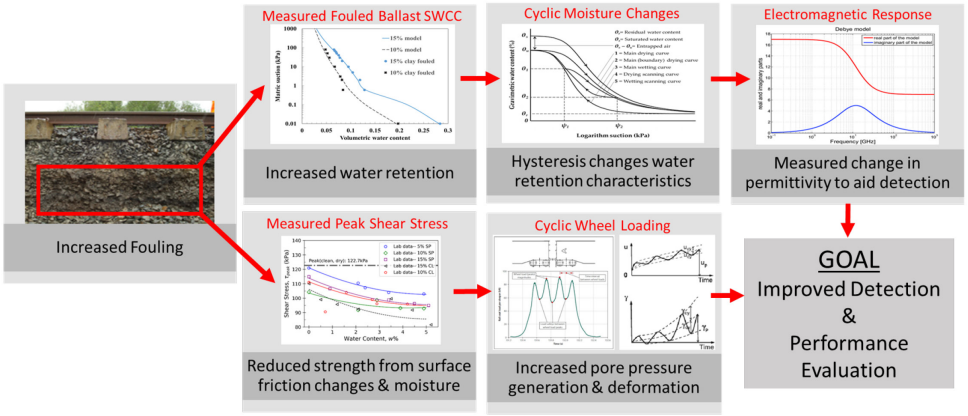
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

A Mechanistic-Phenomenological Investigation of Fouled Ballast to Support In-situ Identification of Fouling

PROJECT DESCRIPTION

- Cyclic loading and wetting and drying affect unsaturated fouled ballast behavior in the field, yet quantification of the strength-deformation-electromagnetic response is remains limited. Researchers will:
  - Measure inter-particle friction and examine surface properties.
  - Measure cyclic mechanical response of unsaturated fouled ballast.
  - Measure hysteretic suction coupled with complex dielectric permittivity.
  - Generate a phenomenological model that couples the mechanical and electromagnetic mechanisms with the overall response.



RAILROAD IMPACT

- Improves understanding of unsaturated and electromagnetic characteristics of fouled ballast, including the role of different fouling materials, water content, density, and shear strength
- Improves understanding of the cyclic response and the role of pore water pressure in the laboratory and field
- Increases safety and efficiency for the rail industry
- Improves nondestructive detection of fouled ballast using technology used by the rail industry

PROJECT PARTNERS

- BNSF
- Texas State University

COST & SCHEDULE

- Funding, FY22: $156,686; 24-month total: $299,574
- Project Duration: September 2022 – September 2024

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Innovative Track Inspection Technologies

PROJECT DESCRIPTION

- Support the introduction of new track inspection approaches and advancement of existing track inspection technologies – with a focus on data interpretation and analysis.
- Research the assessment of FRA's Vertical Track Deflection Measurement System (VTDMS) and alternative approaches to directly measure vertical defection under given loads.
- Provide engineering and data analysis support for Gage Restraint Measurement System, ground penetrating radar, VTDMS, and similar track evaluation technologies.
- Support field activities for FRA track research.

RAILROAD IMPACT

- Broaden the application of innovative technologies to detect degraded track conditions
- Improve the understanding of track behavior through characterization of various track components and parameters.
- Provide practical uses of technology to improve railroad safety and maintenance practices.

PROJECT PARTNERS

- ENSCO, Inc.
- Oklahoma State University
- Instrumentation Services, Inc.
- AP Sensing

COST & SCHEDULE

- Funding, FY23: $1,128,831
- Project Duration: August 2018 – July 2023

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Support for Testing with FRA Inspection Fleet

PROJECT DESCRIPTION

- FRA owns several inspection vehicles which assure and improve the safety of the rail transportation system under the Automated Track Inspection Program (ATIP) program.
- The FRA Office of Research, Development, and Technology (RD&T) uses the DOTX 218/DOTX 220 consist for the development and demonstration of its research products and ideas in accordance with the MOU signed by the FRA Office of Railroad Safety.
- Efforts under this task focus on supporting the operations, maintenance, repairs, and upgrades to the RDT systems installed on the DOTX 218/DOTX 220 consist, including the Vertical Track Deflection Measurement System and ground-penetrating radar.

RAILROAD IMPACT

- Provide research platforms to develop, improve and demonstrate track inspection technologies.
- Allow for the expansion of current track inspection capabilities throughout the railroad industry
- Improve railroad safety and maintenance practices.

PROJECT PARTNERS

- ENSCO, Inc.
- Balfour Beatty Infrastructure, Inc.
- Zetica Ltd.
- Harsco, Inc.
- Vista Clara, Inc.

COST & SCHEDULE

- Funding, FY23: $1,059,880
- Project Duration: August 2018 – July 2023

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Ongoing Support, Improvements to and Development of the GPR System Deployed on DOTX 220

PROJECT DESCRIPTION

- Provide ongoing support and further improvement of the autonomous ground-penetrating radar (GPR) system deployed on DOTX 220.
- Implement and refine the automatic layer picking algorithm successfully demonstrated during the 2020–2022 contract to enhance the ballast condition exception reports with layer interface metrics, such as layer roughness, ballast pockets and moisture likelihood.
- Undertake ongoing enhancements to the RASC Manager client portal, including the introduction of automated productivity reports, QA alerts via email, and reporting of layer metric exceptions.
- Provide detailed Trackbed Inspection Reports for requested locations of interest.

RAILROAD IMPACT

- Broaden the application of GPR to characterize trackbed condition associated with track geometry defects to contribute to quicker root cause assessment.
- Automatically monitor problem areas to assist with tracking trackbed condition change.
- Provide practical uses of technology to improve railroad safety, inspection and maintenance practices.

PROJECT PARTNERS

- Rhomberg Sersa USA, Inc.
- Zetica Rail

COST & SCHEDULE

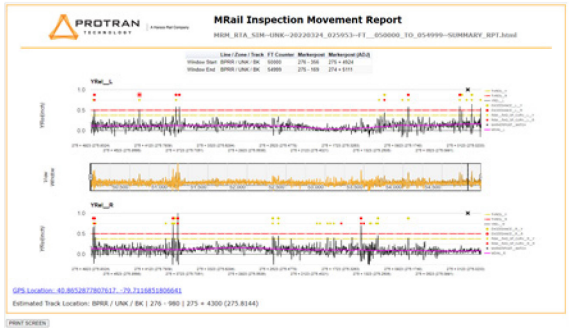
- Funding, FY23: $230,449
- Project Duration: July 2022 – June 2024

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Vertical Track Deflection Measurement System Continued Soft Track Risk: Applications and General Development

PROJECT DESCRIPTION

- Expand and add functionality to DOTX 218 MRail system.
- System software upgrades to include near-real-time exceedance output
- Investigations into alternate hardware solutions with potential implementations
- Refinements to mud spot/soft track risk model using continuously collected data and feedback



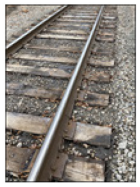


Image of site 2


Image of site 5


Image of site 6


Image of site 7

RAILROAD IMPACT

- Ability to quantify risk related to soft locations in track
- Increased safety and improved maintenance philosophies with signification economic impact
  - Using risk evaluations to target maintenance at locations with more urgent vertical rail deflection profiles
- Availability of a more robust and useful inspection system

PROJECT PARTNERS

- Harsco Rail / Protran Technology

COST & SCHEDULE

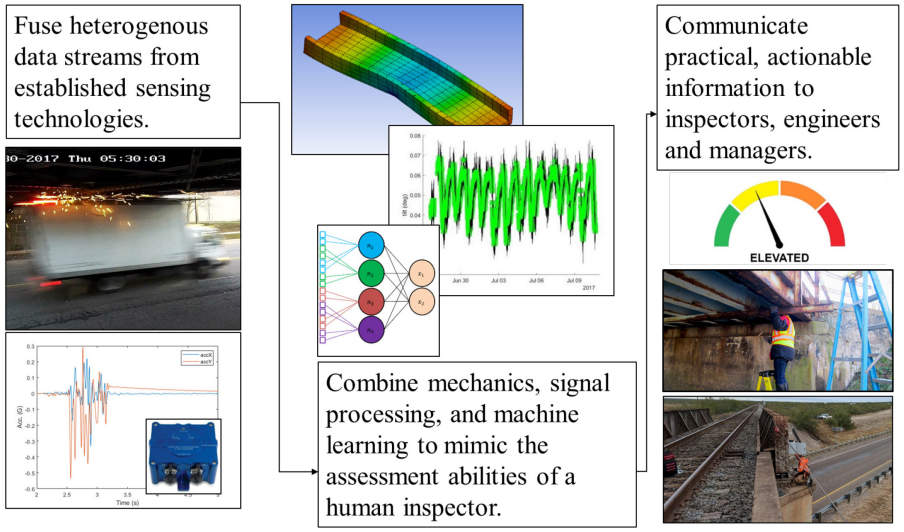
- Funding: $150,000
- Project Duration: September 2021 – January 2023

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Rail Bridge Strike Characterization and Evaluation Using Artificial Neural Networks

PROJECT DESCRIPTION

- Develop a system that detects rail bridge strikes, assesses their severity, and communicates information to bridge managers.
- Train machine learning algorithms to interrogate heterogenous data streams (e.g., time histories, images/video) collected from proven instrumentation systems.
- Augment real-world datasets with finite element simulation data to increase the ability of the system to localize strikes and estimate strike severity.



RAILROAD IMPACT

- Effective bridge strike detection and post-strike evaluations are critical to maximizing safe service of rail infrastructure.
- Light vehicle bridge strikes often cause no structural damage, but still require bridge closure and inspection.
- A system that automatically assesses strike severity and provides actionable condition information (1) promotes safe service operation on and around a bridge, and (2) improves bridge managers' efficiency in making decisions.

PROJECT PARTNERS

- Southern Methodist University
- SENSR Structural Monitoring Solutions
- Long Island Rail Road
- Volpe National Transportation Systems Center

COST & SCHEDULE

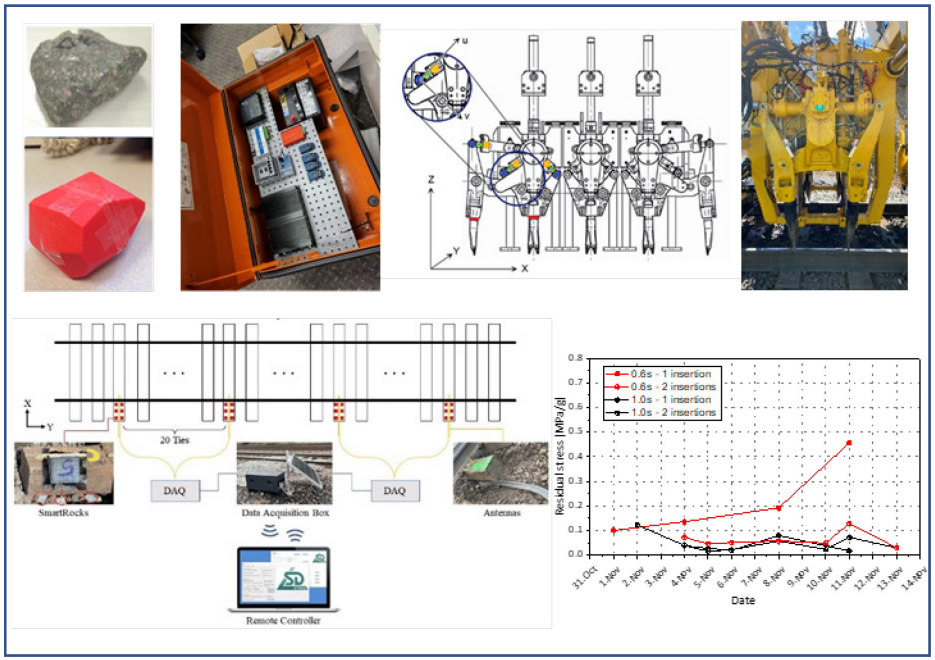
- Funding: $379,370
- Project Duration: May 2020 – May 2023

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Rail Safety Improvement through Enhanced Understanding Of Ballast and Subgrade Interactions

PROJECT DESCRIPTION

- Investigate the impact of tamping on the improvement of track stability by employing SmartRocks, together with Plasser American's latest smart tamping tool.
- Quantify the track stability at ballast particle level by analyzing particle movement and residual stress during and after tamping.
- Identify the effectiveness of tamping parameter in various site conditions, e.g., clean ballast condition and fouled ballast condition.
- The results of this research are expected to greatly improve rail safety by optimizing tamping strategies based on existing ballast conditions



RAILROAD IMPACT

- Optimizing tamping parameters for existing ballast conditions
- Less damage to the ballast particles, therefore slower ballast degradation
- Better compacted ballast during tamping and better ballast stability after tamping, making longer ballast service life and service interval

PROJECT PARTNERS

- Pennsylvania State University
- Norfolk Southern Railway
- Plasser American Corp.

COST & SCHEDULE

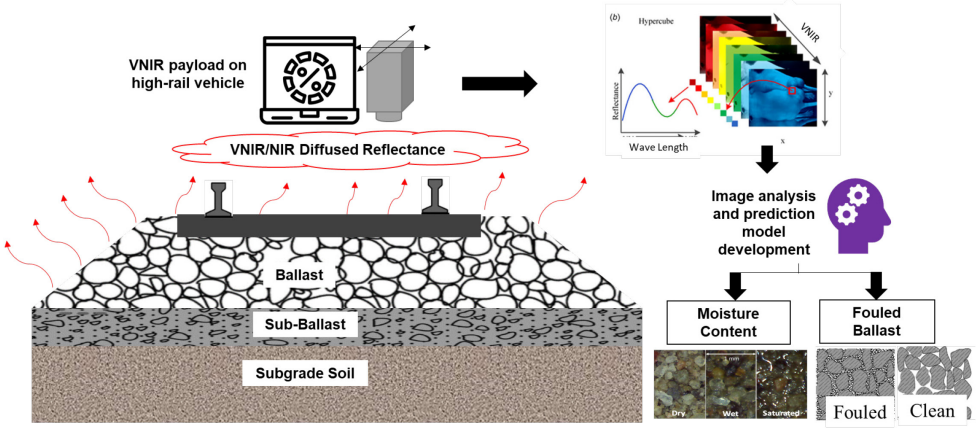
- Funding: $349,538
- Project Duration: April 2021 – April 2023

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Railroad Substructure Moisture Measurement and Monitoring Using Hyperspectral Imagery

PROJECT DESCRIPTION

- Goal: Development of Hyperspectral Imagery Technology for Railroad Ballast Moisture Detection
  - Objective 1: Spectral Characterization of the Ballast
  - Objective 2: Establish a Correlation between Spectral Features and Moisture Content
  - Objective 3: Development of Predictive Models to Quantify Moisture in a Relevant Environment
  - Objective 4: Demonstrate the Feasibility of Hyperspectral Imagery for Field Inspections



RAILROAD IMPACT

- Provide industry with a non-contact technology to measure moisture in ballast as an alternative to ballast sampling.
- Prevent or minimize safety risks associated with field moisture measurement (injuries, trips, falls).
- Prevent or minimize formation of ballast soft-spots, frosting, icing, and early deterioration in tracks.
- Enable a data-driven solution, compatible with existing non-contact track condition assessment.

PROJECT PARTNERS

- University of North Dakota (Prime),
- North Dakota State University,
- Northern Plains Rail Companies,
- Red River Western & Valley,
- ND Public Service Commission

COST & SCHEDULE

- Funding, FY22–23: $119,903
  - Total: $336,165
- Project Duration: September 2022 – September 2025

FRA PROJECT MANAGER: Hugh B. Thompson II • (202) 493-6383 • hugh.thompson@dot.gov

Enhancing Railroad Workforce Training through Equitable, Smart Infrastructure Experiences

PROJECT DESCRIPTION

- Discover evolving technical needs of the rail industry and establish effective training practices.
- Collect student data to determine technical proficiencies and identify barriers resulting from inequity or lack of resources.
- Expand on proven educational frameworks to reach a broader spectrum of future railroaders including those from minority serving institutions.

RAILROAD IMPACT

- Reconcile emerging industry needs with evolving training and education practices, bridging high school and university programs.
- Streamline training programs to include essential skillsets for specific pathways to industry.
- Close gaps in equity and access for diverse students with trajectories toward engineering and vocational careers in the rail industry.

PROJECT PARTNERS

- Southern Methodist University
- Texas State University
- Garland, TX, ISD

COST & SCHEDULE

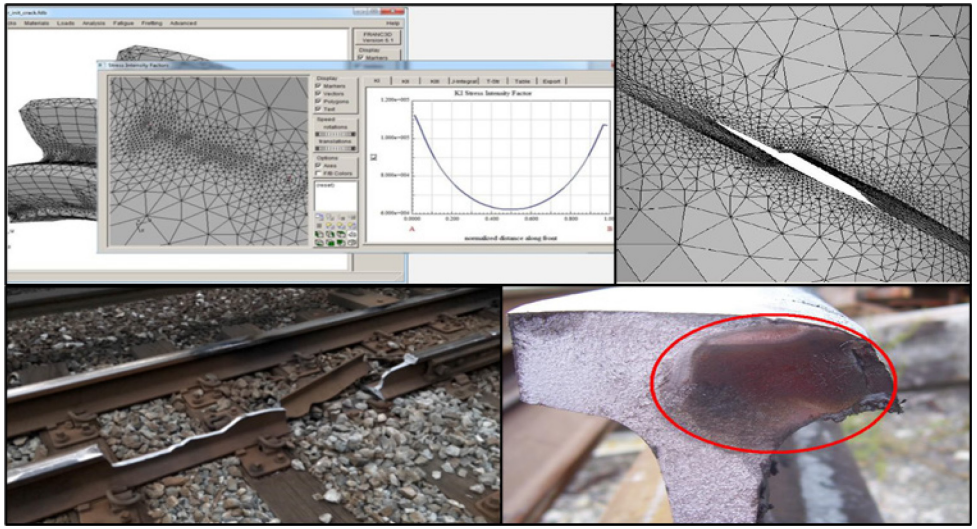
- Funding: $403,579
- Project Duration: August 2022 – July 2025

FRA PROJECT MANAGER: Hugh B. Thompson, II • (202) 493-6383 • hugh.thompson@dot.gov

Physics-based Predictive Modeling of Rail Failures Due to Internal Defects

PROJECT DESCRIPTION

- Develop an artificial-intelligence-based predictive model of rail failures based on internal defect growth to enhance proactive maintenance strategies.
- Apply fracture mechanics modeling to determine regressor strengths.
- Integrate both physical contributors and external factors to forecast time to rail failure for a known defect size.
- Develop a plan for implementing the resulting predictive model as an additional component within the FRA's CWR-Risk software application.



RAILROAD IMPACT

- Effectively minimize the occurrence of service failures on our Nation's rail network.
- Improve continuously welded rail (CWR) management practices and enable more effective maintenance and capital planning.
- Provide a valuable tool to aid in future rail integrity rulemaking processes.

PROJECT PARTNERS

- ENSCO, Inc.
- Canadian Pacific Railway

COST & SCHEDULE

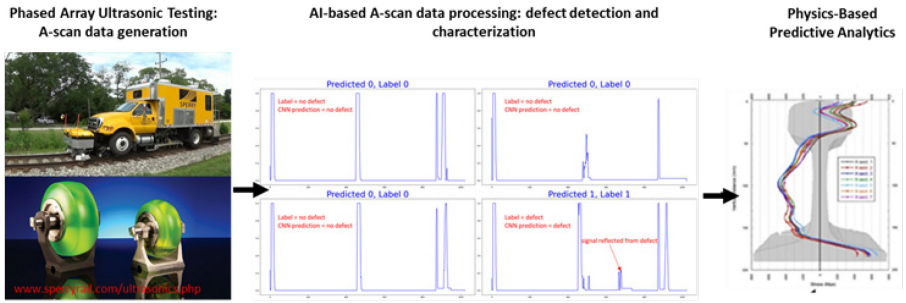
- Funding: $354,531
- Project Duration: July 2022 – March 2024

FRA PROJECT MANAGER: Jay Baillargeon • (719) 584-7155 • jay.baillargeon@dot.gov

Real-Time Defect Characterization and Physics-based Remaining Life Prediction

PROJECT DESCRIPTION

- Develop technology to enable real-time rail internal defect characterization and prediction of the remaining useful life of the rail, which entails:
  - Develop machine-learning-based algorithms to automatically process ultrasonic A-scan data from inspection vehicles.
  - Complete a physics-based (i.e., fracture mechanics) analysis for the remaining useful life of the rail based on the current state of the internal defect.
- Build upon previous FRA-funded efforts in rail internal defect modeling and simulation.
- Focus on transverse rail defects, which account for a large percentage of defects found in revenue service.



PROJECT PARTNERS

- Thornton Tomasetti
- Sperry Rail Service
- David Jeong, Ph.D. (Independent Consultant)
- University of Utah

RAILROAD IMPACT

- Real-time transverse defect detection and characterization at track inspection speeds
- Reduction in human intervention and, in turn, improvement in overall efficiency and accuracy of transverse defect detection and characterization
- Identification and prioritization of repair of safety-critical defects to prevent rail-related failures and, in turn, derailments on our Nation's railways

COST & SCHEDULE

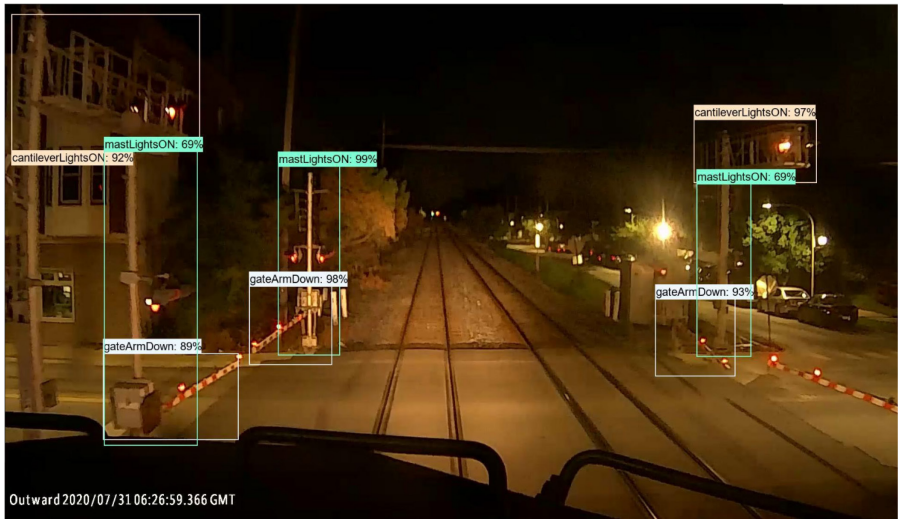
- Funding: $475,003
- Project Duration: September 2022 – September 2024

FRA PROJECT MANAGER: Jay Baillargeon • (719) 584-7155 • jay.baillargeon@dot.gov

Artificial-Intelligence-Aided Machine Vision for Grade Crossing Safety

PROJECT DESCRIPTION

- Develop an advanced machine-vision approach using video from forward-facing cameras installed in the locomotive for inspecting highway-rail grade crossings to ensure compliance with regulations under 49 CFR Part 234 ("Grade Crossing Safety"):
  - Gate arm status [CFR 234.223]
  - Mast light flasher status [CFR 234.217]
  - Validate line of sight requirements [CFR 213.37]
  - Detect variation in flashing light pairs status [CFR 234.225]
  - Calculate warning times [CFR 234.225 234.257]



RAILROAD IMPACT

- Improved public safety due to real-time email and/or text alerts for damaged gate arms, flashers, and other critical safety-related issues associated with highway-rail grade crossings affecting pedestrian or driver safety
- Improved efficiency of crossing repairs via video analysis of equipment failure in advance of maintenance personnel dispatch
- Productivity via automated inspections per 49 CFR Part 234 (gate arms, flashers, warning time, etc.) occur accurately, more frequently, and during revenue service, instead of a separate, dedicated process.

PROJECT PARTNERS

- Wi-Tronix, LLC
- U.S. Federal Highway Administration
- Volpe National Transportation Systems Center

COST & SCHEDULE

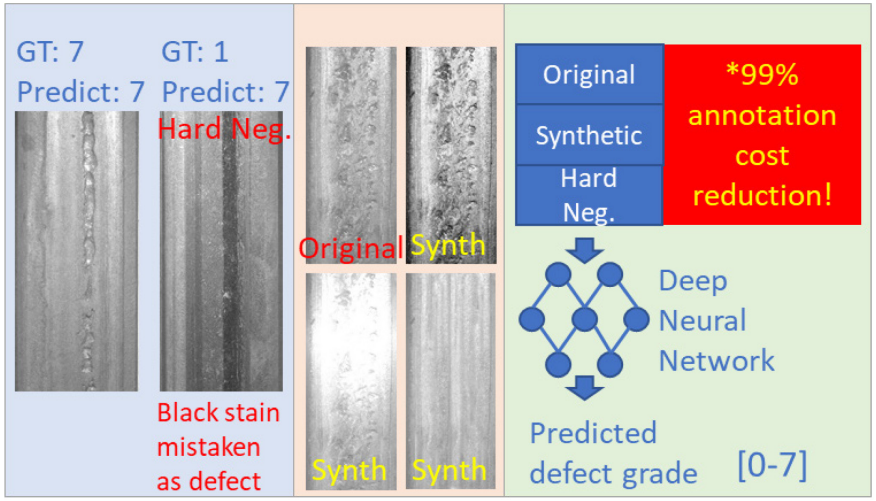
- Funding: $489,980
- Phase II Duration: August 2021 – August 2023

FRA PROJECT MANAGER: Jay Baillargeon • (719) 584-7155 • jay.baillargeon@dot.gov

Deep Learning for Large-Scale Rail Defect Inspection

PROJECT DESCRIPTION

- Use rail surface imagery and classification tools to develop real-time, semi-automated (i.e., “human-in-the-loop”) annotation tools for rail surface inspection.
- Develop an improved neural network for rail surface defect classification based on innovative loss functions, generative data augmentation, and few-shot learning.
- Evaluate the resultant algorithms in a large-scale field evaluation in conjunction with the industry partners.
- Develop a proof-of-concept application for railroad truck-scanning defects to demonstrate generality of resultant methodology.



RAILROAD IMPACT

- Reduction in rail-surface-generated rail failures and increase in overall safety for passenger and freight systems
- Unbiased and more comprehensive rail maintenance planning programs will lead to increased rail life and less unplanned maintenance.
- Real-time classification will enable future autonomous evaluation systems.
- Significantly reduced data annotation costs (1-5% of manual annotation) for novel, AI-based monitoring applications
- Methodology applicable to most other railway component images monitoring

PROJECT PARTNERS

- State University of New York at Stony Brook
- KLD Labs, Inc.
- CSX Transportation

COST & SCHEDULE

- Funding: $148,973
- Project Duration: September 2021 – September 2022

FRA PROJECT MANAGER: Jay Baillargeon • (719) 584-7155 • jay.baillargeon@dot.gov

Field Testing Support at FRA's Transportation Technology Center

PROJECT DESCRIPTION

- Provide multiple university- and third-party-led research initiatives with onsite testing services and equipment at FRA's Transportation Technology Center (TTC) to support technology evaluation in a real-world setting.
- Recent activities under this task include:
  - LiDAR measurement of underfilled ballast shoulder sites.
- Upcoming testing activities include:
  - Precision measurement of track geometry over the High-Speed Adjustable Perturbation Slab Track at TTC.
  - Laboratory testing to characterize the spring rates of both primary and secondary spring sets.

RAILROAD IMPACT

- Provide support for controlled testing at TTC, including opportunities for evaluation in a real-world environment, for new and emerging technologies.
- Develop critical prototype hardware/software for advanced rail inspection technology.
- Focus on the development and evaluation of advanced inspection technologies under revenue-service-like conditions.

PROJECT PARTNERS

- ENSCO, Inc.
- Northern Plains Railroad Services
- Volpe National Transportation Systems Center

COST & SCHEDULE

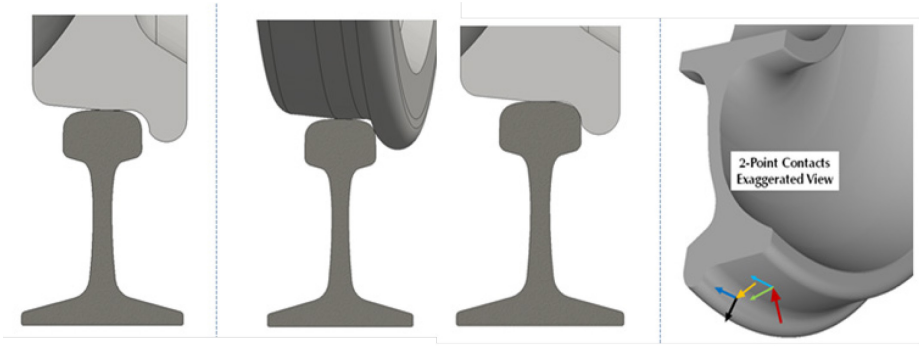
- Funding: $298,924
- Project Duration: October 2022 – September 2025

FRA PROJECT MANAGER: Jay Baillargeon • (719) 584-7155 • jay.baillargeon@dot.gov

Mathematical Modeling of 3D Wheel-Rail Contact

PROJECT DESCRIPTION

- Improving the state of art in wheel-rail contact by using 3D surface for wheel and rail.
- Define an analytical solution to find wheel-rail contact, including lead and lag flange contact.
- Define an analytical expression with a numerical routine to find multiple contacts that can be used with existing multibody vehicle dynamics simulation programs.



Tread contact, zero yaw

Tread and flange contact, non-zero yaw

Tread and flange contact, zero yaw

Tread and flange contact, non-zero yaw

RAILROAD IMPACT

- Improved methodology for wheel/rail contact analysis and vehicle curving behavior
- More accurate prediction of derailment quotient L/V and wheel-climb process
- Improved railroad operational safety against wheel-rail-interaction-related wheel climb derailments

PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding, Phase I FY22: $275,262
- Project Duration: October 2022 – November 2023

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6438 • Ali.Tajaddini@dot.gov

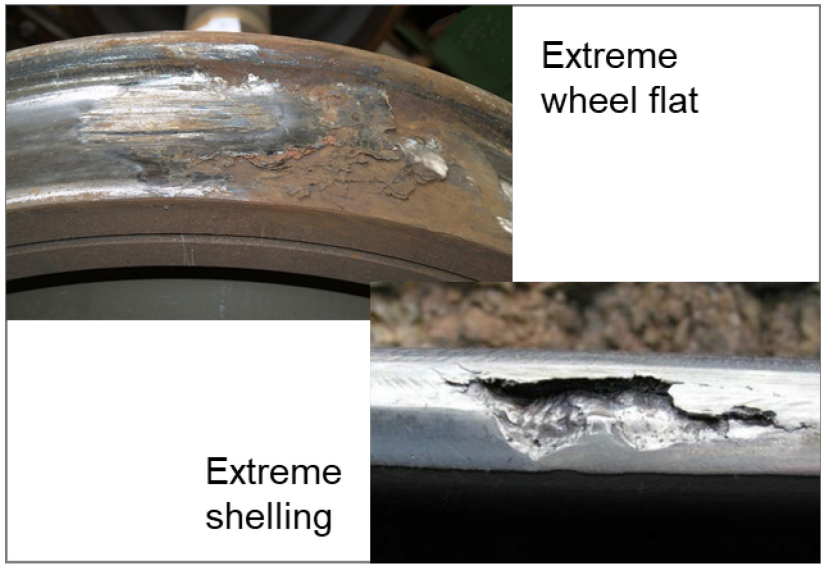
Detailed Wheel-Rail Contact Geometry for 3D Profile Deviation

PROJECT DESCRIPTION

- Extend CONTACT to simulate effects of wheel and rail defects: flats, shelling, out-of-roundness, corrugation.
- Develop detailed 3D analysis of contact stresses, including transient rolling.
- Demonstrate for cases with wheel flat and short-pitch corrugation.
- Demonstrate the development in NUCARS, SIMPACK.

RAILROAD IMPACT

- Investigate peak stresses associated with damaged wheels and rails.
- Understand economic consequences and mitigate safety concerns.



PROJECT PARTNERS

- Vtech CMCC
- Vehicle Dynamics Group LLC
- SNC-Lavalin Group Inc.
- Transportation Technology Center, Inc.

COST & SCHEDULE

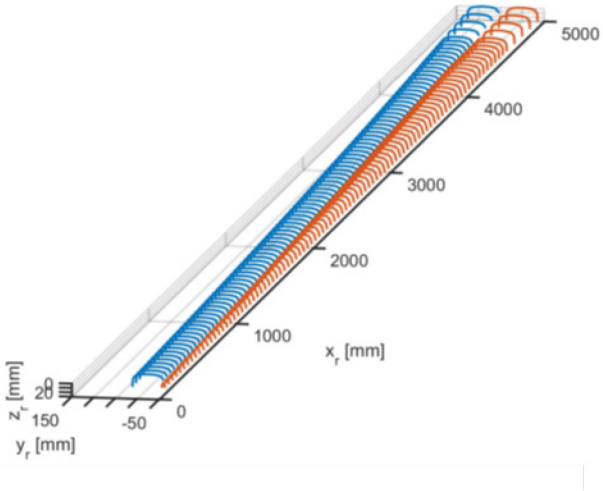
- Funding, FY22: $199,100
- Project Duration: August 2022 – July 2024

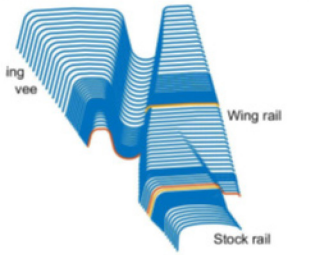
FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6438 • Ali.Tajaddini@dot.gov

Detailed Wheel-Rail Contact Geometry for 3D Special Trackwork

PROJECT DESCRIPTION

- Simulate vehicle-track interaction on rails with longitudinal profile variations: switches, turnouts, guard rails.
- Develop smooth interpolation and 3D analysis of contact location.
- Demonstrate the development in a switch and crossing example.





RAILROAD IMPACT

- Demonstrate vehicle-track interaction with detailed 3D contact solution for special trackwork.
- Enable derailment investigation with more accurate wheel-rail contact.

PROJECT PARTNERS

- Vtech CMCC
- Vehicle Dynamics Group LLC,
- SNC-Lavalin Group Inc.
- Transportation Technology Center, Inc.

COST & SCHEDULE

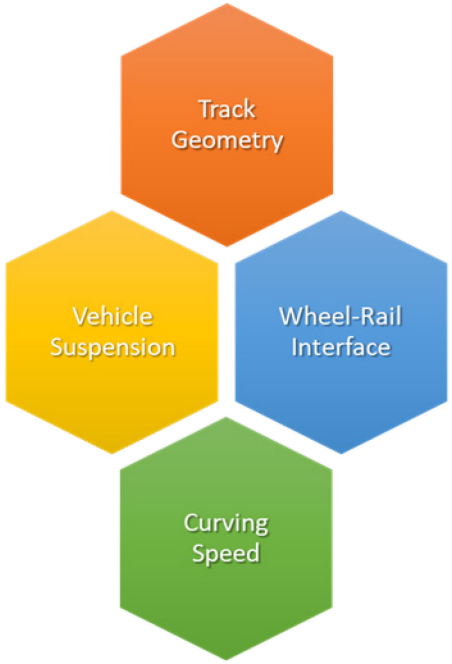
- Funding, FY22: $198,300
- Project Duration: August 2022 – November 2023

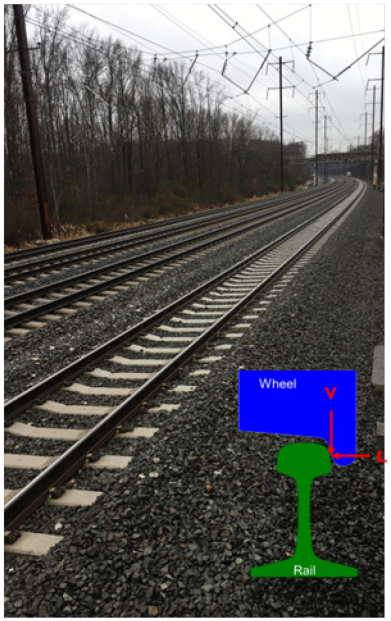
FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6438 • Ali.Tajaddini@dot.gov

Investigate the Effects of Track Quality on Rail Vehicle Safety

PROJECT DESCRIPTION

- Develop models and experimental data to quantify the safety of railroad vehicles operating on track with track geometry irregularities.
- Extrapolate test results to a broader range of track conditions using computer simulation.
- Evaluate the safety of new types of railroad equipment.
- Use results to identify safe operating speeds, maximum allowable track geometry deviations, and other operating conditions needed to minimize the risk of derailment.
- Provide support to the FRA Railroad Safety Advisory Committee.





RAILROAD IMPACT

- Helps provide an infrastructure that supports a variety of vehicles for speeds up to 220 mph.
- Addresses derailment safety concerns and support industry's needs in terms of identifying safe track geometry limits and procedures used for assessing the performance of new rail vehicles from a derailment safety standpoint.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding, FY22: 300,000
- Project Duration: May 2021 – June 2025

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

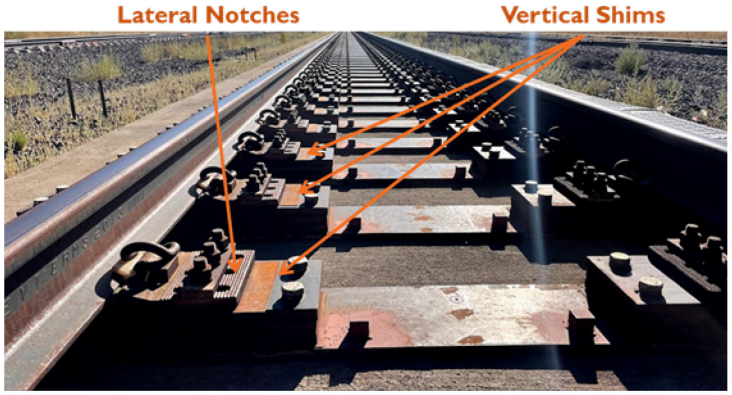
ATGMS Accuracy Using High-Speed, Adjustable Perturbation Test Track

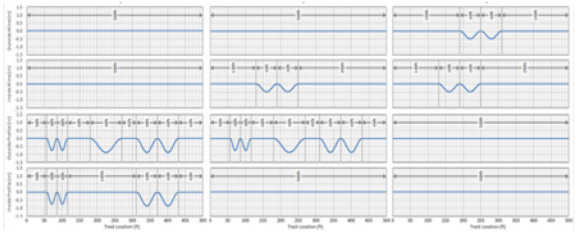
PROJECT DESCRIPTION

- Develop a test procedure that can evaluate the accuracy of Automated Track Geometry Systems (ATGMS).
- Procedure introduces a set of test cases to a 500-foot tangent test track section on the Railroad Test Track and the Transportation Technology Center where alinement and profile track anomalies can be installed.
- Procedure assesses effect of vehicle speed, dynamics, orientation, and direction on ability to measure known perturbations.
- Procedure compares key track measurements (alignment, profile, gage, and crosslevel) to ground truth measurements.

RAILROAD IMPACT

- FRA and railroads rely on ATGMS as one of the leading technologies for assessing the safety of rail infrastructure.
- There has been recent interest in assessing the accuracy of these systems to improve railroad safety.
- Goal is to develop a test procedure that can be used by FRA and industry for assessing the accuracy of other ATGMS.





PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding, FY22: 100,000
- Project Duration: May 2021 – June 2023

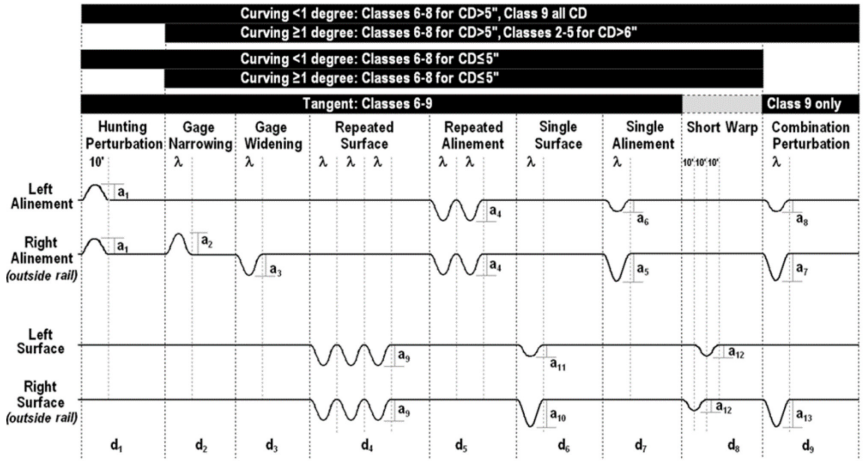
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Support for the FRA Office of Railroad Safety

PROJECT DESCRIPTION

- Build vehicle models to simulate vehicle-track interaction and derailment conditions.
- Provide support for qualification testing and pre-revenue service acceptance testing.
- Develop and update new procedures for assessing the safety of rail vehicles, taking advantage of state-of-the-art computer modeling and testing.
- Assist in derailment investigations.



RAILROAD IMPACT

- Qualification testing identifies potential safety concerns which can be addressed before revenue service.
- Derailment investigations can identify root causes of accident and potentially prevent future accidents.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding, FY22: 400,000
- Project Duration: May 2021 – June 2025

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

SECTION TWO

ROLLING STOCK

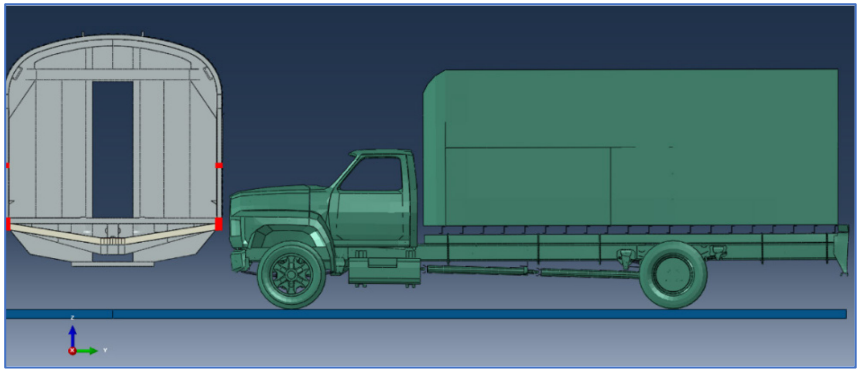
Passenger Equipment Structural Crashworthiness

PROJECT DESCRIPTION

- Develop design strategies for improving the structural crashworthiness of passenger railcars relative to existing designs.
- Develop specifications and regulations and support various waiver requests and evaluations of compliance with FRA regulations.
- Previous work focused on occupied volume integrity (OVI), or the ability of a passenger railcar to support a large longitudinal load without compromising the space occupied by passengers and crew.
- Current focus on side structure integrity criteria. Side strength requirements for various passenger equipment designs are being investigated in response to a National Transportation Safety Board recommendation to FRA.

COST & SCHEDULE

- Funding: $120,000
- Project Duration: August 2018 – September 2023
  - Paper and presentation at The American Society of Mechanical Engineers International Mechanical Engineering Congress & Exposition, November 2018
  - Results of parametric study, December 2019
  - Comprehensive report on side structure integrity, September 2022



RAILROAD IMPACT

- Current longitudinal loading requirement for passenger cars requires the structure to sustain an 800,000-lb. load along the line of draft with no permanent deformation.
- New passenger equipment rule contains alternative OVI requirements which move the evaluation load from the line of draft to the collision load path.
- Similar to OVI, side strength plays a role in accident survivability.
- Modeling performed to assess structural performance under a variety of loading conditions and the tendency for rollover when vehicles are subjected to side impacts.
- Development of techniques for demonstrating compliance with the requirements and conducting assessments of the results of those analyses assist FRA in ensuring passenger vehicles achieve sufficient occupied volume strength.

PROJECT PARTNER

- Volpe National Transportation Systems Center

FRA PROJECT MANAGER: Jeff Gordon • (617) 494-2303 • jeffrey.gordon@dot.gov

Locomotive Structural Crashworthiness

PROJECT DESCRIPTION

- Demonstrate effectiveness of crashworthy components in preventing override in collisions involving locomotives.
- Evaluate performance of the combination of a push-back coupler and deformable anti-climber under full-scale dynamic impact scenarios.
- Design crashworthy components as a retrofit to existing locomotives.
- Perform individual component testing to demonstrate performance and develop technical information to inform finite element modeling.
- Perform routine coupling tests to develop range of expected impact forces and to demonstrate designed behavior.
- First full-scale vehicle-to-vehicle (V2V) impact test performed in January 2019 and the second performed on November 17, 2021, to assess the performance of the retrofit components in a moderate-speed collision for a range of impacted equipment.
- Full-scale train-to-train test to assess the performance of the integrated system performed on August 10, 2022.
- Development of locomotive crashworthiness standards

COST & SCHEDULE

- Funding: $1,109,326
- Project Duration: August 2018 – August 2022
  - FRA report on conventional coupling tests, September 2019
  - Presentation on V2V test #1 results, February 2019
  - Joint Rail Conference paper on coupling tests evaluation, April 2019
  - FRA report on F40 locomotive retrofit, September 2019
  - FRA report on the conventional and CEM coupling tests, September 2019
  - Joint Rail Conference paper on V2V test #1 results, April 2022
  - V2V test #2, November 2021
  - Full-scale train-to-train test, August 2022

RAILROAD IMPACT

- Locomotives, because of their great longitudinal strength and stiffness, are particularly susceptible to override when they collide with another vehicle, and the consequences can be catastrophic.
- Research has shown that conventional anti-climbing structures can deform on impact and form a ramp, increasing the likelihood of override.
- Such behavior was exhibited in a 32-mph collision that occurred in Georgetown, Kentucky, on March 18, 2018 (see photo).
- Research has also shown that the addition of modest structural features to the forward end of a locomotive can greatly reduce the propensity for override.

PROJECT PARTNERS

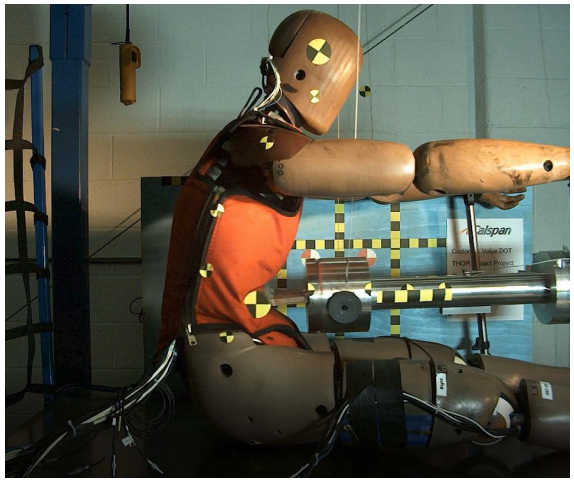
- Volpe National Transportation Systems Center
- CAMX Power
- Transportation Technology Center, Inc.
- CANARAIL Consultants Inc.

FRA PROJECT MANAGER: Jeff Gordon • (617) 494-2303 • jeffrey.gordon@dot.gov

Interior Occupant Protection

PROJECT DESCRIPTION

- The Volpe Center is providing technical support to FRA on research testing of passenger seats and workstation tables to evaluate compliance with revised APTA seat and table safety standards.
- Volpe is providing support for occupant experiments using wheelchair/anthropomorphic test device (ATD) containment devices.
- The APTA safety standards address the crashworthiness of passenger seats, cab seats, and workstation tables in passenger railcars.
- Volpe research assists FRA in the evaluation of the crashworthiness of seats, tables, and interior fixtures for new equipment procurements (Siemens/PRIIA CALIDOT, Siemens/Brightline, Stadler/Caltrain, and Alstom/Amtrak).



COST & SCHEDULE

- Funding for Occupant Protection: $360,000
- Funding for Standards Support and Equipment Evaluation: $75,000
- Project Duration: May 2020 – May 2023
  - Volpe/Calspan THOR-50M abdomen impact test report, Sept. 2020
  - Volpe THOR-50M FE model validation paper, Jan. 2021
  - Volpe FE analyses to evaluate attachment strength requirements for wheelchair restraint devices in locomotive train test, May 2021
  - Final APTA Workstation Table Standard, Rev 2, Dec. 2021
  - Final APTA Seat Standard, Rev 3, March 2021
  - MGA/ Volpe table test report, May 2021
  - Draft APTA Cab Seat Standard, Dec. 2021
  - MGA/Volpe seat test report, June 2022

RAILROAD IMPACT

- Working with seat and table manufacturers and the rail industry to define safety-equivalent options in APTA seat and table standards.
- Disseminate research findings to the rail industry on advanced ATDs to evaluate abdomen injuries specific to workstation tables impacts in passenger train accidents.
- Working with the Rail Vehicles Access Advisory Committee to identify and evaluate crashworthiness protection strategies for passengers in wheeled mobility devices.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Passenger equipment manufacturers, operators, suppliers, and consultants

FRA PROJECT MANAGER: Jeff Gordon • (617) 494-2303 • jeffrey.gordon@dot.gov

Field Investigations

PROJECT DESCRIPTION

- Derive passenger equipment safety research program areas from information gleaned from real-world conditions.
- Identify deficiencies related to equipment performance and operating practices, and inform changes to regulations and industry standards.
- Tune program direction based on the findings of the field investigations to ensure maximum application and effectiveness of research results.

COST & SCHEDULE

- Funding: $110,000
- Project Duration: May 2022 – May 2023
- Accident investigations have been performed for: Lake City, SC, in August 2000; Nodaway, IA, in March 2001; Crescent City, FL, in April 2002; Placentia, CA, in April 2002; Kensington, MD, in July 2002; Flora, MS, in April 2004; Glendale, CA, in January 2005; Chicago, IL, in September 2005; Chicago, IL, in November 2007; Chatsworth, CA, in 2008; Red Oak, IA, in April 2011; Lovelock, NV, in 2011; Goodwell, OK, in June 2012; Bridgeport, CT, in May 2013; Spuyten Duyvil, NY, in December 2013; Philadelphia, PA, in 2015; Hoboken, NJ, in September, 2016; Dupont, WA, in December 2017; Cayce, SC, in February, 2018; Joplin, MT in September, 2021; Clarendon Hills, IL and Mendon, MO in 2022

RAILROAD IMPACT

- Activities include documenting the damage to the equipment (both interior and exterior), reconstructing the sequence of events, and identifying causal mechanisms for injury and fatality.
- Findings serve to assess the current performance of rail equipment, interiors, emergency egress/access, fuel tank integrity, and other safety features.
- Produce technical presentation of the field investigation from the preliminary findings.
- Issue report or paper describing the findings from the field investigations and the accident reconstruction.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Owners/operators of equipment involved in investigated accidents

FRA PROJECT MANAGER: Jeff Gordon • (617) 494-2303 • jeffrey.gordon@dot.gov

Passenger Equipment Glazing Integrity

PROJECT DESCRIPTION

- Develop engineering strategies for improved occupant containment by glazing systems, while meeting all other existing safety, service, and manufacturing requirements.
- Glazing system functions as windows and expected to be impact resistant, provide emergency egress, provide emergency access, be fire resistant, and provide occupant containment.
- Develop detailed plans for drafting, analyzing, and testing engineering strategies for glazing systems.
- Define all safety and operational requirements placed on glazing systems; assess the performance of current glazing systems in meeting those requirements; develop modifications for improving occupant containment; and conduct analysis and testing to compare the performance of conventional and modified glazing systems.
- Test plans have been developed to evaluate glazing retention system performance under prying, pressure, and simulated dragging conditions.
- Phase I testing completed March 2021.
- Phase II launched September 2022 to include testing of glazing systems designs not considered in Phase I.

COST & SCHEDULE

- Funding: $176,966 Phase I; $130,528 Phase II
- Project Duration: September 2022 – September 2024
  - Present research findings to APTA or RSAC, December 2021.
  - Issue report describing Phase I project and results May 2022.

RAILROAD IMPACT

- At least 25 fatalities attributed to glazing malfunction in the last 44 years.
- After the commuter train derailment in Spuyten Duyvil, NY, on December 1, 2013, the National Transportation Safety Board (NTSB) issued a recommendation for more effective passenger containment by glazing systems in derailments.
- NTSB reiterated its recommendation after the derailment in Philadelphia, PA, on May 12, 2015.
- Currently, no FRA regulations exist related to passenger containment by glazing systems.
- Outcomes of this research include strategies for improving the survivability of glazing in rollover accidents to improve occupant containment.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Sharma & Associates, Inc.

FRA PROJECT MANAGER: Jeff Gordon • (617) 494-2303 • jeffrey.gordon@dot.gov

Regulatory Development, Waiver Support, and Technology Transfer

PROJECT DESCRIPTION

- Support development and revision of regulations and safety standards for:
  - High-speed passenger trains
  - Conventional speed passenger trains
  - High-speed passenger trains in mixed service
- Activities include:
  - Definition of accident scenarios of concern and assessment of likelihood and loss from accidents
  - Identification of technologies for improved occupied volume protection, injury prevention, fuel containment, and glazing impact resistance
  - Application of information derived to support policy decisions, regulations, and standards development, and verification of required performance.

COST & SCHEDULE

- Funding: $200,000
- Project Duration: May 2022 – May 2023
  - Presentations and briefings for the National Transportation Safety Board, American Public Transportation Association, and the Railroad Safety Advisory Committee (and its task forces) as requested/needed, TBD
  - Reviews of technical documentation submitted by railroads to demonstrate compliance with FRA regulations as requested, TBD.

RAILROAD IMPACT

- FRA support for rail equipment standards development since the advancement of Amtrak's technical specification for the Acela in 1993, which evolved into FRA's Tier II equipment standards, the first national standards requiring crash energy management.
- Publication of first rule addressing crashworthiness and other features of Tier III passenger equipment on November 21, 2018.
- Additional standards supported include the Passenger Equipment Safety Standards, Locomotive Crashworthiness Standards, and Cab Car End Frame Standards.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Passenger equipment manufacturers, operators, suppliers, and consultants

FRA PROJECT MANAGER: Jeff Gordon • (617) 494-2303 • jeffrey.gordon@dot.gov

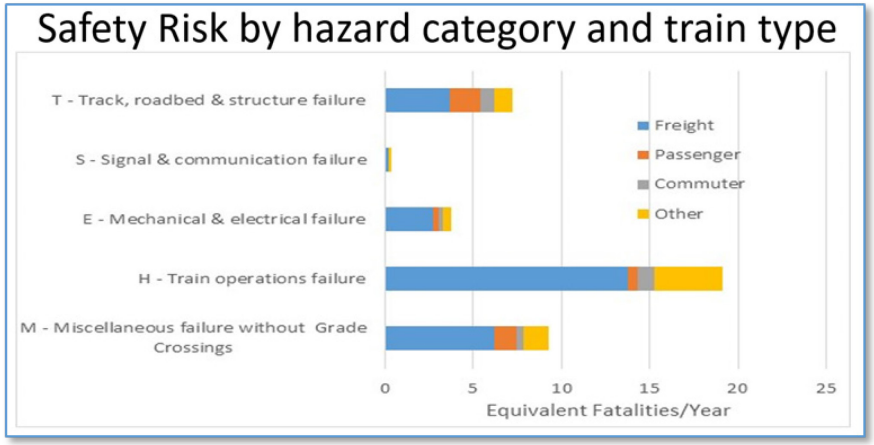
Extended Development of FRA Safety Risk Model

PROJECT DESCRIPTION

- FRA's Office of Research, Development, and Technology (RD&T) manages a large portfolio of research projects chosen, scoped, and focused on improving railroad safety. Rational project selection strategies are of great value in maximizing the effectiveness of the RD&T program.
- RD&T has developed a means of assessing safety risk broadly across the railroad industry, reflected in its Safety Risk Model (SRM), similar to that created and implemented by the Railway Safety Standards Board in the U.K.
- The SRM provides a means for quantitative risk-ranking to facilitate project selection. Knowledge of the characteristics of the distribution of risk will allow FRA to make strategic project investments for maximum safety benefit and allow for future assessments of risk reduction resulting from implementing the products of RD&T efforts.
- Future updates to the model will include the means to assess risk based on regional population density (rural, urban, superurban) to derive "state level" safety risks for the purpose of guiding safety inspections.

COST & SCHEDULE

- Funding: $75,356
- Project Duration: September 2018 – September 2023



RAILROAD IMPACT

- The application of the results derived from the SRM will enable FRA to focus R&D efforts (and limited available resources) on topics which cause the greatest amount of harm (fatalities, injuries, property damage) in the railroad industry.
- This should result in RD&T research products which are of the greatest benefit to the railroad industry in improving safety performance.

PROJECT PARTNER

- Sharma & Associates, Inc.

FRA PROJECT MANAGER: Jeff Gordon • (617) 494-2303 • jeffrey.gordon@dot.gov

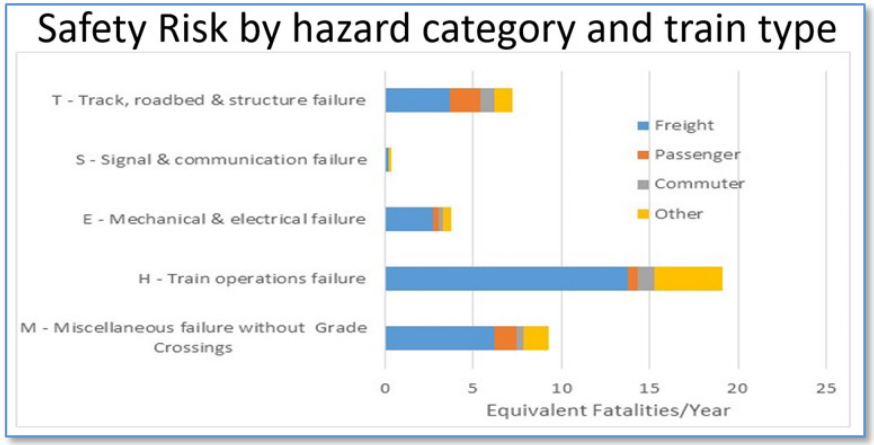
Extended Development of FRA Safety Risk Model

PROJECT DESCRIPTION

- FRA's Office of Research, Development, and Technology (RD&T) manages a large portfolio of research projects consisting primarily of projects chosen, scoped, and focused on improving railroad safety. Rational project selection strategies are of great value in maximizing the effectiveness of the RD&T program.
- RD&T has developed a means of assessing safety risk broadly across the railroad industry, which is reflected in its Safety Risk Model (SRM), similar to that created and implemented by the Railway Safety Standards Board in the UK.
- The SRM provides a means for quantitative risk-ranking to facilitate project selection. Knowledge of the characteristics of the distribution of risk will allow FRA to make strategic project investments for maximum safety benefit and allow for future assessments of risk reduction resulting from implementing the products of RD&T efforts.
- Future updates to the model will include the means to assess risk based on regional population density (rural, urban, superurban) to derive "state level" safety risks for the purpose of guiding safety inspections.

COST & SCHEDULE

- Funding: $74,429
- Project Duration: September 2018 – September 2023



RAILROAD IMPACT

- The application of the results derived from the SRM will enable FRA to focus R&D efforts (and limited available resources) on topics which cause the greatest amount of harm (fatalities, injuries, property damage) in the railroad industry.
- This should result in RD&T research products which are of the greatest benefit to the railroad industry in improving safety performance.

PROJECT PARTNER

- Sharma & Associates, Inc.

FRA PROJECT MANAGER: Jeff Gordon • (617) 494-2303 • jeffrey.gordon@dot.gov

Passenger Train Exterior Side Door Safety – Phase II

PROJECT DESCRIPTION

- According to the FRA Final Rule on Passenger Train Exterior Side Door Safety, *"passenger trains should have their exterior side doors closed when they are moving between stations."* However, many older (legacy) trains do not possess a door safety system to ensure compliance.
  - This leads to the risk of a passenger or an object becoming entangled in the door, preventing it from closing when the train departs a station.
- Failure in the door control system could also cause the exterior side door to accidently open during train movement or not close when departing a station, leading to the risk of passenger ejection.
- Phase II of this project seeks to develop a cost-effective solution to this door safety problem associated with legacy trains.

COST & SCHEDULE

- Funding: $300,000
- Project Duration: May 2022 – May 2024

RAILROAD IMPACT

- Successful development of this novel door safety technology will result in reduced passenger injuries caused by entrapment in passenger train doors or possible ejection should doors open unexpectedly.
- One railroad partner has been identified to provide support and assistance for field testing of the sensor prototype.

PROJECT PARTNER

- Newport Sensors, Inc.

This project is being performed under the Small Business Innovative Research Program.

FRA PROJECT MANAGER: Jeff Gordon • (617) 494-2303 • jeffrey.gordon@dot.gov

Wheel Measuring Device – Phase II

PROJECT DESCRIPTION

- Federal regulations and industry standards impose requirements on railroad wheel geometry to improve safety and avoid derailments. To ensure compliance with these requirements, railroads periodically take certain measurements to determine whether wheels and wheelsets remain fit for service:
  - Wheel diameter
  - Wheel back-to-back spacing (the distance between the back-face of wheels on an axle)
  - Wheel profile (the shape of the portion of the wheel that contacts the rail from back-face to field-side rim)
  - Out of roundness (deviations from uniform wheel diameter)
  - Length and width of wheel defects (e.g., flat spots)
- Other attributes are derived from these measurements, such as wheel flange angle (see APTA PR-M-S-015-06, Rev. 1, Wheel Flange Angle for Passenger Equipment).
- FRA seeks development of a portable wheel geometry measuring device that can be used in the shop and the field by a single operator.

COST & SCHEDULE

- Funding: $400,000 (ADA); $400,000 (Synetics)
- Project Duration: September 2022 – September 2024

RAILROAD IMPACT

- Current manually operated devices used to measure wheel profiles have limited functionality regarding the above list of measurements and can be subject to operator error.
- Improved techniques for measuring railroad wheel geometry will contribute to the overall improvement of railway safety by reducing the occurrence of derailments caused by wheel/rail interface geometry.

PROJECT PARTNERS

- ADA Technologies, Inc.
- Synetics Systems Engineering Corp.

Working independently. This project is being performed under the Small Business Innovative Research Program

FRA PROJECT MANAGER: Jeff Gordon • (617) 494-2303 • jeffrey.gordon@dot.gov

Passenger Fuel Tank Structural Integrity Research

PROJECT DESCRIPTION

- Identify dynamic impact loading of fuel tanks from accident investigations.
- Develop passenger fuel tank computer models.
- Evaluate conventional and alternative fuel tank designs (i.e., diesel multiple unit [DMU]) under blunt impact and raking loads.
- Conduct parametric studies.
- Present to industry stakeholders.

RAILROAD IMPACT

- Development of performance-based scenarios intended to be used to evaluate the puncture resistance of modern fuel tank designs, such as those on DMU locomotives.
- Evaluation of the structural performance of passenger fuel tank designs in accident conditions
- Support FRA Office of Safety in accident investigations and regulatory development efforts.
- Collaborate with APTA PRESS C&S Fuel Tank Working Group to support standard development/revisions.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $430,000
- Project Duration: May 2020 – May 2023

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

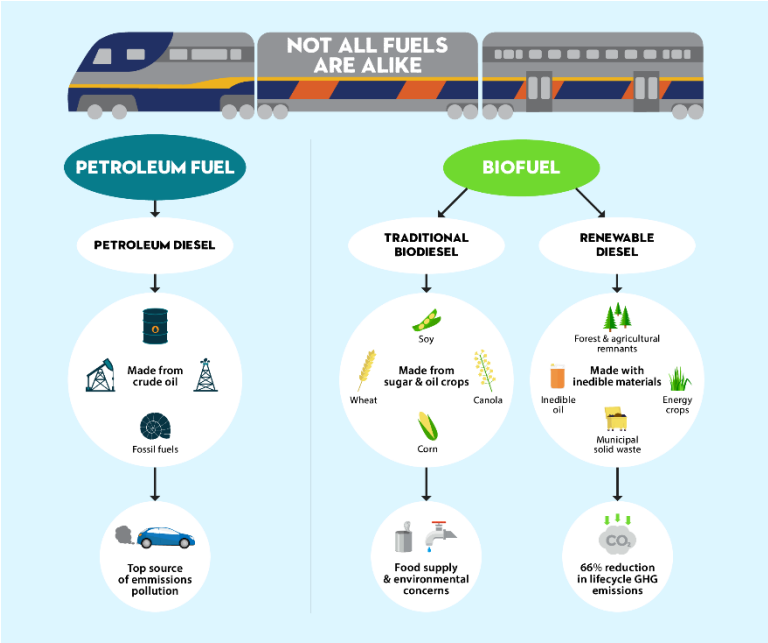
Biofuels for Advanced Locomotive Engines

PROJECT DESCRIPTION

- Perform scoping exercises with combustion simulation and spray visualization of different type of biofuels.
- Develop engine hardware and calibration to operate with select biodiesel fuels.
- Demonstrate engine operation and responses with select alternative fuels.
- Showcase combustion engine ability to operate with reduced carbon footprint and efficient resource utilization.

RAILROAD IMPACT

- Highlight flexibility of operation with unconventional fuel sources.
- Adoption of carbon neutral fuel concept
- Reduced reliance and stress on oil-based supply chain



PROJECT PARTNERS

- Argonne National Laboratory
- U.S. DOE Vehicles Technologies Office
- Progress Rail

COST & SCHEDULE

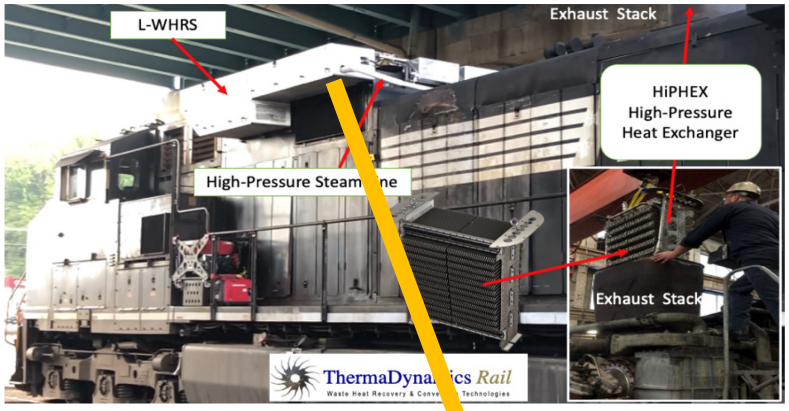
- Funding: $500,000
- Project Duration: September 2022 – August 2025

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

Hybrid Locomotive Waste Heat Recovery System (L-WHRS) Safety and Field Demonstration

PROJECT DESCRIPTION

- Validate technical, safety and reliability performance of L-WHRS.
- Quantify L-WHRS ability to generate pollution-free electric power from locomotive exhaust gases at different operating conditions.
- Develop and test an advanced Energy Storage System (ESS) coupled with the L-WHRS to store recovered energy.
- Develop and demonstrate safe electric power flows between L-WHRS electrical power supply, locomotive BUS, locomotive electrical loads, and the advanced ESS

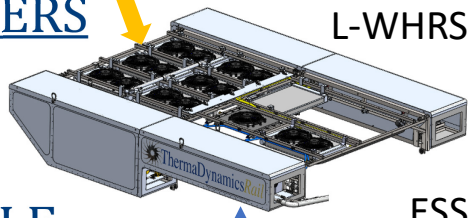


RAILROAD IMPACT

- Retrofitting locomotives with L-WHRS results in reduced fuel consumption and pollutant emissions by tapping otherwise wasted locomotive thermal energy and converting it to electricity.
- L-WHRSs represent a “free,” independent source of pollutant-free electric power that can augment locomotive electric supply.
- Available power can eliminate the need to idle the locomotive engine, or require a shore power connection for maintaining a climate-controlled cab.
- L-WHRS electrical interface programmed to shed hotel loads from locomotive electrical bus and couple them to the ESS and L-WHRS through power conditioning units, enabling safe switching of power sources during operations.
- Depending on ESS scalable capacity, via L-WHRS power flow controller, the ESS can supply locomotive start-up power when the lead-acid experiences deep discharge.

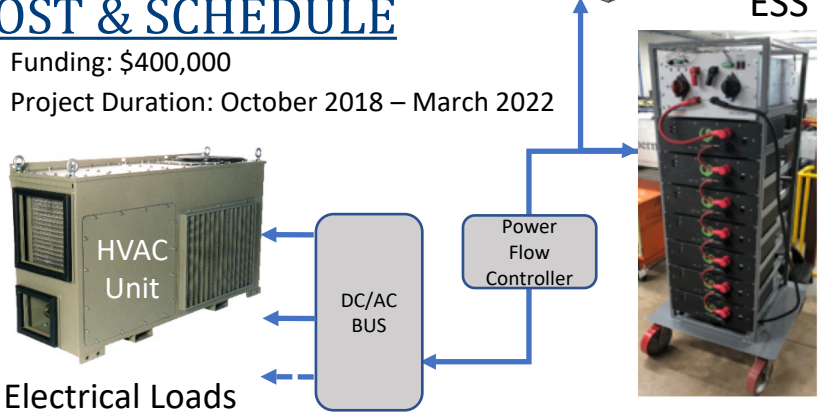
PROJECT PARTNERS

- ThermaDynamics Rail LLC
- Norfolk Southern Railway



COST & SCHEDULE

- Funding: $400,000
- Project Duration: October 2018 – March 2022



U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

A Risk-Informed, Decision-Making Framework for Coastal Railroad System Subjected to Storm Hazards and Sea Level Rise

PROJECT DESCRIPTION

- Develop probabilistic storm simulations based on historical and synthetic hurricane data, including return periods and storm tracks.
- Identify vulnerable segments of railway system (rail tracks and bridges) subjected to storm hazard.
- Provide short-term retrofit solutions to mitigate vulnerabilities in the coastal rail system.
- Integrate wind speed and sea level projections to estimate future inundated rail tracks, water levels, and wave heights. Provide long-term retrofit solutions to mitigate the vulnerabilities in the coastal rail system subjected to climate change and sea level rise.

Planned testbeds owned by CSX transportation and CN. CSX around 150 miles and CN around 130 miles.

RAILROAD IMPACT

- Develop an integrated Python-based Jupyter Notebook to be used by the railroad company for short-term and long-term risk-based decision-making.
- High-fidelity evaluation of storm impacts on coastal railroads, with the consideration of uncertainties
- More reliable coastal railroad system in upcoming storm hazards

PROJECT PARTNERS

- Michigan Technical University
- Canadian National Railway
- CSX Transportation

COST & SCHEDULE

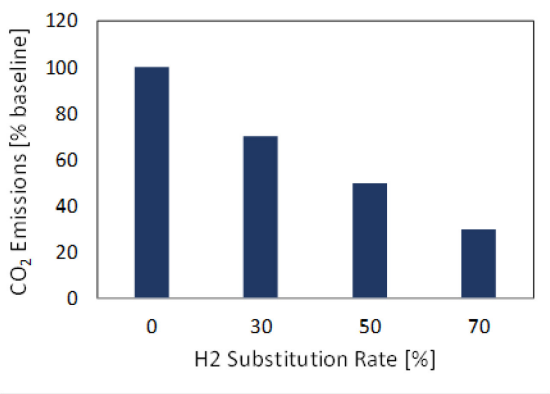
- Funding: $440,000
- Project Duration: May 2022 – May 2025

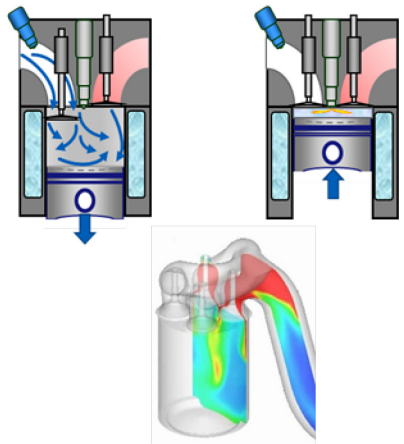
FRA PROJECT MANAGER: Melissa Shurland • (202) 253-6539 • melissa.shurland@dot.gov

Hydrogen Dual Fuel for Greenhouse Gas Emissions Reductions

PROJECT DESCRIPTION

- Port injected hydrogen dual fuel concept
- Single-cylinder engine testing to demonstrate 50% hydrogen substitution.
- Develop engine knock and backfire mitigation strategy.
- Thermodynamic model to project full engine system performance.





RAILROAD IMPACT

- Near-term technology that can produce significant reduction in CO_2 emissions.
- Path to safely introduction of hydrogen into rail industry.
- Fuel flexible concept to enable phased introduction of hydrogen infrastructure.
- Retrofittable technology to accelerate adoption to new and existing locomotive fleet.

PROJECT PARTNERS

- Wabtec
- Oak Ridge National Laboratory

COST & SCHEDULE

- Funding: $500,000
- Project Duration: September 2022 – August 2025

FRA PROJECT MANAGER: Melissa Shurland • (202) 253-6539 • melissa.shurland@dot.gov

Evaluation of Non-Traditional Methods of Reducing Locomotive Emissions for Shortline Railroads

PROJECT DESCRIPTION

- Inventory of short line locomotives
- The proposed 2-phase project will develop a methodology and evaluate short line railroad locomotive emissions through field testing and controlled testing of non-traditional fuel technologies, including additives and injectors.
- Non-traditional fuel technologies such as fuel injectors and additives are already widely used by shortlines. We will use these technologies to measure emissions reductions in a cost-effective manner for the railroads.
- Data collected will be transmitted to government agencies and the industry to help inform them of ways to reduce locomotive emissions.

High-emission locomotive

Low-emission locomotive

RAILROAD IMPACT

- Measuring the emissions and fuel economy benefits from application of the technologies will enable and encourage short lines to adopt emissions reductions strategies.
- Could be applied to approximately 3000 locomotives across the United States.
- Reducing emissions will bring health and environmental benefits to disadvantaged communities, which are frequently located near railyards.

PROJECT PARTNERS

- American Short Line and Regional Railroad Association
- Michigan Technological University
- Lake State Railway Company
- Chicago South Shore & South Bend Railroad

COST & SCHEDULE

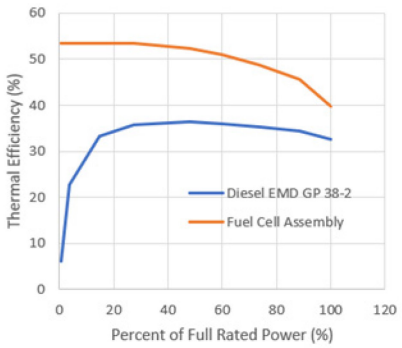
- Funding: $624,000
- Project Duration: August 2022 – August 2024

FRA PROJECT MANAGER: Melissa Shurland • (202) 253-6539 • melissa.shurland@dot.gov

Alternative Fuels Research – Hydrogen and Fuel Cells for Rail Applications

PROJECT DESCRIPTION

- Evaluate the merit of hydrogen fuel cells in railroad applications.
- Analyze consequences related to the release of hydrogen in post-collision scenarios.
- Guidance on best practices for human performance to ensure and maintain safety during hydrogen refueling operations.
- Identify scenarios for potential embrittlement of hydrogen storage equipment due to railroad load environment.



Argonne GREET LIFE-CYCLE MODEL

RAILROAD IMPACT

- Improve the state-of-the-art knowledge on safety and efficiency of alternative fuels, such as hydrogen and fuel cell systems for rail applications.
- Collaborate with railroads to safely implement hydrogen fuel cell technology.
- Availability of a rail module in the Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies (GREET) model provides a tool to assess the efficiency and emissions of alternative fuels in rail.

PROJECT PARTNER

- Sandia National Laboratories

COST & SCHEDULE

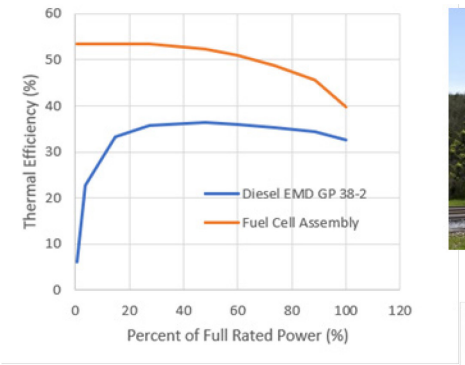
- Funding: $550,000
- Project Duration: August 2020 – December 2025

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

Alternative Fuels Research – Efficiency and Emissions

PROJECT DESCRIPTION

- Evaluate emissions and energy utilization of alternative fuels in freight and passenger equipment.
- Update and maintenance of rail module in Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies (GREET) model.
- Review and update the energy intensity of diesel locomotives using publicly available data to develop the baseline energy use in GREET.
- Calculation of the well-to-pump fuel production and transportation energy use (by primary resource type, e.g., petroleum and hydrogen, etc.) and emissions (by category, e.g., greenhouse gases and air pollutants).



RAILROAD IMPACT

- Improve the state-of-the-art knowledge on emissions and efficiency of conventional and alternative fuels such as natural gas, hydrogen, and other fuels.
- Provide public tool for assessment of emissions and engine efficiency based on fuel type and sources.

PROJECT PARTNER

- Argonne National Laboratory

COST & SCHEDULE

- Funding: $800,000
- Project Duration: August 2020 – Present

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

Alternative Fuels Research – Safety Analyses

PROJECT DESCRIPTION

- Develop crashworthiness standards for alternative fuel tender cars (liquefied natural gas [LNG], compressed natural gas [CNG], hydrogen, etc.).
- Evaluate critical impact scenarios using a combination of testing and computer simulations, i.e., grade crossing impact into fuel tender.
- Conduct small-scale tests to evaluate safety performance issues of new natural gas fuel tenders, i.e., structural crashworthiness, component and fitting structural integrity, fire, etc.
- Evaluate the merit of utilizing hydrogen fuel cells in railroad application.

RAILROAD IMPACT

- Provide science-based data in support of decisions for use of alternative fuels by U.S. railroads.
- Collaborate with railroad industry in development of specifications for next generation of natural gas fuel tender.
- Improve the state-of-the-art knowledge on safety and efficiency of alternative fuels such as hydrogen and fuel cell systems for rail applications.

PROJECT PARTNER

- Volpe National Transportation Systems Center
- Massachusetts Institute of Technology

COST & SCHEDULE

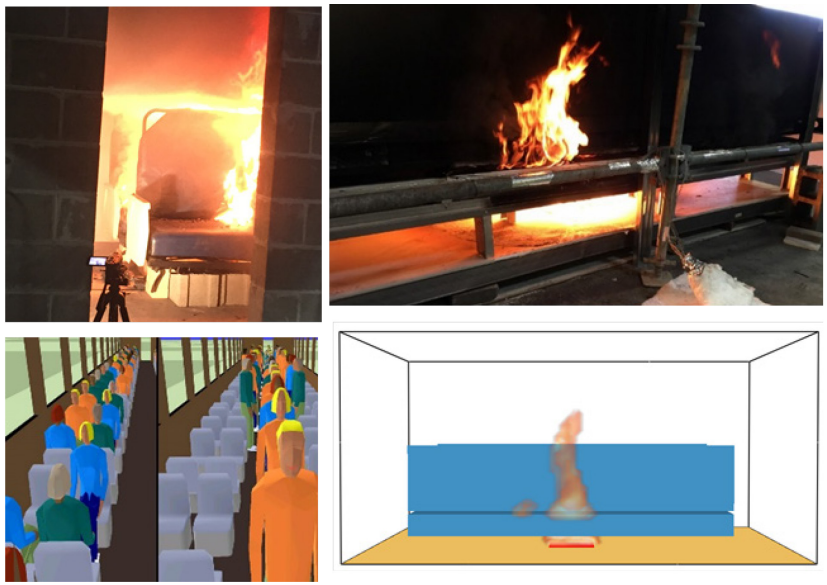
- Funding, FY22: $565,000
- Project Duration: May 2020 – Present

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

Material Flammability Heat Release Rate Requirement Expanded Analysis

PROJECT DESCRIPTION

- Collect material performance data for flammability and smoke based on NFPA 130 and the cone calorimeter (including those meeting EN 45545-2) tests.
- Use collected data to evaluate the heat release rate performance requirement.
- Create a cross-correlation table of materials / function between two standards along with required testing and criteria.
- Compare the data collected to determine whether the previously selected heat release rate-based requirement is adequate based on the larger data set.
- Compare the performance of materials between the two standards to determine which standard is more challenging.



RAILROAD IMPACT

- Streamline U.S. regulations, domestic standards, and international fire safety standards by:
  - Evaluate whether materials passing the EN 45545-2 would also be expected to meet the NFPA / CFR requirements.
  - Determine whether the EN standard could be used for material approval by FRA.
- Public database of demonstrated material performance based on heat release rate requirement for materials used in different applications on the railcar interior.
- Correlation of standards and use of heat release rate would screen out materials that meet ASTM E162 requirements and readily spread flame, causing flashover.

PROJECT PARTNER

- American Public Transportation Association

COST & SCHEDULE

- Funding: $100,000
- Project Duration: September 2022 – August 2024

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

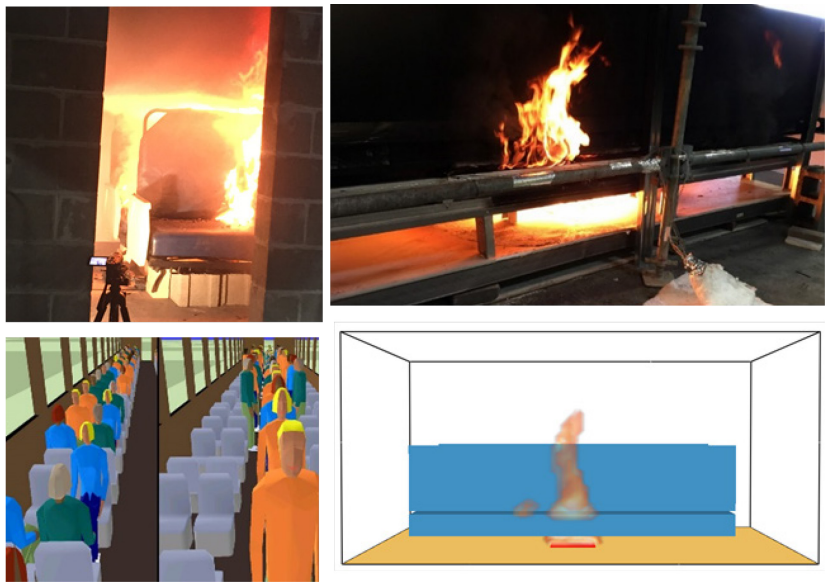
Fire Safety and Emergency Egress Research

PROJECT DESCRIPTION

- Support FRA in evaluating alternative fire performance criteria for passenger railcars.
- Investigate fire suppression technologies for effectiveness in passenger rail environment.
- Evaluate passenger egress from railcars under various fire scenarios.
- Support FRA in reviewing fire hazard analyses submitted by passenger rail operators.
- Review and comparison of U.S. and foreign fire safety requirements for passenger railcars.

RAILROAD IMPACT

- Report on the efficacy of water mist and other fire suppression systems on passenger railcars.
- Research supports the development of knowledge for the quantification of rapid and easy egress from passenger rail cars.
- Interface with National Fire Protection Associations 130 Committee in development and maintenance of industry standards for fire safety of passenger railcars.



PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $515,000
- Project Duration: September 2019 – August 2024

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

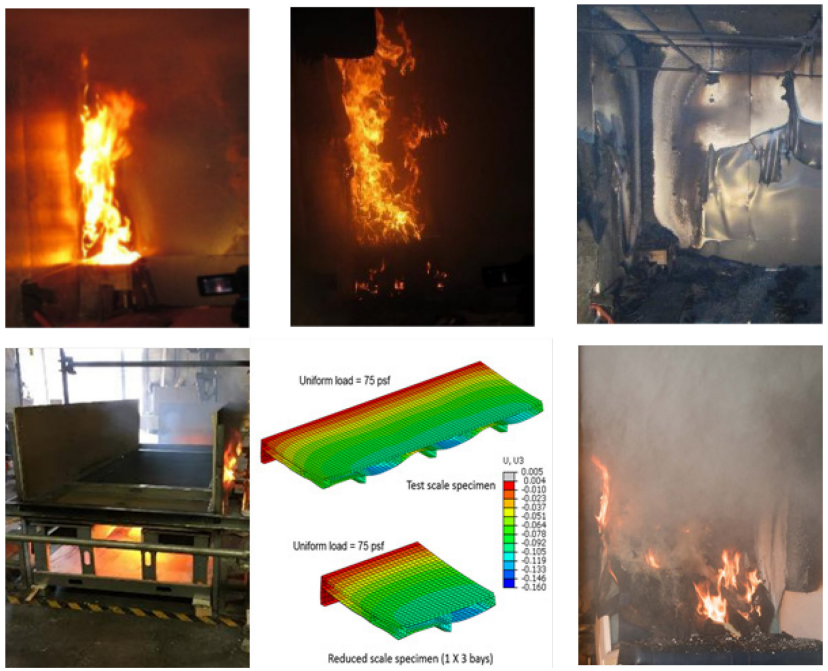
Fire Engineering Research

PROJECT DESCRIPTION

- Evaluate and develop alternative fire performance criteria for passenger railcars.
- Develop models and scaling laws to reduce test article size for quantifying fully developed railcar fire heat release rate.
- Review industry methods for measuring toxicity of burning materials.
- Conduct simulations of passenger egress under various fire scenarios using railExodus®, Pathfinder®, and fire dynamics models.

RAILROAD IMPACT

- Provide validated computer models to predict the fully developed railcar fire heat release rate to support fire hazard assessments and smoke control design.
- Recommend a reduced-scale floor assembly for fire resistance testing to save cost on compliance testing.
- Recommend smoke toxicity measurement methods and criteria for passenger rail car materials.
- Evaluate passenger egress from railcars under various fire scenarios.
- Interface with National Fire Protection Associations 130 Committee in development and maintenance of industry standards.



PROJECT PARTNER

- Jensen Hughes

COST & SCHEDULE

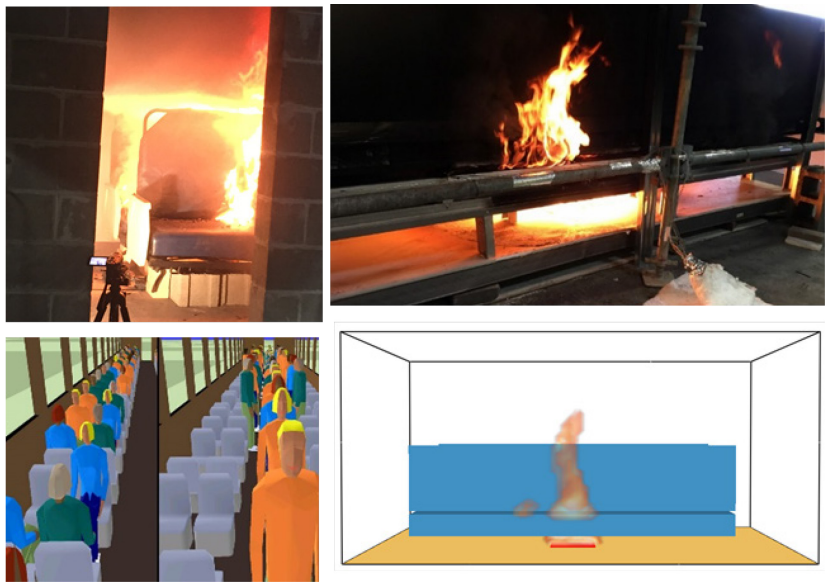
- Funding: $1,887,822
- Project Duration: September 2020 – September 2023

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

Fire Safety and Emergency Egress Research

PROJECT DESCRIPTION

- Support FRA in evaluating alternative fire performance criteria for passenger railcars.
- Provide technical assistance on analysis of the alignment of egress modeling results when coupled with fire prediction models.
- Review and compare fire safety regulations, laws, and standards in the U.S. and around the world.
- Participate in meetings of the National Fire Protection Associations 130 Committee to develop and maintain industry standards for passenger railcar fire safety.



RAILROAD IMPACT

- Inform the development of knowledge for the quantification of rapid and easy egress from passenger railcars.
- Support the advancement of fire safety policies and standards for passenger railcars.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $375,000
- Project Duration: September 2019 – August 2024

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

Water Mist Suppression Systems and Accident/Incident Data Review

PROJECT DESCRIPTION

- Support FRA in researching the feasibility and safety benefits of installing water mist suppression systems in locomotives and passenger railcars.
- Include a review of passenger rail fire events that do not meet the FRA accident/incident reporting threshold to better quantify and assess the potential benefits of fire suppression systems on board rail equipment.

RAILROAD IMPACT

- Inform industry and FRA on the efficacy of water mist and other fire suppression systems in passenger railcars.
- Gain an understanding of the frequency and typical damage of smaller-scale fire events on board locomotives and passenger railcars where water mist or other suppression systems could have a safety impact.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

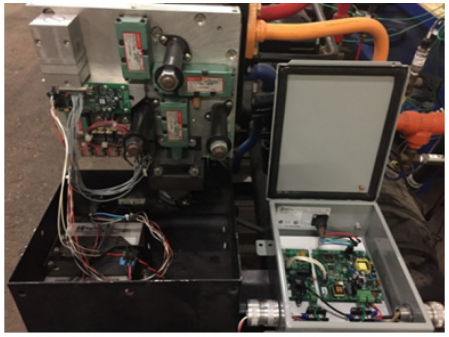
- Funding: $140,000
- Project Duration: June 2020 – October 2022

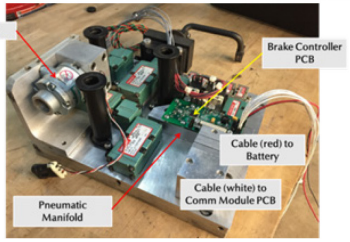
FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

Electronically Controlled Pneumatic Brake with Pneumatic Emulation – Vibration and Environmental Compliance

PROJECT DESCRIPTION

- The safety benefits of electronically controlled pneumatic (ECP) brakes can be fully realized only when significant portions of relevant fleets become ECP-equipped.
- To assist the transition, FRA supported the development of emulator technology. Laboratory and field demonstrations of the technology have been successful.
- This project will further advance emulation technology to ensure performance under harsh railroad conditions.
- Current focus:
  - Upgrade ECP emulation technology hardware for temperature and vibration environment compliance.
  - Conduct S-4200 required tests to confirm performance under cold, heat, and vibration conditions.





RAILROAD IMPACT

- Increased railroad operating safety due to inherently more reliable and effective braking
- An alternative to overlay ECP
- Increased line-haul speeds due to reduce terminal and in-service train delays
- Improved safety for both crew and public due to better-performing equipment
- Increased utility of cars equipped with ECP compared to stand-alone ECP system

PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

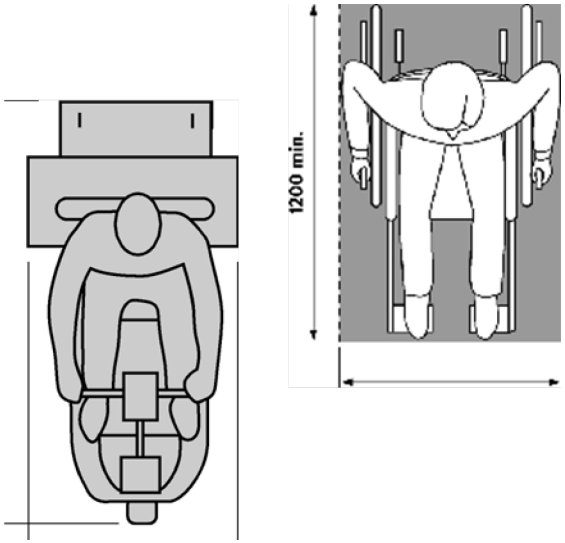
- Funding: $400,000
- Project Duration: September 2020 – August 2022

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

Universal and Inclusive Accessibility for Next Generation of Passenger Rail Equipment

PROJECT DESCRIPTION

- Develop recommendations for improved accessibility on passenger rail equipment:
  - Larger accessible space to accommodate powered wheeled mobility devices.
  - Improved maneuverability in accessible restrooms
  - Automatic controls in accessible restrooms
  - Dual-mode passenger information system to ensure communication with passengers who are deaf or have hearing loss.
- Conduct test to evaluate various containment methods for securing wheeled mobility devices on passenger railcar.
- Quantify the relative motion of wheeled mobility devices during a low-speed train collision.



RAILROAD IMPACT

- Enhanced train travel for passengers with disabilities
- Study of occupant protection for passengers who remain seated in wheeled mobility devices
- Support the development of reasonable and inclusive requirement for accessibility on board railcars.

PROJECT PARTNERS

- Oregon State University
- Volpe National Transportation Systems Center
- Passenger Rail Investment and Improvement Act of 2008 – 305 Next Generation Equipment Committee

COST & SCHEDULE

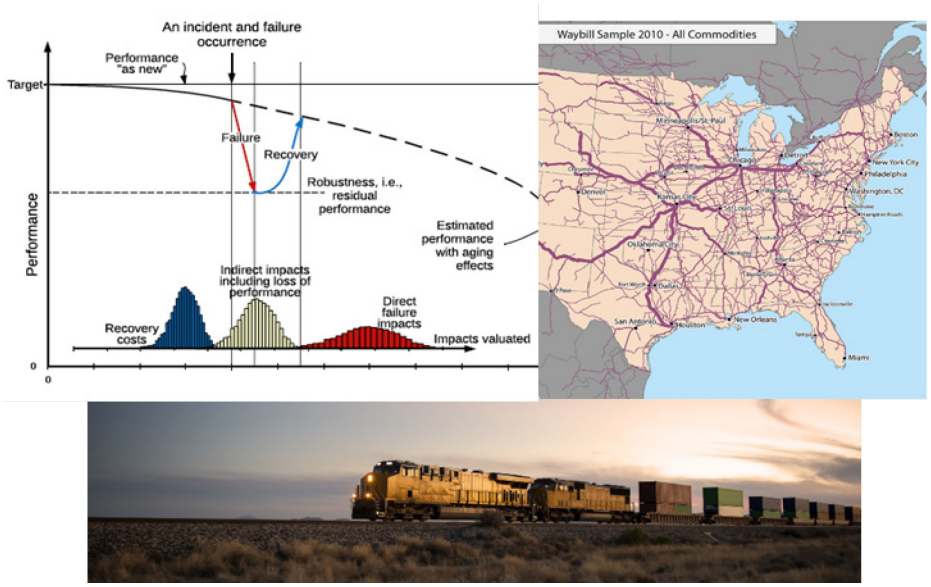
- Funding: $365,000
- Project Duration: April 2017 – Present

FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

Quantifying the Resilience of Freight Railroad Networks

PROJECT DESCRIPTION

- Needs: Shifting freight from roads to rails has many benefits, including road safety, road infrastructure longevity, and energy savings. Enhancing resilience is a key contributing factor.
- Objective: Assess and enhance the topology of Class I railroad networks for robustness, resiliency, efficiency, and throughput effectiveness by cost-effective means.
- Method: Utilize network theory, simulation, Bayesian nets, and resilience quantification models as needed to identify 1) nodal and linkage bottlenecks and criticality and 2) investment strategies to enhance networks with economic efficiency, including scheduling opportunities.



RAILROAD IMPACT

- Enhance topology for increased network robustness and resilience in cost-effective terms.
- Inform policy and decision-making practices.
- Increase economic efficiency.
- Enhance planning and design methods at the network level.
- Plan for and improve on capital spending.

PROJECT PARTNER

- University of Maryland Center for Technology and Systems Management

COST & SCHEDULE

- Funding: $409,957
- Project Duration: May 2020 – November 2022

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Tarek Omar, Ph.D. • (202) 493-6189 • tarek.omar@dot.gov

Emergency Notification Sign Informational Video

PROJECT DESCRIPTION

- The purpose of this video is to educate the public and emergency responders on how to locate and use Emergency Notification Sign information.
- The format of the video will follow the same method used for the rail safety videos.
- The video contains an overall safety message and details of the ENS signs.
- The new video will provide the audience with unique information needed to locate, identify, and relay information on the ENS sign.

RAILROAD IMPACT

- With the development, launch, and distribution of recent videos, FRA has successfully provided vital safety information in a central location.
- FRA received feedback requesting information on the ENS signs.
- ENS signs display information necessary for the public to report an unsafe condition at grade crossings when dispatching information to the railroads.
- These ENS signs are mandatory at all grade crossings which include public, private, and pathway crossings. Phone numbers and USDOT National Crossing inventory number are displayed to relay the appropriate information to the railroads.
- After the release of the safety videos, it was evident that there is a gap in knowledge regarding these ENS signs and how they are used both by the public and the railroads.

PROJECT PARTNER

- KEA Technologies, Inc.

COST & SCHEDULE

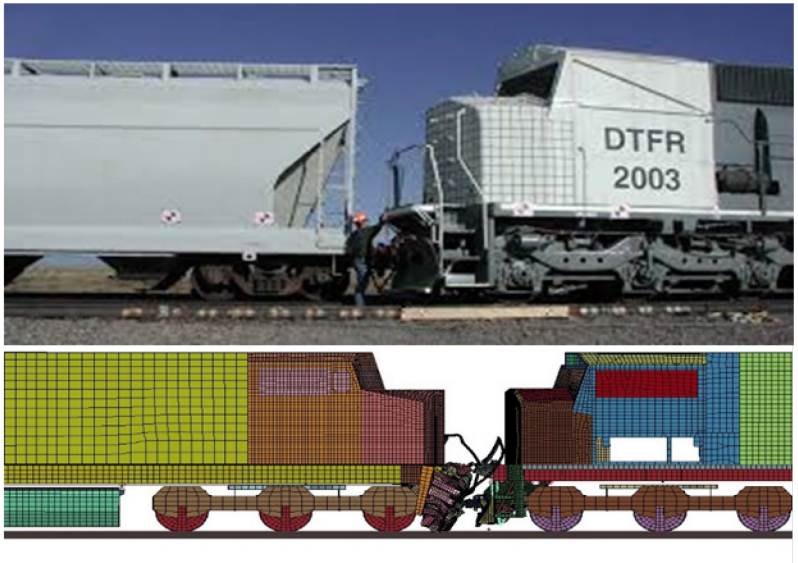
- Funding: $150,000
- Project Duration: September 2020 – March 2022

FRA PROJECT MANAGER: Tarek Omar, Ph.D. • (202) 493-6189 • tarek.omar@dot.gov

Evaluation of Modern Locomotive Crashworthiness Performance

PROJECT DESCRIPTION

- KEA Technologies, Inc. will review the FRA accident database to identify severe collisions involving modern locomotives, including those with a crew casualty.
- Examine available modern locomotive FEA models and develop a pragmatic collision evaluation criteria.
- The KEA team, including George Mason University, will conduct FEA simulations on identified accident cases and compare the locomotive crashworthiness results.
- Plan and carry out static and dynamic tests to validate the FE model for use in modern locomotive collision effects evaluation.



RAILROAD IMPACT

- Crashworthiness compliance with S-580 and the cab-crew protection of modern locomotives will be ensured in online collisions.
- Longer freight trains with higher freight capacity, such as the unit trains and those with distributed power units, can operate with cab-crew safety in collisions.
- Freight railroad operational safety and efficiency will be improved in the future.

PROJECT PARTNERS

- KEA Technologies, Inc.
- George Mason University

COST & SCHEDULE

- Funding: $441,000
- Project Duration: June 2021 – December 2022

FRA PROJECT MANAGER: Tarek Omar, Ph.D. • (202) 493-6189 • tarek.omar@dot.gov

Wireless Digital Train Line for Passenger Trains (Phase IV)

PROJECT DESCRIPTION

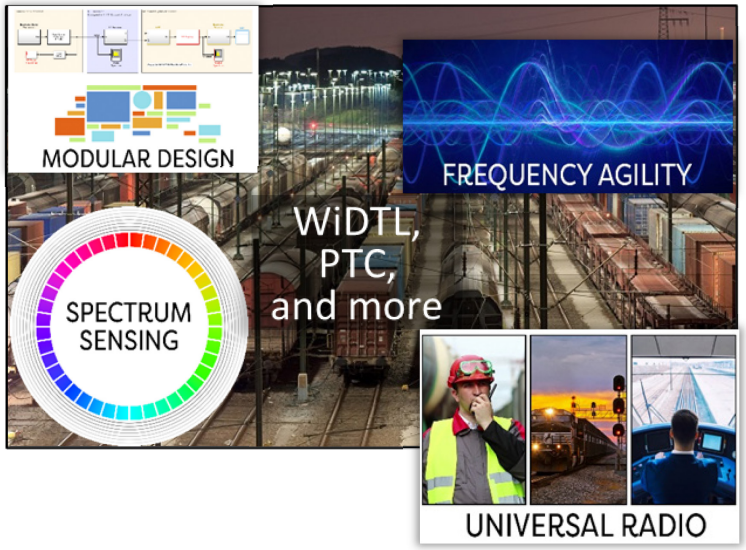
- RF spectrum is nearly saturated, causing problems for many rail applications (e.g., PTC, WiDTL), especially in high-density areas.
- FRA research in previous phases designed and simulated a modern RF system for the 160 MHz RF band, showing its merits and capabilities to support new and existing applications, including for WiDTL onboard signaling and service communications.
- This research aims to realize a full prototype of our transceiver design utilizing a software radio platform, with cognitive radio capabilities and spectrum sensing and a component-driven modular design process.
- This research initiates development of our envisioned universal radio platform – a single radio across applications, RF bands, environments, and form factors (handheld, WiDTL, wayside, etc.).
- This project is conducting extensive field test evaluations of the prototype to demonstrate the merits of 160 MHz as a viable band for modern rail applications.
- This team is working closely with the Next Generation Equipment Committee (NGEC), the Association of American Railroads, Amtrak, Union Pacific Railroad, BNSF, etc.

PROJECT PARTNER

- University of Nebraska-Lincoln Advanced Telecommunications Engineering Laboratory (TEL)

COST & SCHEDULE

- Funding: $178,000
- Project Duration: January – December 2023



RAILROAD IMPACT

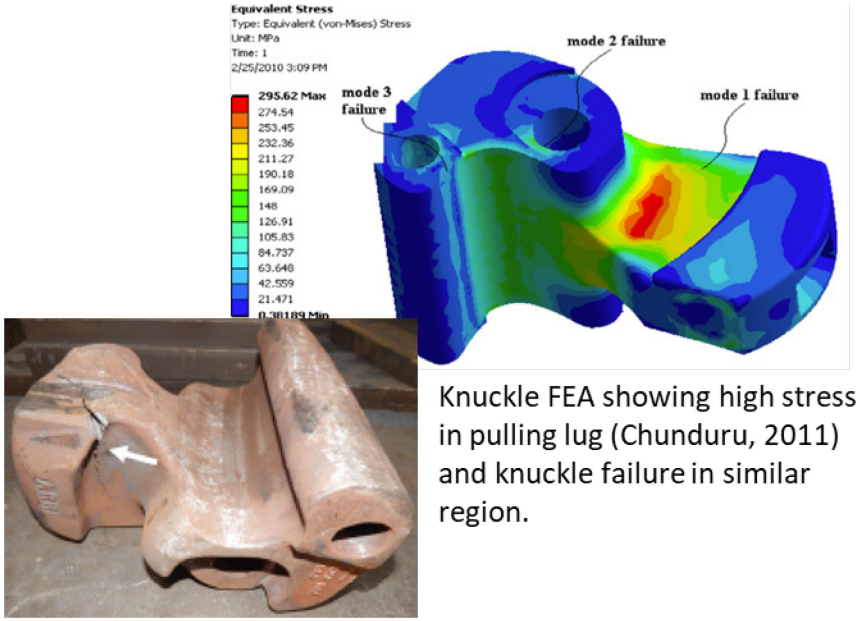
- Establishes path towards Universal Radio Platform, integrating a modular design, cognitive radio capabilities, and wide-range frequency agility.
- Transitions our research into the 160MHz RF band from computer simulation to a full prototype platform.
- Advances readiness for use by railroads in applications such as extending the 220MHz PTC into the 160MHz band to relief congestion in high-density areas.
- WiDTL onboard signaling and long-range wayside communications.
- All developed software radio code, design documents, and performance results are available to the rail industry for adoption into rail applications, further evaluation or customization.

FRA PROJECT MANAGER: Tarek Omar, Ph.D. • (202) 493-6189 • tarek.omar@dot.gov

WAAM for Weld-Enhanced Cast Steel Couplers

PROJECT DESCRIPTION

- Objective: Increase coupler safety and reliability by weld-enhancing knuckle locally in high-stress areas through wire-arc additive manufacturing (WAAM)
- Coupler knuckles fail in high-stress regions by **corrosion fatigue** accelerated by casting defects, surface decarburization during heat treatment, and environment (salt)
- WAAM is a weld repair process for high-stress regions that can improve fatigue strength and corrosion resistance by removing casting and heat treatment defects in three tasks:
  - Process development with standard AWS wire grades
  - High-cycle fatigue on weld material and weld-substrate in air and salt environments
  - Prototype production knuckle and perform M-216 knuckle testing.



Knuckle FEA showing high stress in pulling lug (Chunduru, 2011) and knuckle failure in similar region.

RAILROAD IMPACT

- Safer coupler system that is less likely to fail due to fatigue or corrosion
- More reliable coupler system with consistent load capacity over its lifetime
- Will not change geometry of coupler
- Will build on current weld repair procedures
- High-volume production strategy with limited cost implications

PROJECT PARTNERS

- Michigan Technological University
- Amsted Rail

COST & SCHEDULE

- Funding: $500,00
- Project Duration: April 2022 – December 2024

FRA PROJECT MANAGER: Tarek Omar, Ph.D. • (202) 493-6189 • tarek.omar@dot.gov

Rail Research and Development Center of Excellence Program

PROJECT DESCRIPTION

- Establish and maintain a shared Center of Excellence to advance research and development that improves the safety, efficiency, and reliability of passenger and freight rail transportation.
- Conduct advanced rail research to understand the needs and implications of emerging transportation technologies such as automation and unmanned aerial systems, transportation system use and operations, and infrastructure design.
- Research topics will include train control, human factors, rail infrastructure, shared corridors, grade crossings, inspection technology, remote sensing, rail systems maintenance, network resiliency, operational reliability, energy efficiency, and other advanced technology.
- Develop partnerships to expand rail training.
- Develop rail-focused curricula and programs.
- Build STEM competencies of local and future rail workforce.

RAILROAD IMPACT

- Consortium of universities to advance rail research and innovation
- Increased university participation and partnership
- Expanded talent pool of rail professionals
- Increased technology transfer of prioritized research

PROJECT PARTNERS

- Consortium of universities to be determined

COST & SCHEDULE

- Funding: $2.5M per year; $7.5M total
- Project Duration: 36 months

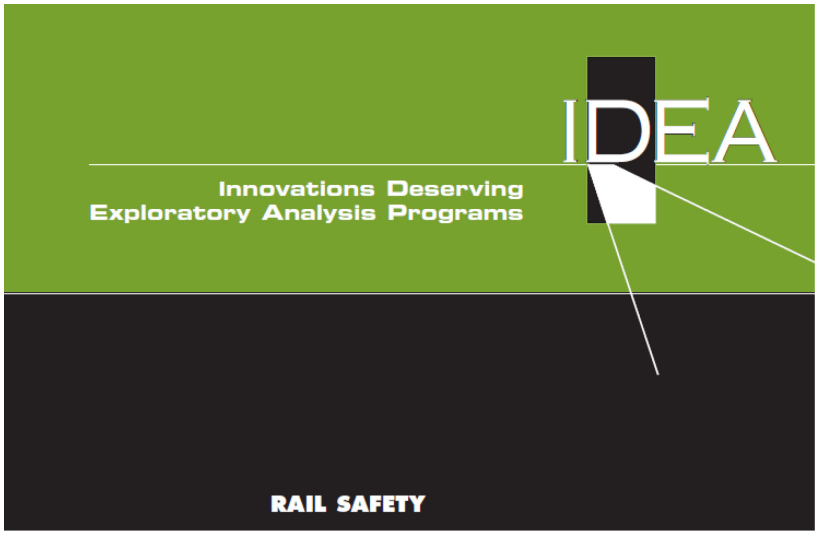
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Tarek Omar, Ph.D. • (202) 493-6189 • tarek.omar@dot.gov

Rail Safety Innovations Deserving Exploratory Analysis (IDEA) Program

PROJECT DESCRIPTION

- IDEA programs differ from traditional research programs in that they are initiated by researchers, inventors, universities, or companies – both within and outside the usual transportation research community – rather than by a request for proposals.
- Each year, three proposals are selected and funded for up to $100,000 each.
- The National Academy of Sciences carries out the Rail Safety IDEA program through the Transportation Research Board.
- Rail Safety IDEA 49, 50, and 51 will be funded in this FY22 program.



RAILROAD IMPACT

- Capture the unexpected concepts that challenge conventional thinking.
- Explore promising but unproven concepts with the potential to advance railroad safety and performance.
- Support university research centers and small companies to improve their railroad research capabilities and expertise.

PROJECT PARTNER

- Transportation Research Board

COST & SCHEDULE

- Funding, FY22: $400,000
- Project Duration: July 2022 – December 2025

FRA PROJECT MANAGER: Tarek Omar, Ph.D. • (202) 493-6189 • tarek.omar@dot.gov

Review of Very Long Train (VLT) Operations

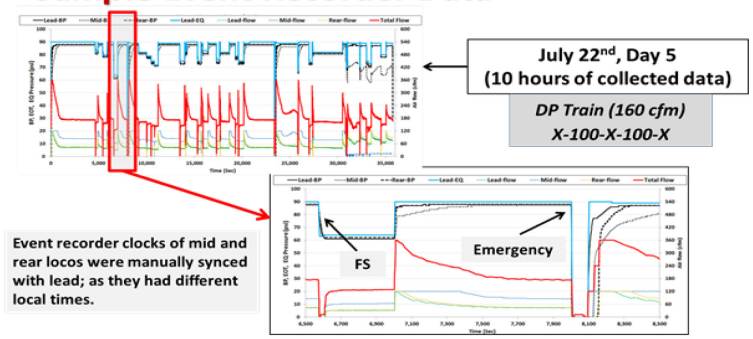
PROJECT DESCRIPTION

There have been notable increases in the length and weight of trains on the North American rail network, with many trains running over 200 cars long. FRA considered it prudent to review and understand train performance and accepted practices for VLT (200+ cars) operations. This effort focuses on confirming the safe performance of the air brake system as well as resulting train dynamics for VLTs through a series of tests and simulations.

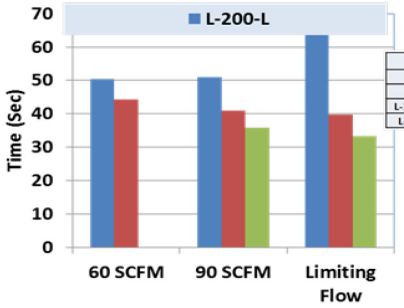
This is a collaborative effort with industry stakeholders, including the Association of American Railroads (AAR) representing the railroads, air brake system vendors, and labor unions. A Test Review Committee (TRC), with representation from the various parties, guides the technical effort.

In Phase III, 200-car stationary tests tests have been completed and preliminary results comparing Phase II and Phase III and Phase III distributed power train configurations have been presented to the TRC.

Sample Event Recorder Data



FS Application – BC Buildup Time



BP Gradient [psi]			
Train	60 SCFM	90 SCFM	Limiting Flow
L-200-L	3.5	6.8	11.5
L-133-L-67-ETD	1.9	2.7	8.9
L-100-L-100-L	1.4	1.9	4.4

Faster buildup times for trains with smaller length between two air sources (with smaller gradient)

RAILROAD IMPACT

- Improved and demonstrated operational safety through better understanding of brake system performance
- Potential to document safety benefits of using technologies, such as distributed power.
- Simulation tools will have been validated under these newer operating regimes, allowing better customization of operating protocols.

PROJECT PARTNERS

- AAR
- Class I railroads (UP, BNSF, NS, CSX, KCS, CN, CP)
- MxV Rail/Technology Center, Inc.
- Wabtec Corp.
- New York Air Brake Corp.
- Sharma & Associates, Inc.
- Rail labor unions

COST & SCHEDULE

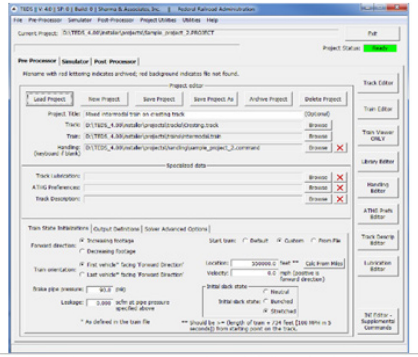
- Funding, FY22: $ 273,500
- Project Duration: September 2020 – September 2023

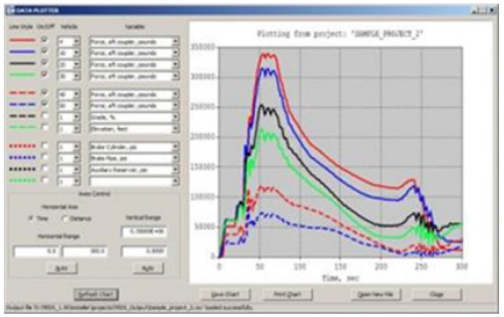
FRA PROJECT MANAGER: Monique Ferguson Stewart • (202) 493-6358 • monique.stewart@dot.gov

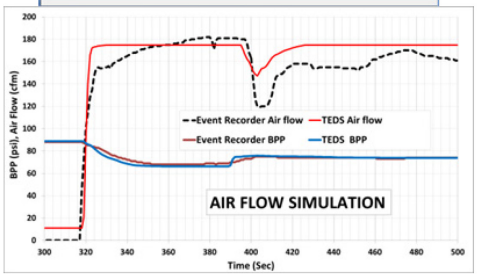
Train Energy and Dynamics Simulator (TEDS)

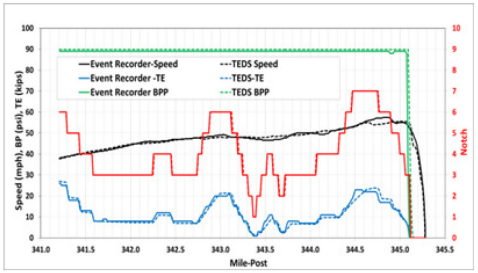
PROJECT DESCRIPTION

- TEDS is a computer program developed by FRA for conducting longitudinal train dynamics simulations.
- It may be used to assist development of guidelines and recommendations to improve train operating safety.
- TEDS is capable of simulating train handling, train makeup, head-end and distributed power, ECP and automatic brake applications for speed control, stopping distances, and emergency stops.
- Published validation details can be found in FRA reports: DOT/FRA/ORD-15/01, DOT/FRA/ORD-20/24, and DOT/FRA/ORD-20/26.
- TEDS has been used successfully for several simulations to assist FRA's Office of Railroad Safety in various investigations and policy studies.
- It is available for public use under a service agreement with FRA and Sharma & Associates, Inc.









RAILROAD IMPACT

TEDS facilitates identification and quantification of safety risks in train operations affected by:

- Equipment
- Train makeup, including free slack between couplers
- Train handling
- Track conditions, including presence of lubricators
- Operating practices
- Environmental conditions
- Certain types of malfunctioning equipment, such as locomotive power drops, leaking air brakes, etc.

PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding, FY22: $150,000
- Project Duration: September 2020 – September 2023

FRA PROJECT MANAGER: Monique Ferguson Stewart • (202) 493-6358 • monique.stewart@dot.gov

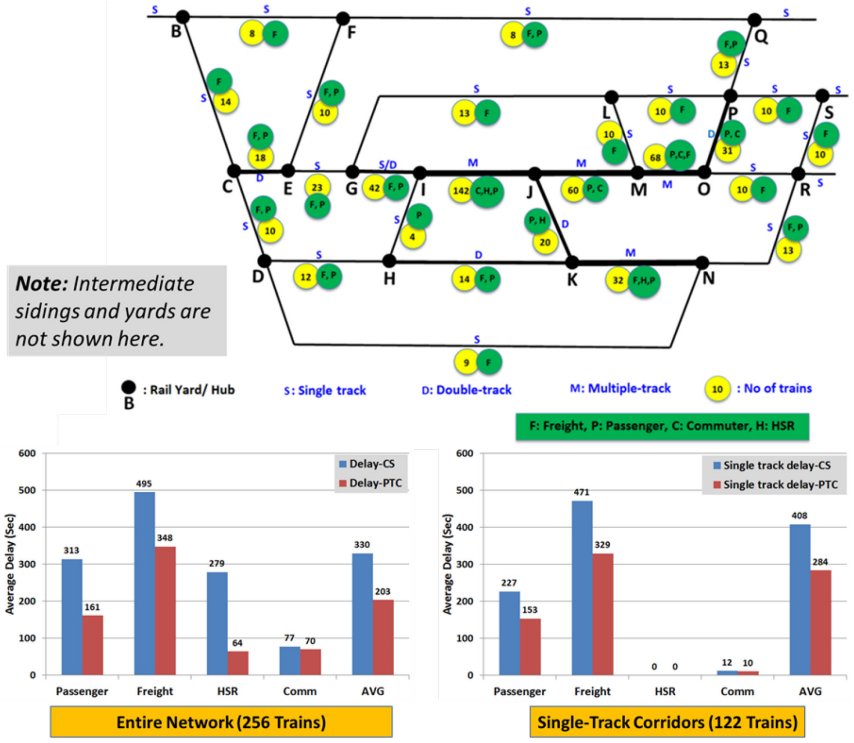
Effects of Technology Implementations on Network Operations

PROJECT DESCRIPTION

- Develop a methodology to quantify network-level benefits for train operations resulting from the implementation of new technologies.
- Use network simulations software OpenTrack® for various network operational characteristics as follows:
  - Different types of corridors: Single-track, double-track, and multiple-track corridors
  - Types of traffic: Dedicated vs. shared-use corridors
  - New technology implementation
  - 4,900 miles of main tracks have been developed with 256 daily trains operating along different sections of the network – with a variety of signaling and braking characteristics.

RAILROAD IMPACT

- Improve traffic congestion analysis.
- Objective evaluation of operating with new technologies
- Capabilities to analyze the network-related parameters of operating trains under PTC systems.
- Quantify network benefits due to new technologies.



PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

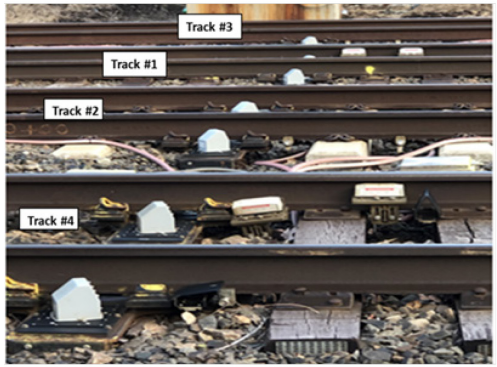
- Funding, FY22: $149,000
- Project Duration: September 2018 – September 2021

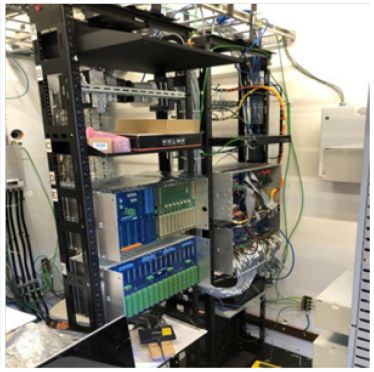
FRA PROJECT MANAGER: Monique Ferguson Stewart • (202) 493-6358 • monique.stewart@dot.gov

Wayside Advanced Technology Systems (WATS)

PROJECT DESCRIPTION

- Partner with Metro-North Railroad (MNR), Long Island Rail Road (LIRR) and New York Atlantic Railway (NYA) to assist with pilot demonstrations of new wayside technology systems to detect defects and precursors to safety-critical defects in rolling stock.
- Document new installation at MNR, LIRR, and NYA.
- Conduct detection threshold analysis to help railroads establish detection thresholds for inspection, alarm, and emergency level actions balanced against their shop capacity and commuter service demands for passenger coaches.
- Identify best practices for implementation and revise the Wayside Implementation Guide.





RAILROAD IMPACT

- Improve the process for demonstrating and implementing new technology.
- Establish a standard process for wayside technology pilot demonstrations.
- Wayside technology systems will reduce the number of incidents and accidents through proactive maintenance, driven by monitored performance of rolling stock equipment and components.

PROJECT PARTNERS

- Sharma & Associates, Inc.
- MNR
- LIRR
- NYA

COST & SCHEDULE

- Funding, FY22: $89,850
- Project Duration: September 2018 – December 2022

FRA PROJECT MANAGER: Monique Ferguson Stewart • (202) 493-6358 • monique.stewart@dot.gov

Advanced Technology Integration – Ecosystem Platform

PROJECT DESCRIPTION

- Develop and integrate a modern, powered, communications and control ecosystem for freight vehicles:
  - Research available communication and control platforms that might be applicable for railroad use.
  - Design and build a three-car test rack for studying the selected prototype ecosystem platform.
  - Utilize the test rack for in-lab testing/development.
  - Initiate the development and acceptance of AAR interchange specifications/standards for an electrical power supply system, an electronically driven hand brake, and the subject ecosystem platform.

RAILROAD IMPACT

- Improve freight railroad operations safety and security.
- A power, communications, and controls platform will make it easier for adoption of various safety and security monitoring device applications.
- Written and adopted standards and recommended practices, by AAR, will open the door for safety and security device implementation that will be allowed for interchange.

PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding, FY19–23: $371,000
- Project Duration: September 2019 – June 2023

FRA PROJECT MANAGER: Monique Ferguson Stewart • (202) 493-6358 • monique.stewart@dot.gov

Expanding Summer Youth Programs in Rail through Virtual Learning and a National Campus Network

PROJECT DESCRIPTION

- Create a nationwide network of hybrid (virtual and on-campus) rail focused summer programs for high school youth.
  - Expand from 20 to 80 students first year, to 120 students second year, and over 200 in third year.
- Develop a standardized curriculum of online resources and hands-on activities to expand interest in rail industry careers.
- Emphasize the variety and breadth of opportunities in the industry and the high-tech nature of many positions.
- Engage several minority-serving institutions.

RAILROAD IMPACT

- Increase outreach of current high school outreach programs by factor of 10 – over 200 youths in year 3 (total of over 400).
- Engage youths and minorities with the vibrant and exciting careers available.
- Create a new pipeline of talent prepared to enter rail industry careers.

PROJECT PARTNERS

- Michigan Technological University (lead), University of Illinois, Penn State Altoona, Univ. of New Mexico, Univ. of South Carolina, California State University, Fresno, AREMA, National Railroad Contractors and Maintenance Association

COST & SCHEDULE

- Funding, Phase I and II: $313,235
- Project Duration: September 2020 – August 2024

FRA PROJECT MANAGER: Monique Ferguson Stewart • (202) 493-6358 • monique.stewart@dot.gov

The Railroaders of the Mid-Century

PROJECT DESCRIPTION

- Design a pilot program with an emphasis on aging, diversity, and image, providing sponsorship to underrepresented groups.
- Complement existing railroad programs with previous success within the U.S.
- Emphasis on engaging Pre-K–12 students to see railroads as a career of choice: UAS, AI, WSS, 3D printer, and rockets.
- Year 1 at the University of New Mexico (UNM) with support from Stanford University and Florida Agricultural and Mechanical University (FAMU); Year 2 implementation focused mainly in the South and Southwest; Year 3: Nationwide implementation.
- Summer school & one-day courses, one annual workshop with FRA, railroads, industry, Pre-K–12 teachers, and diversity experts to augment diversity in the railroad.

RAILROAD IMPACT

- The pilot railroad program will increase the interest of Pre-K–12th graders into railroads, developing talent from the ground-up that is of value to railroads.
- Develop a new image for the railroad industry by implementing new technologies: The Railroaders of the Mid-Century (2050s).
- Youth will be exposed to futuristic skills and training and will target areas of interest to the railroads.
- Railroads will provide input to outreach goals.

PROJECT PARTNERS

- UNM, FAMU, Stanford, University of Illinois, University of Nebraska, University of Tennessee, Michigan Technological University
- CN Railway, New Mexico Rail Runner Express, Transportation Technology Center, Inc., Sandia National Laboratories, Air Force Research Laboratory, NASA, New Mexico Space Grant Consortium, Albuquerque Rocket Society, Sandia Peak Tramway, High Water Mark LLC, Los Alamos County
- Middle and high schools; Explora Museum

COST & SCHEDULE

- Funding, $475,375
- Project Duration: September 2021 – June 2023

FRA PROJECT MANAGER: Mike Jones • (202) 493-6106 • michael.e.jones@dot.gov

Railroading Education: On Track to a Great Career

PROJECT DESCRIPTION

- California State University, Fresno, and partners such as the California High-Speed Rail Authority (CAHRSA), freight railroads, commuter railroads, etc., will raise the visibility and appreciation of railroading careers as a high-tech industry, among intermediate school, high school, and community college students, with an emphasis on students from minority and underrepresented rural communities in the San Joaquin Valley.
- Our team will (1) survey railroad industry organizations to determine current best recruiting practices; (2) collaborate with freight and passenger railroads to determine what railway career opportunities will be today and in the future; (3) research and compile best STEM program practices; (4) engage students in under-represented communities of San Joaquin Valley to measure effectiveness of various outreach strategies; (5) create a railroad careers student outreach toolbox; and (6) develop and implement pilot student railroad outreach programs.

RAILROAD IMPACT

- Association with CAHSR will create a high-tech opinion for careers in the railway industry.
- Inclusion of high-speed passenger rail, Class I freight railroads, shortline freight railroads, and other passenger railways will cover all the types of railroad systems.
- Will provide a comprehensive toolbox that will help railways collaborate with all other partners in the industry to change the public opinion of railroading to that of a high-tech career of choice.

PROJECT PARTNERS

- California State University, Fresno
- CAHRSA

COST & SCHEDULE

- Funding, FY19–23: $203,798
- Project Duration: September 2019 – June 2023

FRA PROJECT MANAGER: Mike Jones • (202) 493-6106 • michael.e.jones@dot.gov

Nondestructive Evaluation (NDE) of Railroad Tank Cars

PROJECT DESCRIPTION

- Disseminate prior NDE probability of detection (POD) results/findings with the tank car industry and stakeholders.
- Conduct a feasibility study to identify the capabilities/limitations of new and advanced NDE methods for tank car inspections.
- Investigate the effects of corrosion on railroad tank car structures and the potential use of state-of-the-art NDE methodologies for remaining tank car shell thickness measurement.
- Gather information on the newer types of tank cars and the common failure modes and determine if newer weld test panels are needed for future POD studies.

RAILROAD IMPACT

- Provides inspection reliability – a key consideration in the safety and operation of tank cars
- Increases safety through technological development
- Addresses industry needs in the areas of maintenance, inspection, and damage tolerance
- Quantification of the NDE methods through POD metrics provides direction and insight into the current capabilities of the industry when using the allowed NDE methods.
- Provides for operator and procedure qualifications

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Tank car industry and stakeholders
- NDE equipment OEMs

COST & SCHEDULE

- Funding, FY21: 240,000
- Project Duration: October 2018 – September 2022

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

Tank Car Impact Tests

PROJECT DESCRIPTION

- This is a continuation of FRA and industry tank car impact research programs:
  - Develop and improve test methods.
  - Provide data for improving modeling methods.
  - Design and construct test fixtures.
- Prepare and test various tank car designs:
  - DOT 105 – April 27, 2016
  - DOT 117 – September 28, 2016
  - DOT 105 – July 26, 2017
  - DOT 105 – August 1, 2018
  - DOT 111 – October 30, 2018
  - DOT 113C120W – November 19, 2019
  - DOT 113 Surrogate – June 11, 2020
  - DOT 113 Surrogate w/LN2 – 2021
  - DOT 113C120W9 w/LN2 – 2021/2022
- Analyze and provide the data for validation of finite element models.
- Reports on test and model results

RAILROAD IMPACT

- Development of performance-based testing requirements
- Development of methods to evaluate the crashworthiness and structural integrity of different tank car designs.
- Evaluation of crashworthiness performance of tank cars used in the transportation of hazardous materials.

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- U.S. Pipeline and Hazardous Materials Safety Administration
- Volpe National Transportation Systems Center
- Tank car manufacturers

COST & SCHEDULE

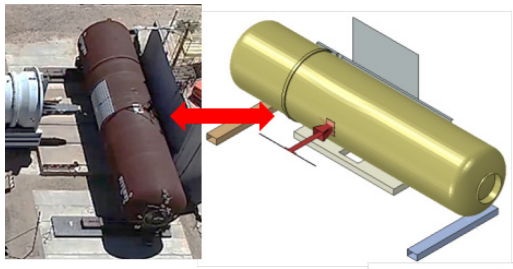
- Funding, FY22: $1M
- Project Duration: July 2015 – September 2023

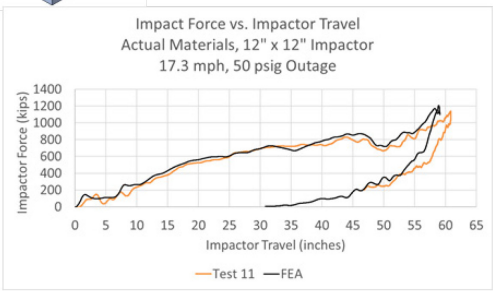
FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

Tank Car Impact Finite Element Analysis

PROJECT DESCRIPTION

- Evaluate puncture resistance of various DOT 113 tank cars and surrogate tanks in standardized shell impact scenario.
- Validate computational models so that they can reliably be used to study service conditions with hazmat.
- Study effects of cryogenic temperature on puncture behavior of DOT 113 tank cars.
- Examine effects of parameters such as support conditions, impactor size, etc., on shell puncture.
- Develop computational models of tank car designs under impact conditions, including cryogenic conditions.
- Compare test data with model results to validate models and improve modeling techniques.





RAILROAD IMPACT

- Development of methods to evaluate and compare the crashworthiness and structural integrity of different tank car design features (e.g., different materials, material thicknesses).
- Evaluation of crashworthiness performance of tank cars used in the transportation of hazardous materials.
- Development of objective methods for demonstrating validation of computational models.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- U.S. Pipeline and Hazardous Materials Safety Administration
- Transportation Technology Center, Inc.
- Tank car manufacturers

COST & SCHEDULE

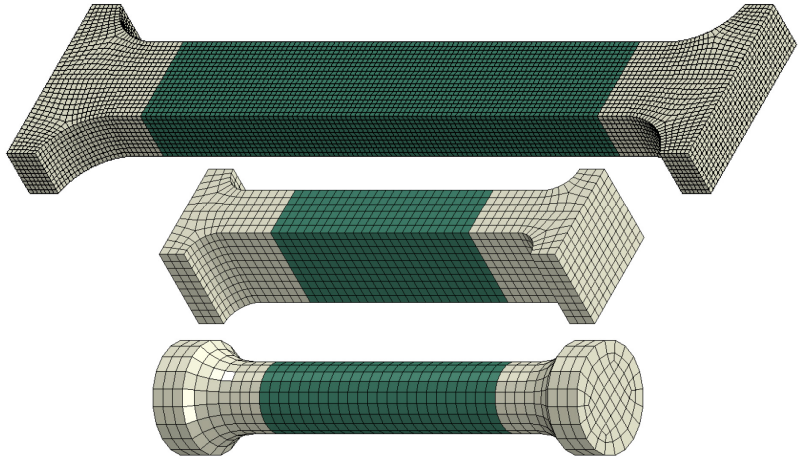
- Funding, FY22: $300,000
- Project Duration: May 2020 – May 2023

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

Behaviors of Tank Car Construction Materials

PROJECT DESCRIPTION

- Conduct engineering analyses and develop computational tools to evaluate structural performance of railroad tank cars under normal operating conditions.
- Conduct material testing to determine mechanical properties and fracture behavior of tank car steels.
- Conduct study on fabrication techniques affecting material properties of TC128 steel.
- Develop computational models of tank car steels.
- Examine properties of stainless steel(s) used in cryogenic DOT 113 tank cars.



RAILROAD IMPACT

- Understanding the range of material behaviors in tank car fleet needed to determine baseline tank car fleet structural performance.
- Developing computational models of these materials supports parametric studies of material variations.
- Understanding the effects of fabrication techniques on mechanical properties in “as-built” cars can identify potential benefits to tank car performance.
- Previous research has focused on mechanical properties of carbon steels (e.g., TC128).
- Cryogenic tank cars (DOT 113) use a carbon steel outer tank/stainless steel inner tank at cryogenic temperature.
- Understanding of stainless steel behaviors under cryogenic operating conditions needed to determine baseline DOT 113 structural performance; examine alternative designs.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Transportation Technology Center, Inc.
- Tank car manufacturers

COST & SCHEDULE

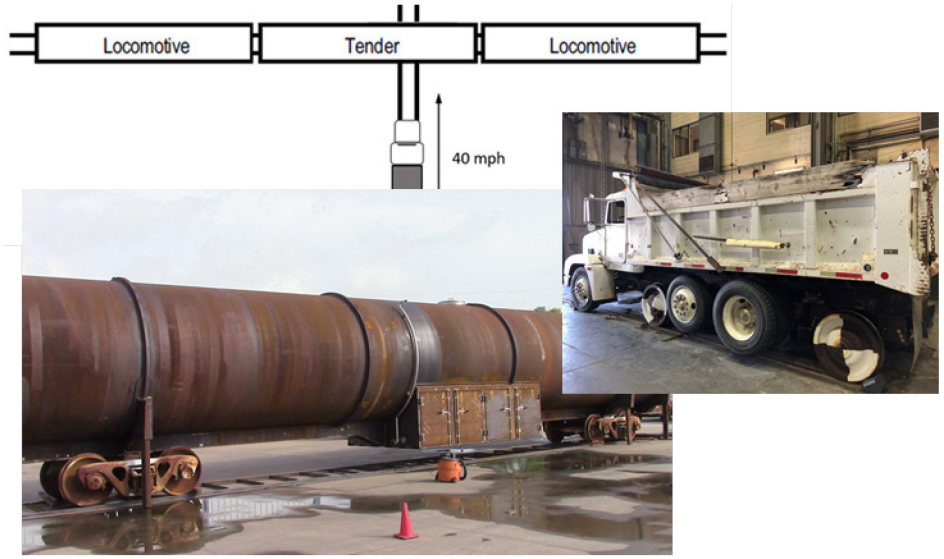
- Funding, FY22: $100,000
- Project Duration: May 2020 – May 2023

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

Grade Crossing Impact Test of Liquefied Natural Gas Tender

PROJECT DESCRIPTION

- Provide data to help evaluate the survivability of the valve functions to cut off supply and shut off any liquefied natural gas (LNG) or gas flow under certain grade crossing accident conditions.
- Test and analyze new LNG tender in grade crossing scenario outlined in draft Association of American Railroads (AAR) standard, AAR Natural Gas Fuel Tender Specifications, M-1004.



RAILROAD IMPACT

- Support use of LNG as a locomotive fuel
- Potential fuel cost savings
- Potential clean fuel technology

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Volpe National Transportation Systems Center
- Taylor-Wharton (formerly CVA)

COST & SCHEDULE

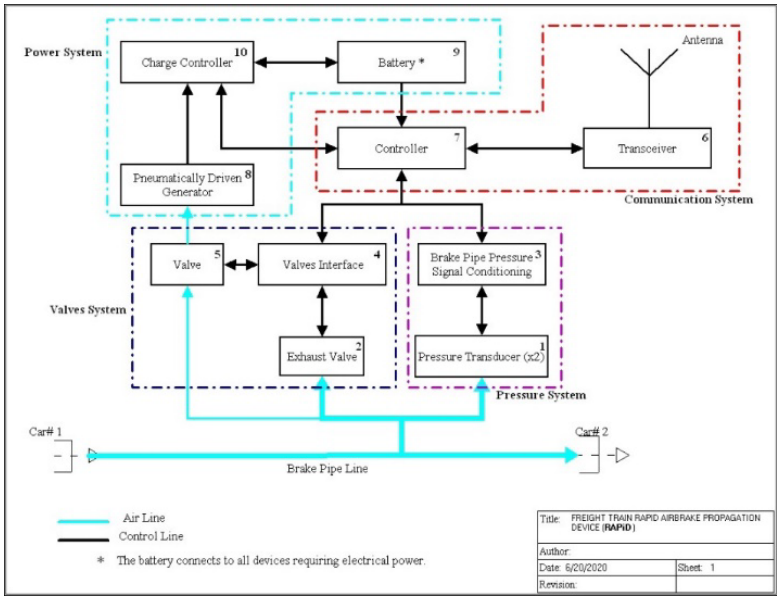
- Funding: $875,000
- Project Duration: August 2018 – September 2022

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

Freight Train Rapid Airbrake Propagation Device (RAPiD)

PROJECT DESCRIPTION

- Increasing freight train air brake signal propagation speeds has the potential to improve the safety of train operations.
- The objective of this project is to conceptualize and develop methods that can accelerate the propagation of the brake signal along the length of the train, short of an ECP-style implementation on every car.
- Prototyping and demonstration of such a system is planned as part of future work.
- An additional element is to integrate the electrically driven set and release hand brake (EDHB) with RAPiD to provide smart automatic hand brake applications on freight cars after a train is stopped, or when needed, via RAPiD or locomotive engineer control.



RAILROAD IMPACT

- RAPiD is envisioned to improve the safety of freight train operations by creating a method by which air brake signal propagation speeds are increased.
- EDHB integration will mitigate the very dangerous condition of runaway trains.

PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

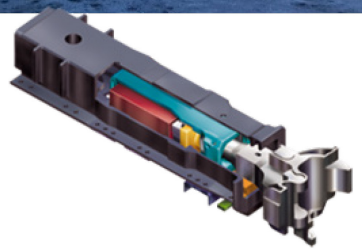
- Funding: $449,550
- Project Duration: May 2020 – August 2023

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

Tank Car Research

PROJECT DESCRIPTION

- FRA has shown that high-magnitude coupling forces that occur in yard operations have the potential to exceed yield limits of mild steel.
- FRA, Union Tank Car, and Amsted Rail recently completed a comprehensive test program to characterize tank carload environments at Amsted Rail's test facility in Camp Hill, PA.
- This task is focused on comprehensive analysis of the collected impact test data to arrive at limiting conditions for coupling speed and impacting mass.
- Additional testing will focus on brake system performance in revenue service operations.



RAILROAD IMPACT

- Create better understanding of the operational environment and root cause of fractures on tank cars.
- Develop speed and mass combination curves to mitigate tank car stub sill failures.
- Conduct over-the-road brake testing to target a variety of issues faced by the industry.

PROJECT PARTNERS

- ENSCO, Inc.
- Union Tank Car Co.
- Amsted Rail Company, Inc.

COST & SCHEDULE

- Funding, FY22: $250,000
- Project Duration: September 2018 – September 2023

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

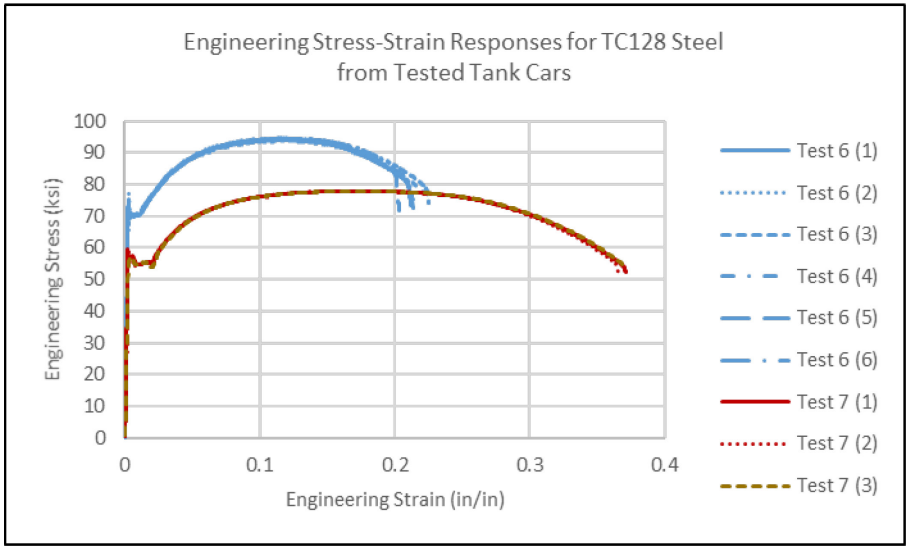
Tank Car Research

PROJECT DESCRIPTION

- Conduct engineering analyses and develop computational tools to evaluate structural performance of railroad tank cars under normal operating conditions.
- Conduct material testing to determine mechanical properties and fracture behavior of tank car steels.
- Conduct study on fabrication techniques affecting material properties.
- Develop computational models of tank car steels.

RAILROAD IMPACT

- Previous industry- and FRA-sponsored research has revealed a wide range of material properties found in the U.S. tank car fleet.
- Additional data has become available since that research was conducted.
- Understanding the range of material behaviors in tank car fleet needed to determine baseline tank car fleet structural performance.
- Developing computational models of these materials supports parametric studies of material variations.
- Understanding the effects of fabrication techniques on mechanical properties in “as-built” cars can identify potential benefits to tank car performance.



PROJECT PARTNERS

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

COST & SCHEDULE

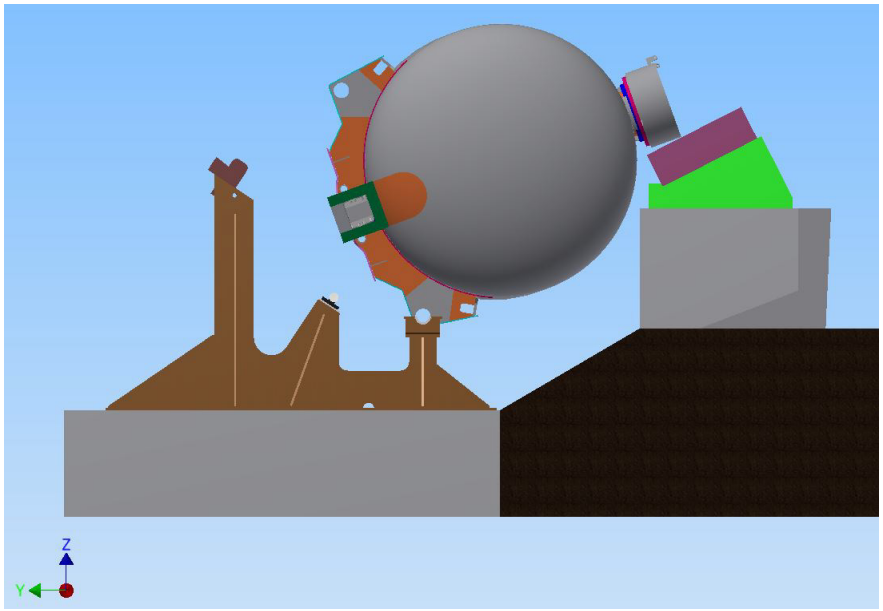
- Funding, FY20: $150,000
- Project Duration: August 2018 – May 2023

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

Improving Safety of Tank Car Fittings in Hazmat Service

PROJECT DESCRIPTION

- Evaluate the performance of top fittings protection used on current design tank cars, particularly those used in unit trains carrying flammable materials, under rollover conditions.
- Conducted through a series of analytical simulations and full-scale rollover tests
- Designs considered include:
  - CPC-1232 style designs
  - Innovative, industry-proposed options
- Calibrate analytical models to test results.
- Develop criteria and protocols for future industry research.



RAILROAD IMPACT

- Improve overall safety of tank car operations by mitigating the release of hazardous material in tank car rollover derailments.
- Help develop performance information that can be used by the industry for standards development.
- Develop recommendations for future design and testing of fittings for industry use.

PROJECT PARTNERS

- Sharma & Associates, Inc.
- Tank car manufacturers
- Class I railroads (CSX, UP, BNF, CP, NS)

COST & SCHEDULE

- Funding, FY20: $235,000
- Project Duration: February 2016 – August 2023

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

Fire Performance of a UN-T75 Portable Tank

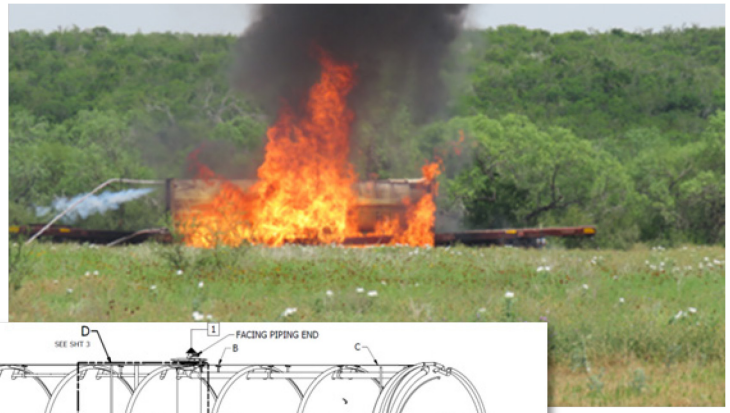
PROJECT DESCRIPTION

PHASE I:

- Conducted a full-scale fire test on a UN-T75 portable tank (see photograph)
- Obtained experimental data
- Provided a realistic fire exposure of the UN-T75 tank on a flatcar, simulating a fire exposure in accident conditions
- Conducted a computer simulation of the experiment data
- Used nitrogen as a commodity and a diesel fire

PHASE II:

- Repeated Phase I test with LNG in test tank instead of liquid nitrogen
- Made improvements to internal instrumentation, including several floating temperature measurements (see schematic), which will be used for future computer model validation.



RAILROAD IMPACT

- Evaluate the survivability of the portable tank in fire conditions.
- Evaluate the performance of the pressure relief device.
- Obtain important data for future design improvements.
- Improvements to crashworthiness of tender

PROJECT PARTNERS

- Southwest Research Institute
- Sharma & Associates, Inc.
- Florida East Coast Railway
- Friedman Research Corp.
- Transport Canada
- PHMSA
- Taylor-Wharton

COST & SCHEDULE

- Funding, FY22: $750,000
- Project Duration: September 2017 – September 2023

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

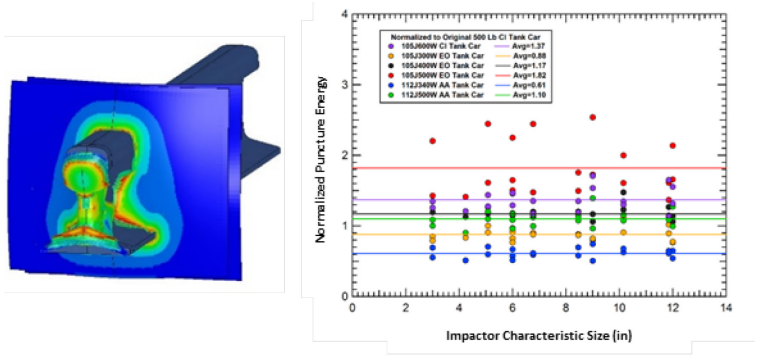
Evaluation of the DOT-113C120W9 LNG Tank Car Puncture Resistance

PROJECT DESCRIPTION

Recent FRA ruling allows transport of LNG by rail, but the puncture resistance of the DOT-113C120W9 design has not been fully established.

Apply existing modeling techniques for tank car puncture assessment under various impact conditions to the DOT-113C120W9 and evaluate relative performance to other designs in a revision to report DOT/FRA/ORD-13/17. Compliment the test program.

- Refine the constitutive model for cryogenic ASTM A240 304 stainless steel and simulate the material testing:
  - Generate LS-DYNA models for puncture analysis and incorporate cryogenic inner tank material constitutive model.
  - Perform a series of impact/puncture analyses for a variety of additional impact conditions and compare performance to other tank car designs.
  - Evaluate designs with increased inner and outer tank thicknesses to assess optimum design for increased puncture resistance.



Relative Puncture Resistance of Various Tank Designs

RAILROAD IMPACT

- Reduce risk of building fleet of LNG tank cars with insufficient puncture resistance requiring future rulemaking and obsolescence.
- Reduce number of Hazmat releases.
- Prevent potential casualties from derailments.
- Reduce liability costs for the railroads.

PROJECT PARTNER

- Applied Research Associates, Inc.

COST & SCHEDULE

- Funding, FY22: $750,000
- Project Duration: September 2022 – September 2023

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

Protecting Hazardous Material Tank Cars from Heat

PROJECT DESCRIPTION

- Evaluate DOT 105, DOT 112, and DOT 117 thermal protection performance during a fire produced by a derailment.
- Use Fire Dynamic Simulator as fire simulation and evaluate heat transfer to determine time to internal critical temperature.
- Phases:
  - Research and data collection
  - Fire and heat transfer simulation
  - Effects on cooling water
- Evaluate a particular derailment case to understand cooling delay times.

RAILROAD IMPACT

- Understand required cooling time during derailment event.
- Consider the results in emergency response tactics.

PROJECT PARTNER

- Engineering Systems inc.

COST & SCHEDULE

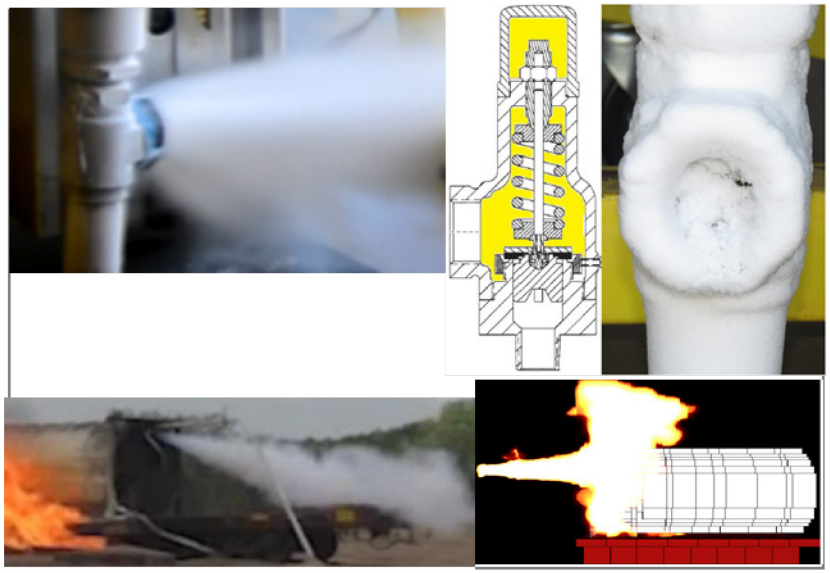
- Funding, FY22: $196,800
- Project Duration: April 2022 – September 2023

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

Improving Thermal Protection of Cryogenic Tank Cars through Testing, Analysis, and Evaluation of Pressure Relief Valve (PRV) System Performance

PROJECT DESCRIPTION

- Characterize PRV system performance in off-nominal (inverted, liquid flow, damaged pipes) conditions through physical testing.
- Apply PRV performance under atypical conditions to full tank FE model and evaluate risk of tank failure due to reduce pressure relief.
- Characterization of PRV performance and response to ignition of LNG exhaust gas.
- Use M&S to apply exhaust gas jet conditions to neighboring tanks to evaluate their response.
- Identify and evaluate potential solutions to the problems observed.
- Suggest test and/or design criteria to mitigate foreseen deficiencies in PRV performance.



RAILROAD IMPACT

- Quantify PRV performance under real-world conditions.
- Characterize effect of reduced PRV performance on likelihood of tank failure.
- Develop improved test/design criteria to mitigate foreseen performance deficiencies.
- Improve the safety of cryogenic tanks in derailment events.
- Improve state-of-the-art knowledge on the safety and performance of PRV systems for hazardous material transport by rail.
- Update emergency response protocols according to observed tank orientation and PRV function

PROJECT PARTNERS

- Friedman Research Corp.
- Southwest Research Institute
- Taylor Wharton (Industry Partner
- CIRCOR International, Inc.
- Lawrence Livermore National Lab

COST & SCHEDULE

- FY 22 Funding: $260k
- Project Duration: September 2022– September 2023

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

Improved Models for Estimating Tank Car Fire Performance

PROJECT DESCRIPTION

- This research proposes to develop a higher-fidelity, multi-zone approach for modeling the thermal performance of tank cars (pressure vessels) under fire conditions that incorporates several critical, physical, and safety-relevant phenomena such as:
  - Boundary layer effects
  - Liquid temperature stratification
  - Boiling at both tank wall and top fluid surface and corresponding pressure rise
  - Structural effects of high temperature on tank walls
  - Single- and multi-phase flow through the PRD, etc.
- The methodology developed through this project will be validated against available test data (from the several fire tests conducted by FRA), as well as other available test and simulation data.

RAILROAD IMPACT

- Increase the safety and reduce the risks associated with derailments of hazardous materials tanks for both railroad personnel and emergency responders.
- Improve the fidelity and reliability of models available to tank car designers and builders to assist in the sizing of PRDs and thermal protection systems.
- Address the non-conservatism built into current thermal analysis models being used by the railroad industry.

PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding, FY22: $326, 404
- Project Duration: September 2021 – September 2023

FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

SECTION THREE

TRAIN CONTROL & COMMUNICATION

Automated Train Operations Specifications and Safety

PROJECT DESCRIPTION

This research area develops requirements needed to define an interoperable Automated Train Operation (ATO) system that meets industry safety and automation objectives. This project area focuses on a) ATO system functional and performance requirements development, b) ATO system interface requirements development, and c) definition and progression of safety analysis tasks to demonstrate the ATO system is being defined to meet safety objectives.

Project Efforts:

1. Definition of functional and performance requirements for a Train Energy Management Performance (TEMP) monitoring system needed to mitigate potential hazards introduced by incorrect interaction with Locomotive Control Systems (LCS).
2. Definition of interface and messaging requirements between ATO back office subsystems
3. Definition of ATO back office subsystem functional and performance requirements
4. Definition of an ATO safety program to progress safety analysis tasks in conjunction with system definition activities.

RAILROAD IMPACT

- The primary goal is to ensure that an interoperable ATO system is defined to meet industry safety and automation objectives.
- ATO requirements and safety documents will be published into the Association of American Railroads' (AAR) specifications library.

PROJECT PARTNERS

- FRA Office of Railroad Safety
- AAR member railroads

COST & SCHEDULE

- Funding: $2,304,683
- Project Duration: Sept. 2019 – Sept. 2022
- Continuation planned for 2023

FRA PROJECT MANAGER: Jared Withers • (202) 493-6362 • jared.withers@dot.gov

Automated Train Operations (ATO) Sensor Platform

PROJECT DESCRIPTION

The sensor platform (SP) project is a demonstration to validate SP concepts and requirements; it also supports further definition of SP performance parameters. The SP is a demonstration prototype intended to verify the feasibility of sensor performance aspects of the SP requirements but is not intended to be representative of a final SP product. The SP project involves testing multiple types of sensors in a variety of scenarios representing railroad operating conditions.

Project Objectives:

- Provide verification of sensor platform requirements associated with sensor function and performance.
- Demonstrate capability of commercial off-the-shelf (COTS) sensor equipment as applicable to ATO.
- Collect sensor data that may be usable for the development of sensor platform analysis software.

PROJECT PARTNERS

- BNSF
- Canadian National Railway
- Canadian Pacific Railway
- CSX Transportation
- Kansas City Southern Railroad
- Norfolk Southern Railway
- Union Pacific Railroad

RAILROAD IMPACT

- The objective of the ATO SP project is to design, build, and test a prototype using COTS sensors to demonstrate the ability of those sensors to meet the functional and performance requirements of an ATO sensor platform as defined in the ATO External Environmental Sensor Platform Specification documentation. Additionally, the ATO SP project findings will inform the modification of existing ATO SP specifications.

COST & SCHEDULE

- Funding: $854,650
- Project Duration: August 2020 – July 2022
- Continuation planned for 2023

FRA PROJECT MANAGER: Jared Withers • (202) 493-6362 • jared.withers@dot.gov

Automated Train Operations (ATO) Sensor Test Bed

PROJECT DESCRIPTION

The ATO Safety Sensor Test Bed (ATO SP Test Bed) project is expected to be a multi-phased effort to define an industry standard facility for conducting requirements verification testing of ATO sensor platform (SP) capabilities and performance. The initial phase of the ATO SP Test Bed project focuses on the development of the test cases required to verify the function and performance of an ATO sensor platform.

Project Objective:

- Develop test cases capable of verifying an ATO sensor platform sufficiently meets industry published functional and performance requirements.
- Procure and install necessary equipment to support test requirements.

PROJECT PARTNERS

- BNSF
- Canadian National Railway
- Canadian Pacific Railway
- CSX Transportation
- Kansas City Southern Railroad
- Norfolk Southern Railway
- Union Pacific Railroad

RAILROAD IMPACT

- The primary goal is to provide a means by which any ATO SP, regardless of sensor technology deployed, can be verified using a uniform set of test cases and evaluation criteria to ensure adherence to industry performance standards.

COST & SCHEDULE

- Funding: $479,347
- Project Duration: September 2019 – March 2022
- Continuation planned for 2023

FRA PROJECT MANAGER: Jared Withers • (202) 493-6362 • jared.withers@dot.gov

Onboard Broken Rail Detection Research and Development

PROJECT DESCRIPTION

The project scope involves research into a suitable onboard broken rail detection system. The objective is to develop a viable working concept for an onboard broken rail detection system.

The major tasks for this project include:

- Review of prior research
- Track impedance characterization
- Development of a transmission line model of the track
- Coil optimization and evaluation for signal transmission and reception
- Investigation of potential alternate solutions
- Preparation and delivery of project artifacts and deliverables, including a report summarizing project highlights and findings

RAILROAD IMPACT

- Advancements in train control methods like moving block can significantly increase productivity while maintaining safe following train distances. However, a new broken rail detection method is needed to fully leverage full moving block operations, as the current method that involves the use of track circuits limits the benefits. There are potential advantages to onboard methods of detecting rail breaks compared to track-based methods. For example, onboard methods have the potential to reduce infrastructure and maintenance costs associated with track circuits.

COST & SCHEDULE

- Funding: $1,441,311
- Project Duration: October 2019 – March 2022
- Continuation planned for 2023

FRA PROJECT MANAGER: Jared Withers • (202) 493-6362 • jared.withers@dot.gov

Next Generation Head-of-Train and End-of-Train Device Development

PROJECT DESCRIPTION

The NGHE project aims to fully specify a NGHE system that enhances safety and reliability – and supports future methods of train control. A component of NGHE, Positive Train Location (PTL) provides a framework and methodology for enabling the precise end-of-train position to the accuracy required to discriminate track centerline (track occupancy) for use by advanced methods of train operations.

NGHE Project Highlights:

- Produce a set of functional and performance systems engineering documents for the complete NGHE system (HOT and EOT segments).
- Perform a hazard analysis relative to existing and future methods of railroad operations.

PTL Project Highlights:

- Work with a technology vendor to develop a working PTL EOTD segment prototype.
- Update PTL HOTD requirements to include additional functionality.
- Verify performance of the prototype PTL EOT segment against requirements established in the previous phase through field testing at the Transportation Technology Center.

RAILROAD IMPACT

- The primary goal is to ensure that safety, efficiency, and productivity of railroad operations are enhanced, and deficiencies with the current EOT system are addressed.

PROJECT PARTNERS

- AAR Train Control, Communications, and Operations Committee
- AAR Wireless Communications Committee
- Railroad Industry Advisory Group

COST & SCHEDULE

- Funding: $1,879,000
- Project Duration: September 2019 – January 2022
- Continuation planned for 2023

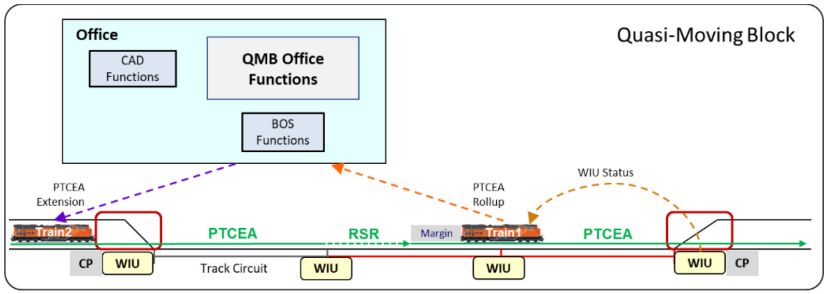
FRA PROJECT MANAGER: Jared Withers • (202) 493-6362 • jared.withers@dot.gov

Quasi-Moving Block (QMB) Train Control

PROJECT DESCRIPTION

This research area investigates a new method of train control that has the potential to enhance railway safety, reliability, and operational performance by leveraging Positive Train Control (PTC) technology. This work is part of an ongoing program to support higher reliability and capacity train control.

1. **QMB** consists of governing any train operation in PTC territory by the issuance of non-overlapping movement authorities, known as PTC Exclusive Authorities (PTCEA). This offers more consistency in train control as well as safety improvements over current Overlay PTC, including the ability to provide rear-end collision protection and collision protection within a joint authority. QMB offers improved capacity and reliability beyond Overlay PTC and is a logical step in the migration to a full moving block train control method.
2. **Centralized Interlocking (CIXL)** introduces an office-based interlocking system that leverages the QMB design and PTCEA concept. CIXL has the potential to improve overall system availability when compared to current field interlocking systems.
3. **Office Safety Checker (OSC)** is the primary office safety function required for QMB, full moving block, and CIXL.



PROJECT PARTNERS

- Class I railroads
- Passenger and commuter railroads
- Meteorcomm LLC

COST & SCHEDULE

- Funding: $2,016,761
- Project Duration: September 2019 – June 2022
- Continuation planned for 2023

RAILROAD IMPACT

- The primary goal is to specify a method of train control that builds upon PTC technology to enhance safety, capacity, and reliability.

FRA PROJECT MANAGER: Jared Withers • (202) 493-6362 • jared.withers@dot.gov

Road Remote Control Locomotive (Road RCL)

PROJECT DESCRIPTION

This research area promotes railroad safety and efficiency objectives to provide the capability for qualified railroad personnel to perform switching operations on the line-of-road without crew presence within the cab of the controlling locomotive. Switching operations on the line-of-road can include setting out cars at industry sidings and setting out bad-order cars outside of yard areas.

Project Efforts:

1. Develop Road RCL concept of operations.
2. Conduct a Preliminary Hazard Analysis on a Road RCL system that leverages Positive Train Control (PTC)-, Energy Management Systems (EMS)-, and Automated Train Operation (ATO)-related onboard systems.
3. Develop requirements documentation for a Road RCL system integrated with PTC-, EMS-, and ATO-related onboard systems.

RAILROAD IMPACT

- The primary goal of this project is to improve operational efficiency during line-of-road switching operations while meeting safety objectives.
- Road RCL requirements and safety documents will be submitted to the Association of American Railroads (AAR) for use at its discretion.

PROJECT PARTNERS

- AAR member railroads

COST & SCHEDULE

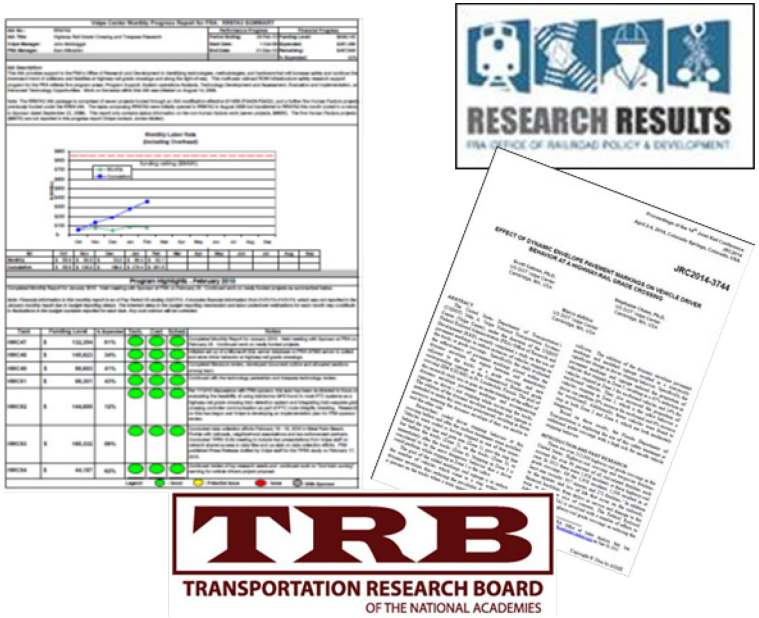
- Funding: $971,685
- Project Duration: August 2020 – September 2022
- Continuation planned for 2023

FRA PROJECT MANAGER: Jared Withers • (202) 493-6362 • jared.withers@dot.gov

Grade Crossing and Trespass Research Program Support

PROJECT DESCRIPTION

- Provide program management and quick response, conduct special studies not covered in any existing task, and provide support for other requests requiring immediate attention.
- Participate in professional activities within the scope of research topic not specifically funded under another task (e.g., TRB AHB60 Committee, AREMA, ITE, technical papers).
- Information exchange on cutting-edge technologies and/or strategies for grade crossing safety and trespass prevention (including outreach to FRA grade crossing managers).
- Provide reports to define and track, on a periodic basis, key activities in support of the research program.



RAILROAD IMPACT

- Information exchange with State DOTs and railroads on cutting-edge technologies and/or strategies for grade crossing safety and trespass prevention.
- Quick-response capability in support of FRA RD&T
- Support to FRA RD&T on studies requiring immediate action not covered in any existing task.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $250,000
- Project Duration: July 2021 – July 2026

FRA PROJECT MANAGER: Francesco Bedini Jacobini • (202) 493-0800 • francesco.bedini@dot.gov

Grade Crossing Accident Reconstruction with Drones

PROJECT DESCRIPTION

- Study the use of drone-based accident reconstruction techniques for grade crossing accidents, with focus of improving recovery time.
- Results were specific to crossings but approach could be more generally applied to other rail incidents (e.g., derailments, trespass incidents). FRA purchased a drone and accident reconstruction software for a drone-based trespass research study conducted with the Brunswick, Maine, Police Department in 2018–2019.
- This study used that work, along with the law enforcement accident reconstruction community's and NTSB's experience, to assess the feasibility of using the technology for investigating rail accidents.

RAILROAD IMPACT

- Information exchange with State DOTs and railroads on cutting edge technologies and/or strategies for grade crossing accident reconstruction
- Objective of improving recovery time after a rail incident
- Increase public and first responder safety.
- Quick response capability in support of FRA RD&T

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $150,000
- Project Duration: July 2021 – August 2022

FRA PROJECT MANAGER: Francesco Bedini Jacobini • (202) 493-0800 • francesco.bedini@dot.gov

Quasi-Quiet Zone Study

PROJECT DESCRIPTION

- Perform acoustics research into effectiveness of locomotive horn sounding in advance of closely spaced grade crossings.
- Under the Train Horn Rule (49 CFR Part 222), locomotive engineers must begin to sound train horns at least 15 seconds, and no more than 20 seconds, in advance of all public grade crossings.
- Areas where crossings are very close together, sometimes separated by a single city block, are disproportionately affected by train horns. In these areas, neighborhoods several crossings downstream may be subjected to the sounding of the horns at each crossing up to and past their location.

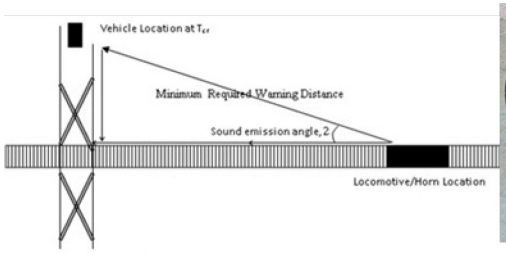
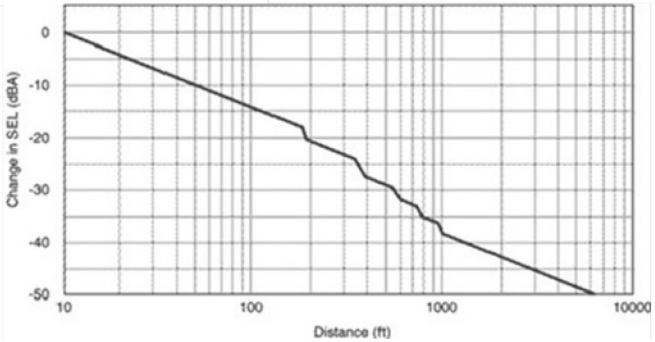


Figure 1. Critical Grade Crossing Geometry



RAILROAD IMPACT

- Auditory warnings represent an important adjunct to visual warnings in alerting the motorist to an approaching train.
- Through applying current research and new technology, this project will facilitate development of site-specific locomotive horn strategies for closely spaced grade crossings, thereby reducing noise.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

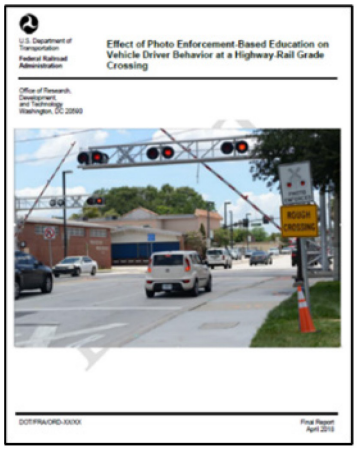
- Funding: $150,000
- Project Duration: July 2021 – October 2022

FRA PROJECT MANAGER: Francesco Bedini Jacobini • (202) 493-0800 • francesco.bedini@dot.gov

Grade Crossing Toolkit

PROJECT DESCRIPTION

- This project supports the development of a highway-rail grade crossing safety measures toolkit, like the rail ROW trespass mitigation measures toolkit currently under development by FRA RD&T.
- The toolkit will contain guides, noteworthy practices, and research results on the implementation of a wide range of grade crossing safety treatments.
- Such a resource has been developed in Europe and is widely used – the SAFER-LC Toolbox (https://safer-lc.eu/). FRA has developed a toolkit for rail ROW trespass treatments and has identified the need for a similar resource repository for grade crossing safety countermeasures for U.S. stakeholders.



RAILROAD IMPACT

- Provides FRA partners with information on cutting-edge technologies and/or strategies for grade crossing safety
- Fosters an exchange of information on grade crossing safety countermeasures among stakeholders
- Facilitate implementation and evaluation of innovative safety technologies
- Facilitates development of site-specific strategies for grade crossings, thereby improving rail safety

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $150,000
- Project Duration: July 2021 – October 2022

FRA PROJECT MANAGER: Francesco Bedini Jacobini • (202) 493-0800 • francesco.bedini@dot.gov

SECTION FOUR

HUMAN FACTORS

Railway Worker and Operator Performance

PROJECT DESCRIPTION

This research area examines the impacts of personal (age, sleep deprivation, motivation, memory, etc.), environmental (noise, temperature, vibration, etc.), and social (status, role, etc.) conditions that may affect job performance and safety.

Sample Acquisitions:

1. *VA Tech Commute Times:* Conduct surveys and focus groups to identify and assess various aspects of fatigue. Provide recommendations on best practices for combating fatigue in the railroad industry.
2. *Railroaders' Guide to Healthy Sleep Website Update:* Provide scientifically valid information about the importance of sleep; proven, practical tips and strategies for improving sleep health.
3. *Combating Performance Degradation in Railroad Operations:* Conduct pilot testing to assess whether habituation to alerts exists in locomotive engineers.
4. *Predictive Scheduling System Development For Railroad Workers:* Develop and demonstrate a low-cost solution to predictive work scheduling.

RAILROAD IMPACT

- Fatigue in the transportation industry has been a top priority of the National Transportation Safety Board since 1990.
- Improve job performance and safety through innovative, science-based research, and demonstration programs that lead to reductions in injuries and deaths due to human error.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Virginia Tech Transportation Institute
- KEA Technologies

COST & SCHEDULE

- Funding: $400,000
- Project Duration: May 2018 – May 2025

FRA PROJECT MANAGER: Shala Blue • (202) 493-0168 • shala.blue@dot.gov

Automation, Operating Personnel Information Management, and Control

PROJECT DESCRIPTION

The operation of automated systems in dynamic operational environments requires a human-centric approach to their HMI design and implementation to avoid human error that can lead to catastrophic accidents. Research is conducted in human-automation interaction and teaming to affect the design, certification, and implementation of automation.

Sample Acquisitions:

1. Human-Automation Teaming (HAT) and Track Inspection: The authors present a general process for designing HATs, then explore how this design process can be applied to track inspection. The report addresses four track inspection tasks (data collection, data analysis, decision making, and action).
2. User-Centric Design of a Locomotive Operational Display. Emphasis on a human factors design and software development process to create a cab console user interface to provide necessary situation awareness
3. Driver-State Monitoring (DSM). Design effective DSM system that monitors crew alertness in the presence of automated systems.

COST & SCHEDULE

- Funding, FY22: Approx. $1.1M
- Project Duration: October 2022 – September 2024

RAILROAD IMPACT

- Ensure safety is enhanced, not degraded, by new technology and automation.
- Prototypes may be designed and tested to benchmark the safety and performance characteristics of automated technologies.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Monterey Technologies Incorporated
- Virginia Tech Transportation Institute

FRA PROJECT MANAGER: Mike Jones • (202) 493-6106 • michael.e.jones@dot.gov

FRA Office of Railroad Safety Support

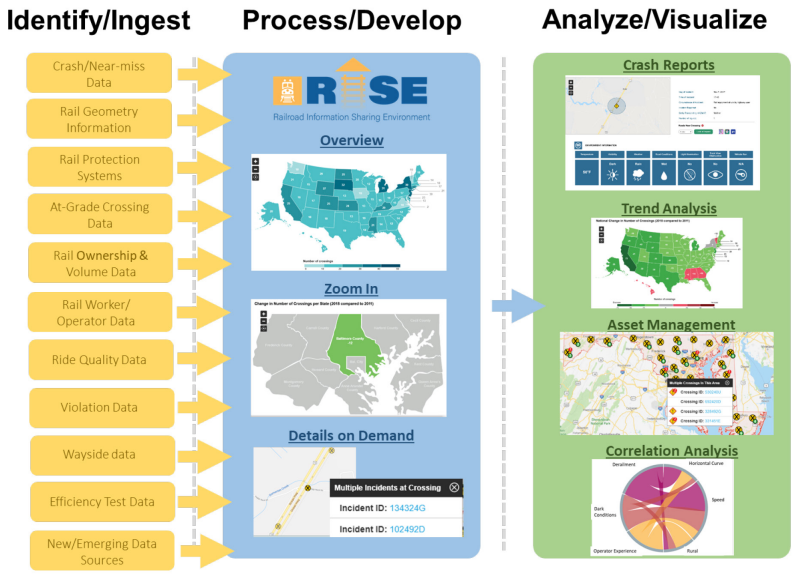
PROJECT DESCRIPTION

Support FRA's Office of Railroad Safety (RRS) by providing subject matter expertise, consultation, research, data, and tools to improve railroad safety. RRS works closely with RD&T to provide insight into research needs.
Sample Acquisitions:

1. *Railroad Information Sharing Environment (RISE) Program Development:* Produce a RISE prototype that streamlines the process of querying, analyzing, and visualizing rail data. Document outputs of the RISE prototype and assess the feasibility to support rail safety analysis.
2. *Railroad Committee Support (e.g., SOFA, FAMES):* Provide ongoing support for RRS stakeholder committees; support the creation of committee charters, communication and outreach, and database maintenance and analysis.
3. *Scenario-Based Training (SBT):* Evaluation of the effectiveness of SBT implemented at passenger railroads to address close call reports; determine whether SBT can reduce human factors accidents and incidents.

RAILROAD IMPACT

- RD&T supports RRS requests for research and subject matter expertise for time sensitive safety issues.



PROJECT PARTNERS

- Center for Advanced Transportation Technology Laboratory, University of Maryland
- Volpe National Transportation Systems Center
- FRA Office of Railroad Safety
- NASA
- Partnering passenger railroads

COST & SCHEDULE

- Funding: $625,000
- Project Duration: September 2019 – May 2025

FRA PROJECT MANAGER: Mike Jones • (202) 493-6106 • michael.e.jones@dot.gov

Motorist Behavior at Highway-Rail Grade Crossings

PROJECT DESCRIPTION

This research area examines the human factors that significantly affect motorist behavior at grade crossings.

Sample Acquisitions:

1. *Intelligent Abnormal Situation Awareness Platform:* Develop an affordable and field-deployable system to detect and evaluate anomalous situations (trespassing and suicide) in real time at crossings and share information with law enforcement and railroads for enhanced safety.
2. *In-Vehicle Auditory Alerts at Grade Crossings:* Design various and conduct subsequent empirical experiments involving driving simulators to evaluate their effects on motorist behavior and, more broadly, grade crossing safety.
3. *Modeling Grade Crossing Treatments in Virtual Reality:* Test novel grade crossing treatments in virtual reality; observe and measure behaviors and perceptions of motorists, pedestrians, and bicyclists.

RAILROAD IMPACT

- The number of grade crossing incidents and accidents has remained steady for the past 10 years.
  FRA believes that new approaches must be applied to this resistant and pervasive problem.
- FRA seeks new technologies and methods to augment time-tested strategies to reduce the number of preventable accidents.

PROJECT PARTNERS

- FRA Office of Railroad Safety
- Michigan Technological University
- University of South Carolina
- University of New Mexico
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: Approx. $1.2M
- Project Duration: October 2018 – January 2024

FRA PROJECT MANAGER: Shala Blue • (202) 493-0168 • shala.blue@dot.gov

Railroad Trespass Prevention

PROJECT DESCRIPTION

This research seeks to better understand the leading cause of rail-related death in the U.S. The Human Factors Division supports research that is aligned with the National Strategy to Prevent Trespassing on Railroad Property.

Sample Acquisitions:

1. *Trespass and Suicide Prevention Toolbox:* Develop an online portal of trespass and suicide prevention tools and countermeasures tailored for the implementation needs of rail carriers.
2. *Development of Railroad Trespassing Database Using Artificial Intelligence (AI):* Develop pilot trespassing database using AI; feasibility/proof of concept study of real time video data using AI.

RAILROAD IMPACT

- Improve understanding of the causal factors behind why individuals contemplating suicide consider this method to end their lives.
- Identify countermeasures to prevent accidents attributable to trespassing. Identify and plan new efforts to support FRA rail trespass prevention.

PROJECT PARTNERS

- Rutgers University
- Volpe National Transportation Systems Center
- ENSCO, Inc.

COST & SCHEDULE

- Funding: $590,000
- Project Duration: May 2020 – May 2025

FRA PROJECT MANAGER: Shala Blue • (202) 493-0168 • shala.blue@dot.gov

Railroad Suicide Prevention

PROJECT DESCRIPTION

This research area explores one of the leading causes of rail-related death in the U.S. – suicide.

Sample Acquisitions:

1. *Data Quality Improvements:* Continue to gather information about the prevalence of suicides on rights-of-way (ROWs), as well as demographic characteristics of individuals involved and characteristics of time and location that may impact countermeasure development.
2. *Countermeasure Development, Implementation, and Evaluation:* Work with railroad carriers to implement pilot tests of various countermeasures to understand which could mitigate suicides on ROWs. Develop rail-specific guidelines for reporting suicides on ROWs.
3. *Outreach:* Work with U.S. and international stakeholders to better understand how to improve public discussion of railroad suicide incidents.

RAILROAD IMPACT

- Reduction in the number of suicide casualties that occur on the railroad ROWs.
- Reduction in service disruption and employee time off due to suicide incidents.
- Better understanding of potential countermeasures and improved understanding of feasibility of implementing countermeasures to mitigate suicides.
- Improvement in the quality of data being collected on suicide and trespass casualties by railroad carriers.
- Involvement of other groups who may be able to share countermeasure costs.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Various railroad carriers
- Various universities
- Operation Lifesaver

COST & SCHEDULE

- Funding: $590,000
- Project Duration: May 2020 – May 2025

FRA PROJECT MANAGER: Shala Blue • (202) 493-0168 • shala.blue@dot.gov

Short Line Safety Institute (SLSI)

PROJECT DESCRIPTION

The Human Factors Division continues to provide program monitoring and support of SLSI. It provides safety culture assessments and training to small railroads, which are typically located in rural areas. SLSI funding is an earmark grant provided annually by Congress.

Sample Acquisitions:

1. *SLSI grant:* SLSI seeks to improve safety practices and provide safety training for Class II and Class III freight railroads to build a stronger, sustainable safety culture.
2. *SLSI evaluation:* Conduct an independent evaluation of SLSI's program improvement and funding accountability.
3. *Pilot project for the Confidential Close Call Reporting System (C^3RS) and shortline railroads:* Develop a model of C^3RS implementation for small railroads.

RAILROAD IMPACT

SLSI:

- Conducts safety culture assessments and provides recommendations on how to improve safety culture.
- Provides training and education about safety culture.
- Serves as a research center that compiles and disseminates information on safety needs and trends.
- Communicates to stakeholders about safety culture improvement efforts.

PROJECT PARTNERS

- Short Line Safety Institute
- ASLRRA
- FRA Office of Railroad Safety
- University of Connecticut
- Volpe National Transportation Systems Center

COST & SCHEDULE

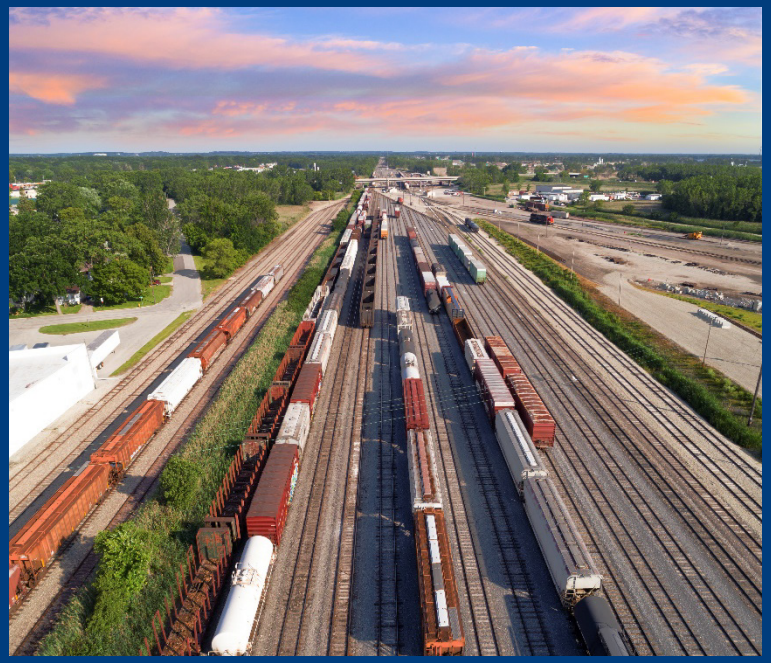
- SLSI grant: ~$2.5M per year
- Volpe evaluation of SLSI: ~$100,000 per year
- SLSI C^3RS pilot project: $100,000
- Project Duration: September 2019 – May 2025

FRA PROJECT MANAGER: Starr Kidda • (202) 493-1300 • starr.kidda@dot.gov

Contact Us

Federal Railroad Administration
1200 New Jersey Avenue, SE
Washington, DC 20590

Connect with us **USDOTFRA**



U.S. Department of Transportation
Federal Railroad Administration