RAIL

MOVING AMERICA FORWARD

FRA Office of Research, Development, and Technology

Current Research Projects

U.S. Department of Transportation
Federal Railroad Administration

December 10, 2021

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

RESEARCH SECTIONS

SECTION ONE

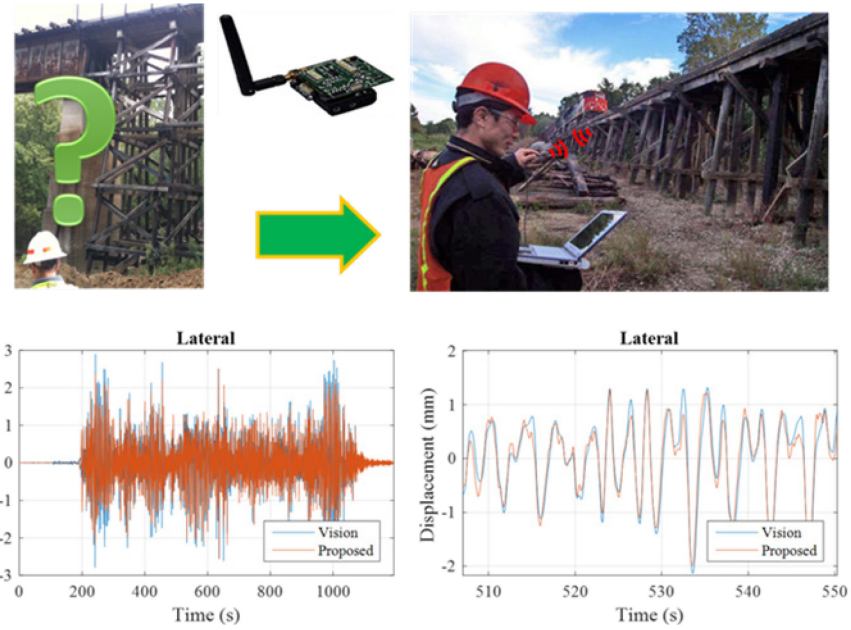
TRACK

Bridge Condition Assessment Using Smart Sensors

PROJECT DESCRIPTION

Phase 2 Development Effort:

- Project partners continue to conduct field trials of equipment on multiple bridges in U.S. Midwest.
- Establish service limit thresholds based on measured data.
- Test the reference-free displacement estimation algorithms and user interface.



RAILROAD IMPACT

- Accurate, reference-free bridge displacement estimations under revenue traffic
- Dynamic bridge safety limit thresholds
- Wireless technology – no fixed installation required
- Quantitative data for railroad use in prioritization of bridge maintenance and replacement

PROJECT PARTNERS

- University of Illinois at Urbana-Champaign
- FRA Office of Railroad Safety
- Class I – Canadian National Railway; multiple shortline railroads

COST & SCHEDULE

- Funding: $650,000
- Project Duration: February 2013 – February 2022

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Investigation of Timber Crosstie Spike Fastener Failures

PROJECT DESCRIPTION

- Identify and quantify the extent of spike failures in the field.
- Collect data on operating conditions, environmental characteristics, track construction, maintenance, and age.
- Develop and test failure cause hypotheses.
- Make recommendations to eliminate failures.
- Conduct laboratory and field experiments to characterize the dynamic load environment in areas of spike failures.
- Develop numeric models to describe load conditions and predict failures.
- Isolate root cause(s) of spike failures.
- Conduct accelerated testing of new fastener system designs at the Transportation Technology Center.

RAILROAD IMPACT

- 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.

COST & SCHEDULE

- Funding: $610,000
- Project Duration: April 2018 – December 2021

PROJECT PARTNERS

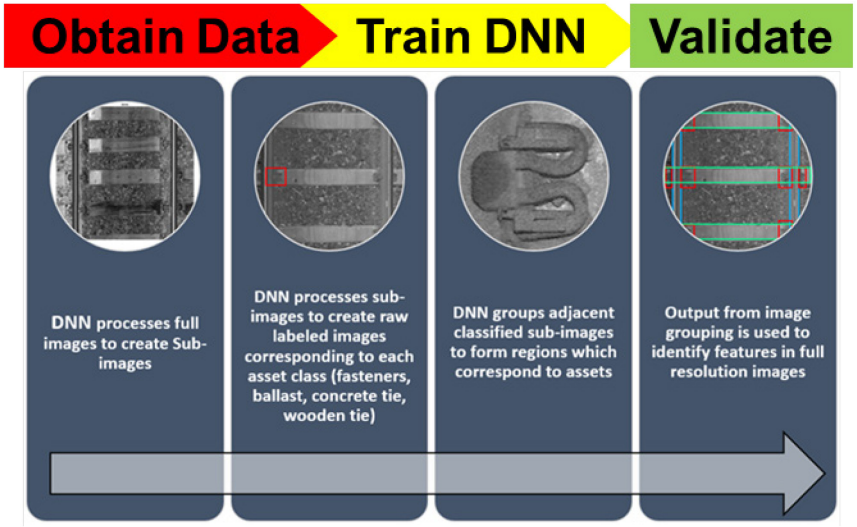
- University of Illinois at Urbana-Champaign
- Volpe National Transportation Systems Center
- Class I railroads: Norfolk Southern Railway, BNSF Railway, CSX Transportation, Union Pacific Railroad, and Canadian National Railway
- Suppliers: Pandrol, Vossloh North America, and Evertrack

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Automated Track Change Detection

PROJECT DESCRIPTION

- Evaluate the potential for laser triangulation and deep neural networks to improve railway inspections.
- System training – TTC HTL – (2019 – 2020)
- Train a DeepCNet-based neural network to identify and classify track features.
- Develop algorithms to compare feature changes between discrete data collection runs.
- Field development and demonstration (2021 – present) with CSX and other Class I railroads
- Develop effective reporting methods using human factors engineering.



RAILROAD IMPACT

- Advance technology-augmented human inspection capabilities to yield improved track condition awareness and safety.
- Provide tools necessary to automate CFR 213 Subpart F.
- 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.
- BNSF Railway
- Canadian National Railway
- Transportation Technology Center, Inc.
- Volpe National Transportation Systems Center

COST & SCHEDULE

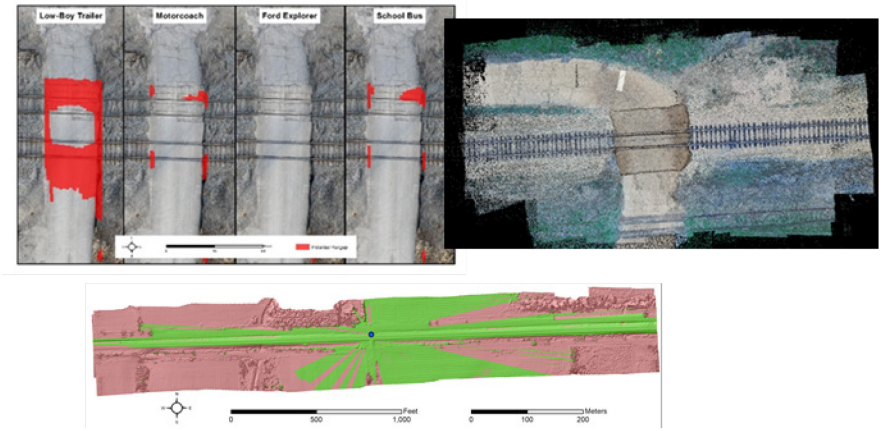
- Funding: $556,941
- Project Duration: April 2019 – May 2023

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Automated, Drone-Based Grade Crossing Inspection System – Small Business Innovative Research (SBIR)

PROJECT DESCRIPTION

- Phase 1 and Phase 2 SBIR program (two projects) to develop an automated method to inspect grade crossings with unmanned aerial vehicles (UAVs, or drones).
- Systems will measure the humped condition of grade crossings to industry standards, sightlines for motor vehicles near the crossing, and the location and type of safety appliances and signage associated with each crossing.
- Systems employ advance photogrammetry techniques that use data commercially available drones and camera systems.
- Drone systems shall operate in compliance with FAA Part 107 regulations.



RAILROAD IMPACT

- There are over 200,000 railroad grade crossings in the U.S.
- Humped grade crossings have resulted in numerous low-clearance vehicle hang-ups, train strikes, and fatalities.
- Drone-based inspection can provide an efficient, accurate method to inspect grade crossings.

PROJECT PARTNERS

- Michigan Tech Research Institute
  - MTRI Crossing-i System
- VisioStack, Inc. (Phase 2 completed August 2021)
  - Visiostack AXIS crossing management system

COST & SCHEDULE

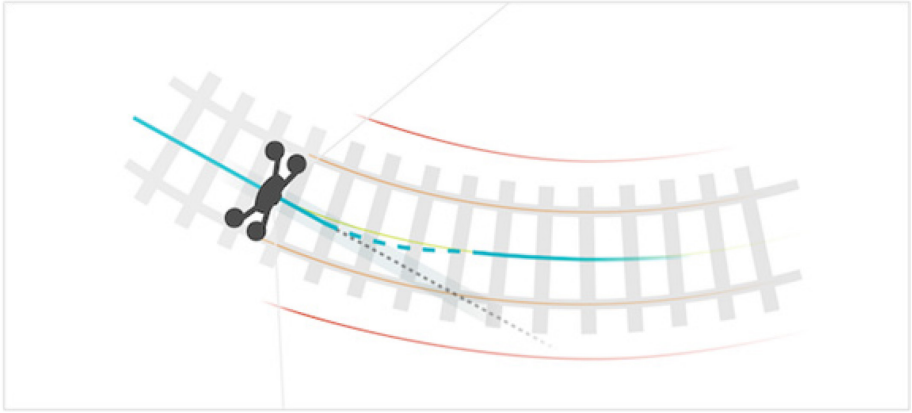
- Funding: $900,000
- Project Duration: September 2019 – August 2021

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Drone-Based Track Inspection Automated Track Centerline Detection and Flight Automation

PROJECT DESCRIPTION

- Develop a drone-based system that can automatically detect rails and the track centerline.
- Integrate live feedback from the detection model to autonomously fly along the track centerline.
- The system will help with the inspection of grade crossings.
- Flights can collect imagery to help inspect infrastructure for features and anomalies such as switch and frog point wear or missing fasteners.
- Successful development and safety case analysis may support applying for a Part 107 waiver to perform BVLOS inspections.



RAILROAD IMPACT

- Current drone operations are limited by LOS operations and in GPS-enabled regions.
- This system (licensed API) would allow railways 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 railways 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 Transportation
- Florida East Coast Railway

COST & SCHEDULE

- Funding: $163,357
- Project Duration: September 2020 – September 2022

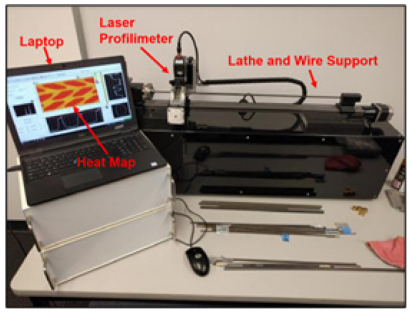
FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Implementation of Machine Vision Technology for Pre-Stressing Wire Quality Control – Concrete Ties

PROJECT DESCRIPTION

- Partner with Technology Development Institute to deploy existing technology into Nucor-LMP, Inc. prestressing wire manufacturing facility to enable indented wires to consistently meet product specifications.
- Design new system based on existing research and user input.
- Build new system and custom software.
- Verify system and develop reference standard.
- Deploy system and collect initial data.
- Write and submit the final report.

In-Plant
Wire Indent Scanning



Reduce In-Track
Failures

RAILROAD IMPACT

- Deploy technology previously developed under FRA-supported 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, Inc.

COST & SCHEDULE

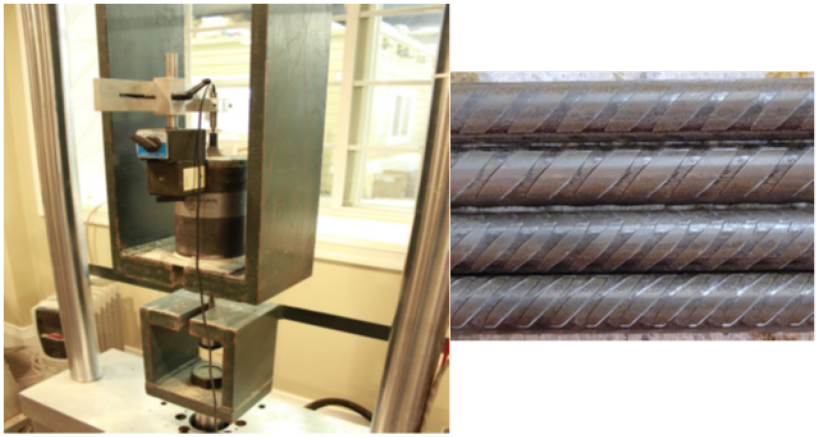
- Funding: $100,000
- Project Duration: July 2021 – June 2022

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Large Diameter Pre-Stressing Wire Correlation – Concrete Ties

PROJECT DESCRIPTION

- Industry is moving to larger indented wire types: 7 mm, 8 mm, and 10.5 mm – versus 5.32 mm.
- 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
- Testing plan includes:
  - Wire indent scanning using automated indent scanning technology (FRA funded)
  - ASTM 1096 testing (FRA funded development of this test standard)
  - Prism casting to establish wire bond and transfer length properties
  - Bending failure tests



RAILROAD IMPACT

- 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 result in adjustments to industry standards.

PROJECT PARTNERS

- RJ Pereman and Associates
- Nucor-LMP, Inc.
- RAIL.ONE
- voestalpine Nortrak

COST & SCHEDULE

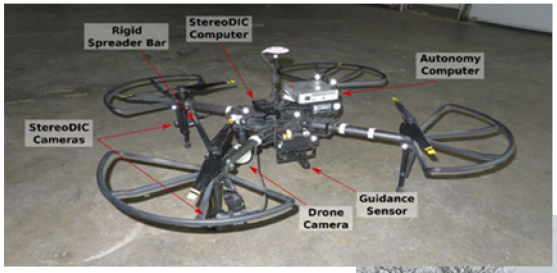
- Funding: $170,400
- Project Duration: September 2020 – June 2022

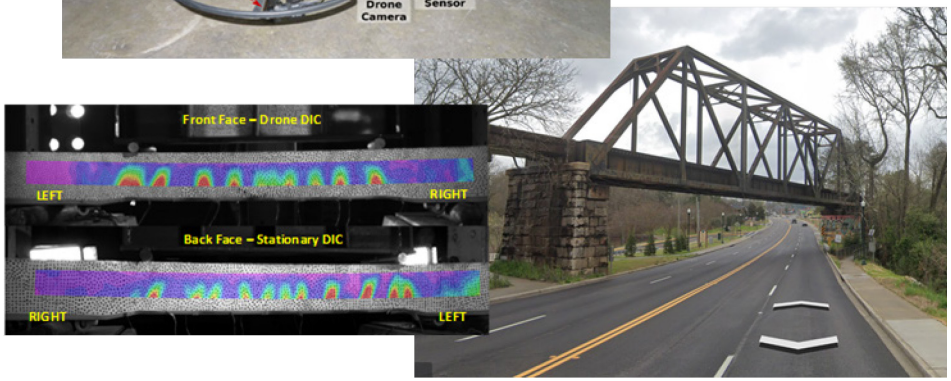
FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Drone-Based Infrastructure Inspection Using Digital Image Correlation Technology

PROJECT DESCRIPTION

- Partners will field-test an unmanned aircraft (drone) equipped with an autonomous 3D digital image correlation system (StereoDIC) for the acquisition of full-field, deformation, shape, and damage potential measurements of railroad structures and track under any loading conditions.
- Other activities include:
  - Site selection and aircraft preparation
  - Testing protocol
  - Platform adjustments
  - Field implementation and testing





RAILROAD IMPACT

- Improve safety by early detection of potential failures with non-destructive technology.
- Drone system can access remote locations and difficult-to-access monitoring points.
- The autonomous data acquisition system can be rapidly deployed on-demand or on a routine basis.
- 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

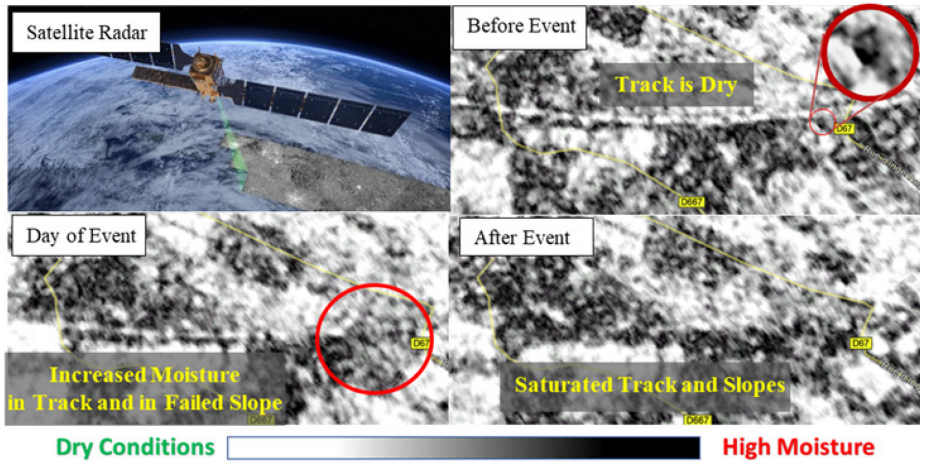
- Funding: $100,000
- Project Duration: July 2021 – June 2022

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@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 Transportation

COST & SCHEDULE

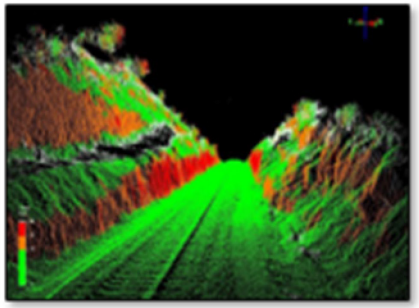
- Funding: $310, 819
- Project Duration: June 2021 – June 2023

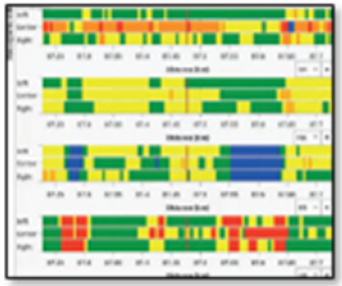
FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Ground Hazard Database and Warning System

PROJECT DESCRIPTION

- Advanced ground hazard database using Zetica's RASC Viewer
- Populate a 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 using RASC Manager
- 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.
- Technology based on industry-accepted trackbed monitoring platform RASC Viewer.

PROJECT PARTNERS

- University of Illinois at Urbana-Champaign
- Balfour Beatty Infrastructure US, Inc.
- Sixense, Inc.
- Amtrak

COST & SCHEDULE

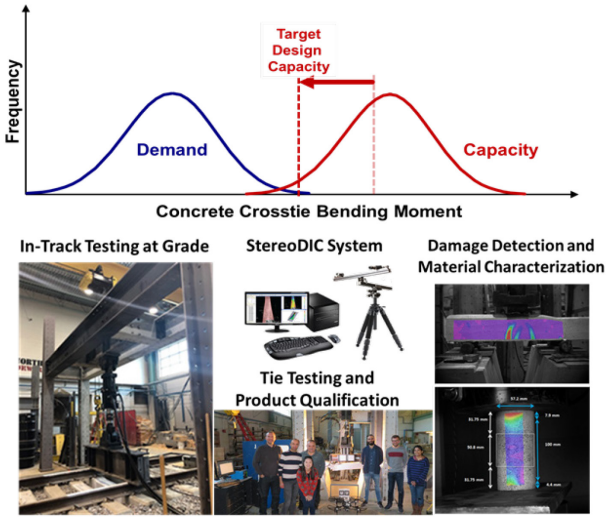
- Funding: $485,336
- Project Duration: September 2021 – September 2024

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Development of Performance-Based Concrete Crosstie Specifications for the U.S.

PROJECT DESCRIPTION

- Develop comprehensive performance-based concrete crosstie design specifications for Class I railroads to facilitate longer life cycles and enhance safety.
- Paper study for prioritization of design focus areas and establishing performance criteria.
- Laboratory experimentation to fill gaps in prior research and develop new hybrid design.
- Manufacture of three prototype designs.
- Field and lab testing to validate the crosstie design in accordance with industry tests.



RAILROAD IMPACT

- Comprehensive performance-based design criteria for concrete ties
- Specific designs of prototype crossties in conjunction with end users and tie suppliers
- Manufacture of prototype crossties
- Laboratory and field validation testing and simulated revenue service testing on the High Tonnage Loop at TTC

PROJECT PARTNERS

- University of Illinois at Urbana-Champaign
- Kansas State University
- University of South Carolina
- voestalpine Nortrak, Vossloh Concrete Tie, CXT Concrete Ties
- Amtrak, BNSF, CN, UPRR

COST & SCHEDULE

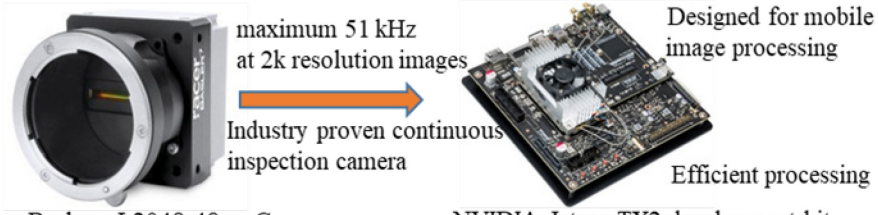
- Funding: $280,000
- Project Duration: May 2021 – November 2023

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Autonomous Power-Efficient Track Inspection System (APTIS)

PROJECT DESCRIPTION

- Develop an autonomous power-efficient track inspection system that can be integrated on hi-rail or full-size rail vehicles.
- Use mobile edge computing and AI and machine learning.
- Fully autonomous and modular architecture design
- Field evaluation and decision making to obtain a real-time inspection system with no need for post-processing.
- Three-phase development plan



- CNN based AI,
  (accurate and intelligent)
- Transfer learning
  (library quality and adaptation)
- Weight Quantization & Parallelization of GPUs
  (reduce computing load & save power)

RAILROAD IMPACT

- 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-size rail vehicles
- Advances FRA's goals to develop technology-augmented human inspection tools, techniques, and systems.

PROJECT PARTNERS

- University of South Carolina
- CFD Research Corp.
- CSX Transportation
- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: $154,216 (Phase 1)
- Project Duration: September 2021 – September 2024

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Heavy-Axle-Load (HAL) Research and In-Track Testing

PROJECT DESCRIPTION

- Provide an opportunity to evaluate HAL track infrastructure subjected to a range of track, operational, and climatic conditions – under which to evaluate the performance of:
  - New and alternative component designs and materials
  - Improved track maintenance procedures
- Optimize the effectiveness of HAL testing by placing experiments in track segments with representative HAL operating environments.
- Current studies/experiments include:
  - Quantification of grinding requirements for varying levels of rolling contact fatigue removal using a prototype measurement system.
  - Improved premium and post-weld treatments

RAILROAD IMPACT

- Better understanding of the effects of HAL on railway infrastructure and root causes of HAL-related problems
- Mitigate adverse effects of HAL on track degradation and improve operational safety.
- Help reliably estimate track component life and reduce track-caused accidents.
- Safer and more and reliable infrastructure for heavy-haul freight transportation

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Association of American Railroads
- Norfolk Southern Railway
- Union Pacific Railroad
- Canadian National Railway
- BNSF Railway

COST & SCHEDULE

- Funding: $653,538
- Project Duration: July 2020 – 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

- Disseminate prior NDE probability of detection results/findings with the tank car industry and stakeholders.
- 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 have included:
  - On-track testing for the university-led research on new methods for rail flaw detection.
  - Field evaluation of a nuclear magnetic resonance imaging system for moisture detection in ballast.
  - Field evaluation of a prototype, vibration-based measurement system for rail neutral temperature.

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 PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: $1,003,498
- Project Duration: April 2017 – September 2022

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 commercially available technologies for inspecting highway-rail grade crossings to ensure compliance with regulations under 49 CFR Part 234 (Grade Crossing Safety).
- Apply this approach to video footage from locomotive forward-facing cameras to observe and report on the current state of infrastructure at highway-rail grade crossings, including, but not limited to: presence and condition of crossing gates, other warning devices, required signage, pavement markings, and adequate sight distance for pedestrians and drivers alike.

RAILROAD IMPACT

- Aligns with the U.S. Department of Transportation's strategic goals for Safety and Innovation by advancing technology that improves the efficiency of safety inspections on U.S. railways and highways.
- Timely reporting (i.e., real time or near-real time) of critical safety-related issues associated with highway-rail grade crossings affecting pedestrian and driver safety.
- Further advancement of artificial intelligence capabilities and technologies for multi-model transportation applications

PROJECT PARTNERS

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

COST & SCHEDULE

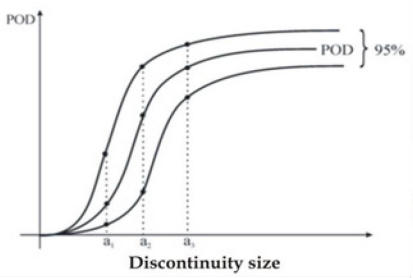
- Funding: $489,980
- Phase II Duration: August 2021 – August 2023

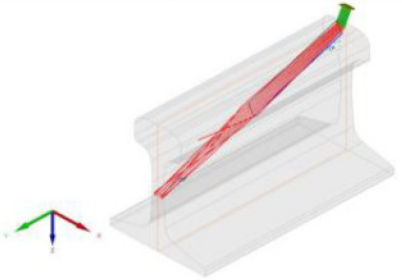
FRA PROJECT MANAGER: Jay Baillargeon • (719) 584-7155 • jay.baillargeon@dot.gov

Evaluation Procedures for Track Inspection Technologies

PROJECT DESCRIPTION

- Further develop procedures for quantifying the effectiveness of track inspection technologies.
- Establish a uniform approach for design and execution of performance assessment testing for track inspection technologies.
- Investigate sample size requirements, repeatability, reproducibility procedures, and acceptance criteria as they relate to the evaluation of track inspection technology effectiveness.
- Demonstrate the feasibility of the model-assisted probability of detection methodology and its application in the railroad industry.





RAILROAD IMPACT

- Develop an approach for standardizing the evaluation of effectiveness of existing and emerging track inspection technologies.
- Establish confidence in the effectiveness of new inspection technologies, thereby facilitating adoption for regular use in safety assurance.

PROJECT PARTNERS

- ENSCO, Inc.
- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: $499,800
- Project Duration:
  - Phase I: September 2019 – July 2020
  - Phase II: July 2020 – March 2021
  - Phase III: March 2021 – September 2022

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

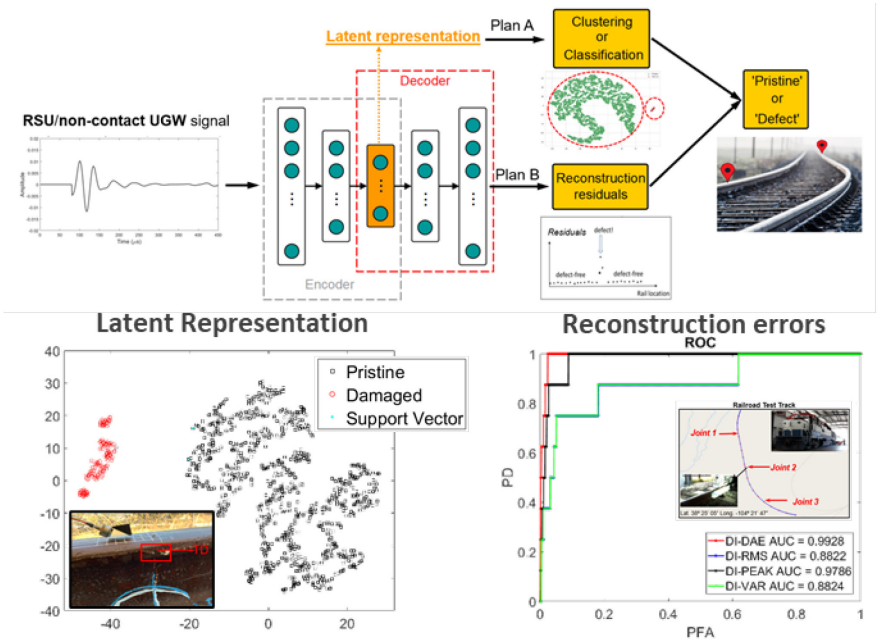
High-Speed Rail Inspection Using Anomaly Detection

PROJECT DESCRIPTION

- Develop an anomaly detection framework that features both semi-supervised learning algorithms as well as automatic feature learning for both contact and non-contact ultrasound systems by using:
  - Ultrasonic rolling search unit data
  - Field test data from a prototype, non-contact, ultrasonic guided wave inspection system
  - Recent advancements in machine learning for robust rail defect detection capabilities
- Address upcoming, unprecedented data challenges from full-scale deployment of rail flaw inspection systems in a practical and effective manner.

RAILROAD IMPACT

- Improve track safety and reliability, and minimize the risks of track defect-induced accidents through:
  - A well-documented rail defect detection database which enables future benchmark studies.
  - Improved reliability of defect detection by applying recent advancements in anomaly detection.
  - Improved robustness of rail defect detection by applying recent advancements in deep neural networks and data analysis.



PROJECT PARTNERS

- University of Utah
- Sperry Rail Service
- Avanti Technologies, LLC

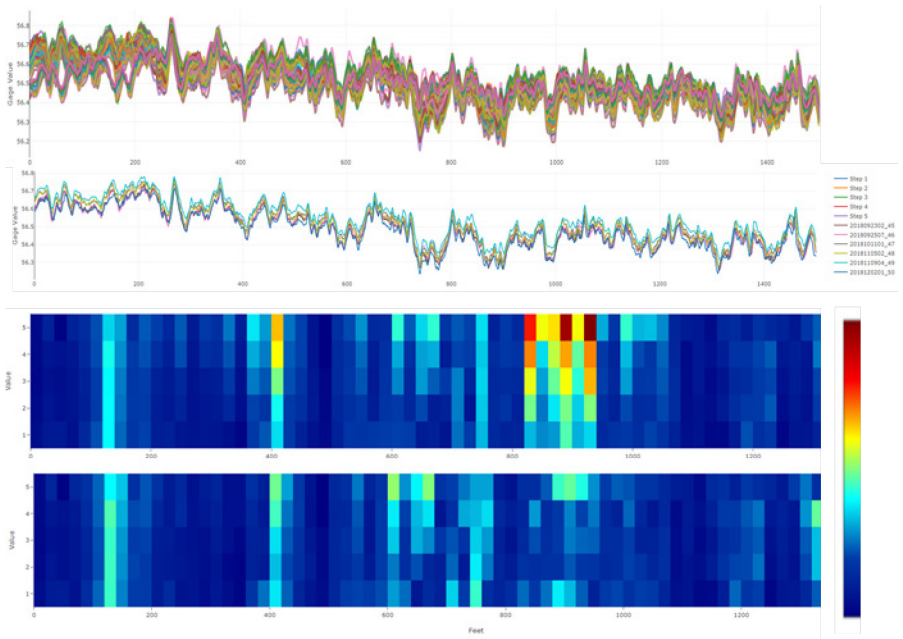
COST & SCHEDULE

- Funding: $180,000
- Project Duration: June 2020 – December 2021

Advanced TGMS Forecasting Models

PROJECT DESCRIPTION

- Investigate advanced analytical approaches for forecasting foot-by-foot track geometry, including quantitative time series.
- Develop and validate an advanced predictive model for foot-by-foot surface and alignment track geometry measurements with consideration of the effects of seasonality and asset type.
- Investigate additional applications of the forecasting models, such as cleaning and filtering data or generating missing data points due to sensor malfunctions or low speeds.
- Develop a preliminary user interface for selected model(s).
- Conduct multiple case studies to demonstrate the capability of the developed model(s).



RAILROAD IMPACT

- Provide industry with tools for long-term insight into the future behavior of track geometry to aid in planning preventive maintenance.
- Models will improve data cleaning and filtering and generate missing data points.
- Further advance application of autonomous track geometry systems through integration with advanced predictive analytics.

PROJECT PARTNER

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $199,982
- Project Duration:
  - Phase I: October 2020 – January 2021
  - Phase II: February 2021 – September 2021

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

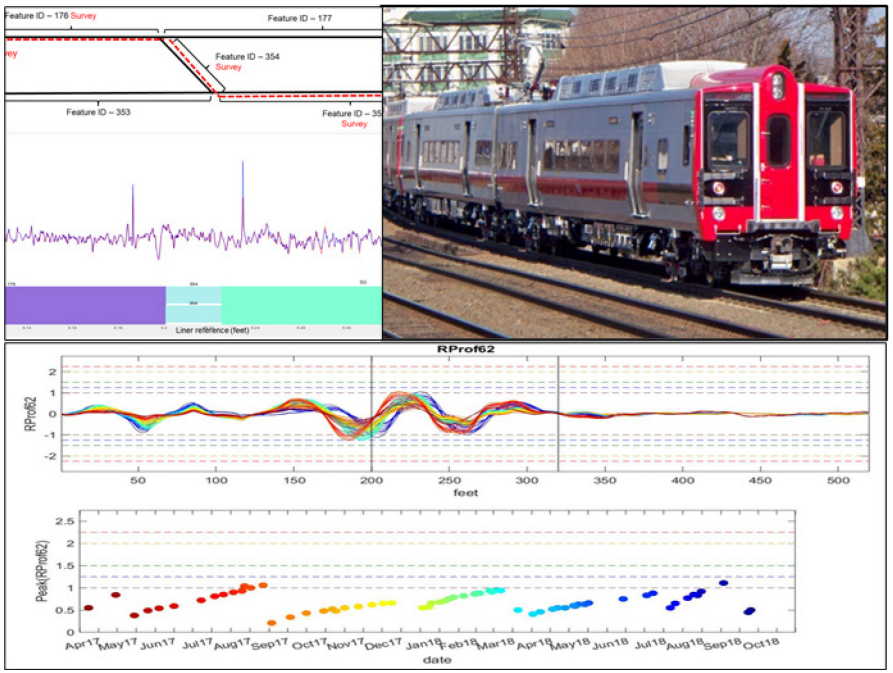
Development of Predictive Analytics Using ATGMS Data

PROJECT DESCRIPTION

- Autonomous track geometry measurement systems (ATGMS) provide routine, frequent, track-related data that allow railroads to better monitor track conditions and facilitate predictive approaches to preventive maintenance.
- This project uses large volumes of these recursive track geometry measurements to develop and implement automated processes for analyzing, predicting, and reporting track locations of concern, including those with significant rates of degradation.

RAILROAD IMPACT

- This project demonstrates to the entire railroad industry the utility of continual assessment of frequently collected track condition data.
- Processes to be developed will provide the basis for timely preventive maintenance to address safety-related issues long before they become problematic, improving safety and reliability for the entire network.
- As part of a long-term strategy, this information can also be used to identify the cause of deterioration and to guide the choice of corrective action to improve track performance and safety.



PROJECT PARTNERS

- ENSCO, Inc.
- Metro-North Railroad

COST & SCHEDULE

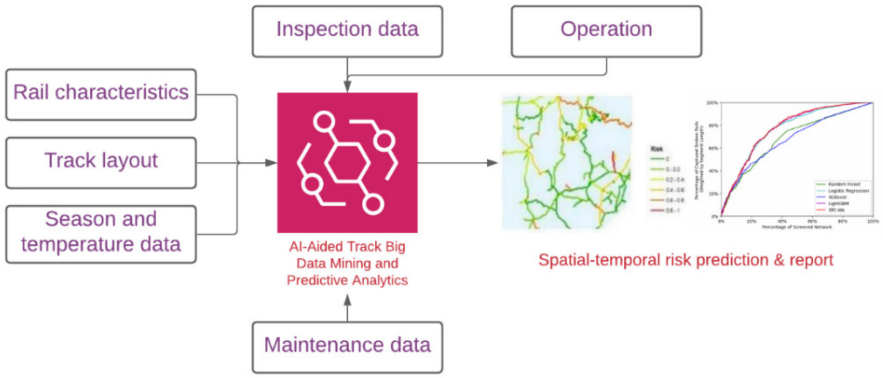
- Funding: $688,144
- Project Duration:
  - Phase I: October 2018 – June 2019
  - Phase II: July 2019 – December 2020
  - Phase III: January 2021 – December 2021

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

Artificial Intelligence-Aided Track Risk Analysis

PROJECT DESCRIPTION

- Develop an Artificial Intelligence (AI)-Aided Track Risk Analysis (AI-TrackRisk) tool, initially focused on rail failures.
- AI-TrackRisk is an intelligent system that can automate track data modeling, predictive analytics, and risk visualization – ultimately supporting optimal track inspection and maintenance decisions.
- The project is currently in Phase II (further development, validation, and implementation), and new data received from industry partners is being processed to improve the tool's prediction of broken rails.



RAILROAD IMPACT

- The initial development (Phase I) showed the feasibility of using AI for automated track data integration, modeling and predictive analytics. The identification of high-risk locations on the network can support predictive track maintenance and safety improvement.
- The further development (Phase II) will lead to the implementation of the technology in the operational environment.
- Acquire new knowledge and tools pertaining to how AI can be used to support track data mining and predictive analytics.

PROJECT PARTNERS

- Rutgers University
- CSX Transportation
- Port Authority Trans-Hudson

COST & SCHEDULE

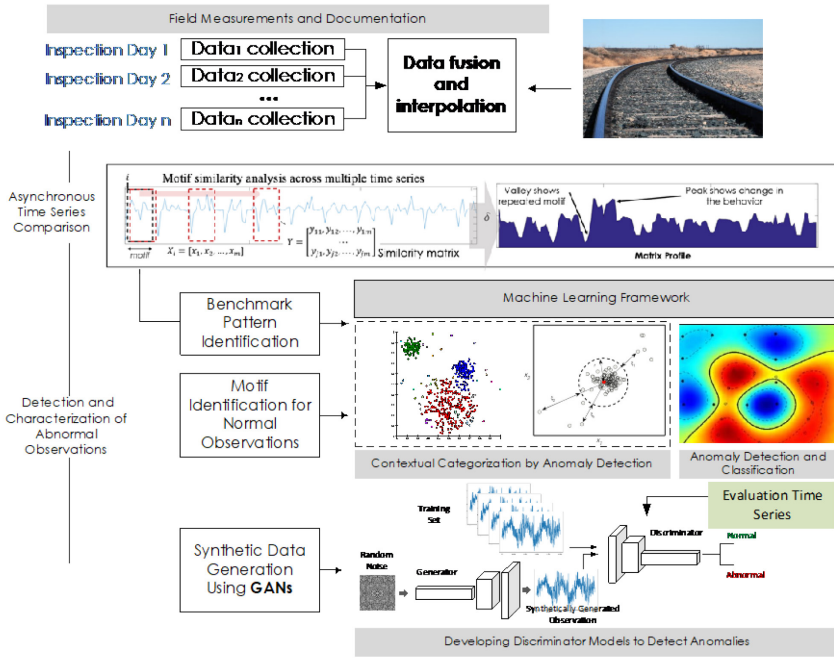
- Funding: $675,609
- Project Duration: August 2018 – September 2022

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

Machine Learning Methods for Track Condition Assessment

PROJECT DESCRIPTION

- Develop a machine learning framework to establish a knowledge base (analogous to that of an experienced operator) as a baseline for normal versus abnormal behavior for any given segment of track, simulating the manual inspection process.
- Use the knowledge base for each new inspection run along with machine-learning-based anomaly detectors to identify track segments that deviate from normal trending, implying the potential need for preventive maintenance, similar to the process of exception flagging by an operator.
- Draws on methods of asynchronous time series comparison, synthetic data generation for balancing data, and machine learning algorithms for detection and characterization of abnormal observations.



RAILROAD IMPACT

- Provide foundational, data-driven techniques for moving toward reducing laborious manual processing of large quantities of inspection data.
- Reduce the number of false positives for automated monitoring systems by leveraging state-of-the-art machine learning techniques.
- Reduce costly in situ inspections and increase productivity of preventive maintenance process on U.S. railways.

PROJECT PARTNERS

- Virginia Polytechnic Institute and State University
- Amtrak

COST & SCHEDULE

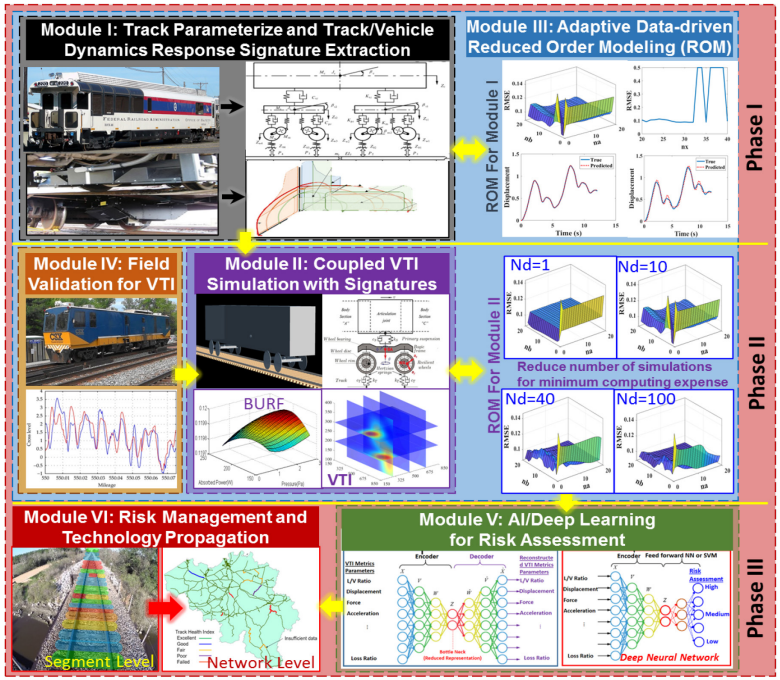
- Funding: $283,000
- Project Duration: August 2020 – July 2022

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

Intelligent Risk Assessment and Prediction System (i-RAPS)

PROJECT DESCRIPTION

- Develop an intelligent Risk Assessment and Prediction System (i-RAPS) framework that will integrate adaptive sampling and data-driven, reduced-order modeling for risk prediction.
- Process large volumes of track inspection data to parameterize the condition of the track system through response-based identification.
- Develop and utilize finite element modeling for parametrized tracks within the identified space of working conditions to extract track signatures (i.e., B-spline impulse response functions).
- Simulate complex vehicle/track interactions using fast-coupling algorithms for different combinations of track and vehicle signatures.



RAILROAD IMPACT

- Revolutionize the current practice for the inspection and risk assessment of North American railway track by proposing the “track genome” method.
- Quantify the track conditions with a single overall risk index to unify risk management and decision making.
- Use the vast amount of track inspection data and identify the sensitive and critical track components state changes.
- Quantify the deterioration rate and “limit state” of track components for different track sections to facilitate condition-based and “track-dependent” maintenance.

PROJECT PARTNERS

- University of South Carolina
- CSX Transportation

COST & SCHEDULE

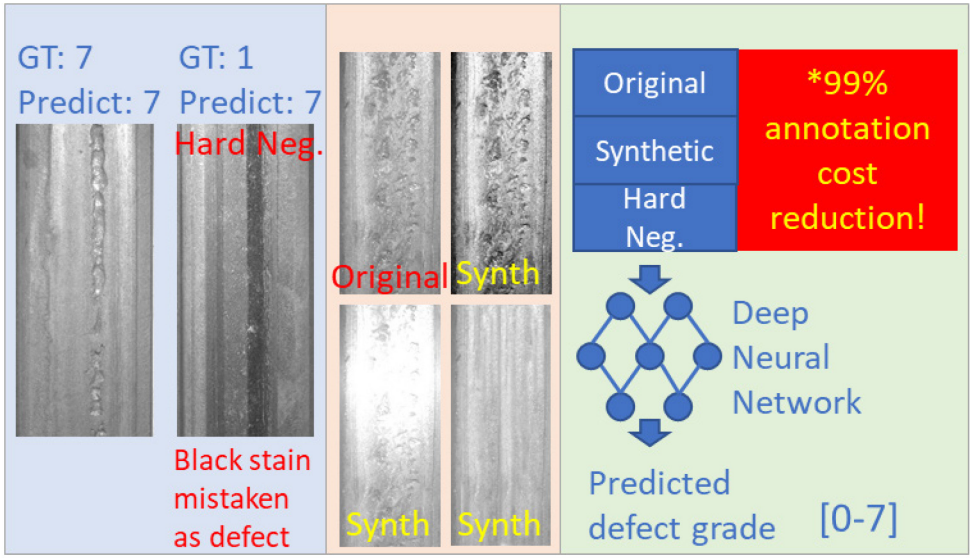
- Funding: $395,000
- Project Duration: June 2020 – June 2023

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 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 of 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 image monitoring systems.

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- KLD Labs, Inc.
- CSX Transportation

COST & SCHEDULE

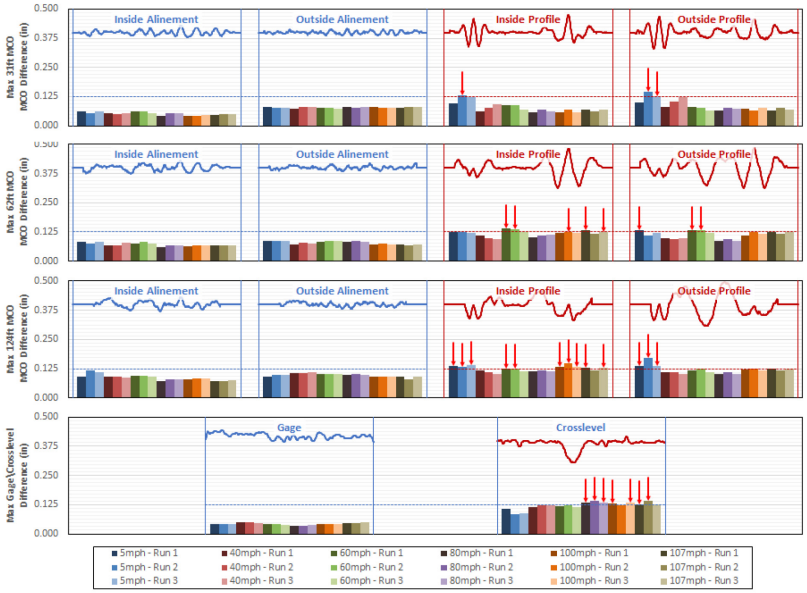
- Funding: $148,973
- Project Duration: September 2021 – September 2022

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

Procedure for Assessing ATGMS Accuracy

PROJECT DESCRIPTION

- Develop a test procedure to evaluate the accuracy of Automated Track Geometry Systems (ATGMS).
- Procedure applies a set of test cases to a 500-foot tangent test track where geometric track anomalies can be installed and adjusted for a comprehensive accuracy assessment.
- 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: $400,000
- Project Duration: May 2020 – June 2022

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

Ground Truth Measurement of Track Geometry

PROJECT DESCRIPTION

- FRA has constructed a 500-foot tangent test track with adjustable fasteners to allow the introduction of known geometry deviations for evaluation of track geometry measurement systems (TGMS) and their accuracy.
- Efforts will focus on developing a measurement device that can determine the actual track geometry installed on the concrete slabs accurately and quickly identify it as ground truth.
- These highly accurate measurements will be the baseline from which TGMS accuracy is compared.

RAILROAD IMPACT

- System will establish conditions of test track used to verify the accuracy of track geometry measurement systems.
- Once the condition of the test track is precisely determined, the results of the system will serve as a benchmark for validating a wide range of measurement systems and dynamic modeling exercises.

PROJECT PARTNERS

- ENSCO, Inc.
- Volpe National Transportation Systems Center

COST & SCHEDULE

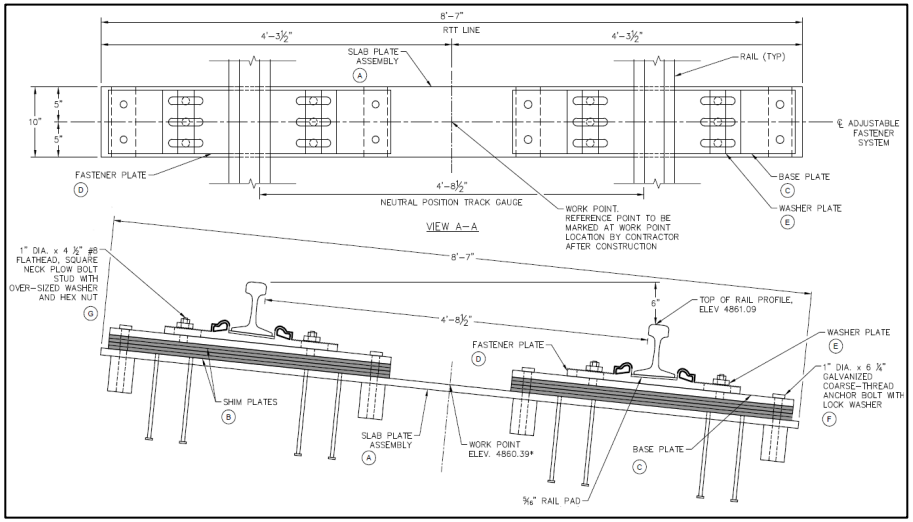
- Funding: $621,314
- Project Duration: September 2018 – December 2021

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

Adjustable Precision Curved Track Anomaly Test Section

PROJECT DESCRIPTION

- This project covers the design development as well as the construction of a curved test track section on the high-speed test track at FRA's Transportation Technology Center (TTC) where geometric track anomalies can be installed and adjusted.
- The curved test track section will supplement the existing tangent high-speed adjustable perturbation slab track test section previously built at TTC.



RAILROAD IMPACT

- Track geometry testing is a critical function for safety and operations of railroads, especially for high-speed passenger trains.
- The track anomaly section can be used to validate a track geometry measurement system, especially for high-speed track inspection.
- The track anomaly test section will also provide a unique testing platform where vehicle-track interaction modeling simulations can be validated and existing and new technologies can be tested.

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- David Evans and Associates, Inc.
- RailWorks Corp.

COST & SCHEDULE

- Funding: $5,771,643
- Project Duration: September 2018 – June 2022
  - Construction scheduled for 2022

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

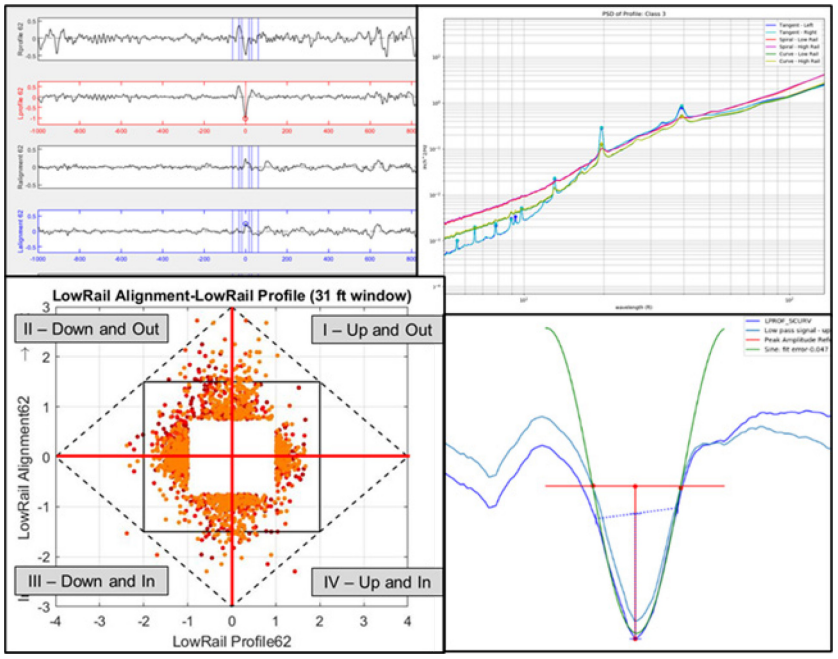
Vehicle-Track Interaction Testing, Modeling, and Analyses 2

PROJECT DESCRIPTION

- Complete track characterization data analysis and document the results in a final report.
- Perform statistical analysis to determine the predominant amplitude and wavelength content of track geometry.
- Quantify and understand correlations between different vertical (profile, crosslevel), lateral (alignment), and gage variations.
- Determine the prevalence of combined track geometry perturbations.

RAILROAD IMPACT

- Provide information about the current state of track conditions in respect to track geometry across the nation's rail network.
- Provide data to support assessing derailment risks, potential regulatory action, and further research.



PROJECT PARTNER

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $161,907
- Project Duration: September 2021 – September 2022

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

Influence of Track Irregularities on Derailment Safety

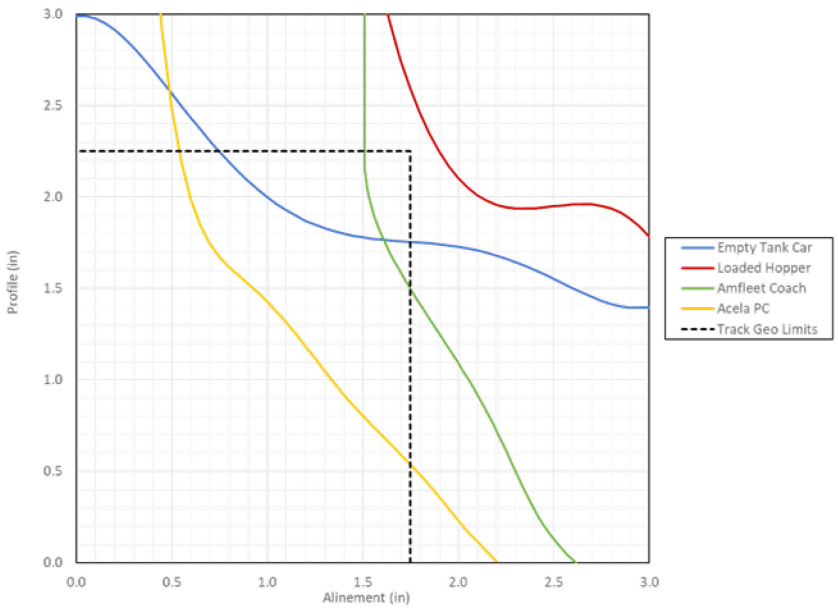
PROJECT DESCRIPTION

- Develop validated computer models of freight and passenger rail vehicles to study dynamic response for speeds up to 220 mph.
- Collaborate with TTCI on developing validated tank car computer model, including the effects of liquid slosh on vehicle dynamics on track Classes 1 through 5.
- Perform parametric studies using computer modeling to study the relationship between vehicle performance, track geometry, and derailment safety.
- Use model 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 FRA Track Geometry RSAC task.

RAILROAD IMPACT

- Help provide an infrastructure that supports a variety of vehicles for speeds up to 220 mph.
- Address derailment safety concerns and support industry's need for identifying safe track geometry limits and procedures used for assessing the performance of new rail vehicles from a derailment safety standpoint.
- Work with industry to develop a tank car model suitable for examining the response of tank cars to track geometry deviations with the inclusion of sloshing effects, examining the effects of combined track geometry deviation on vehicle performance.

Class 3, Combined Down and Out Safety Envelope for Different Equipment



PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

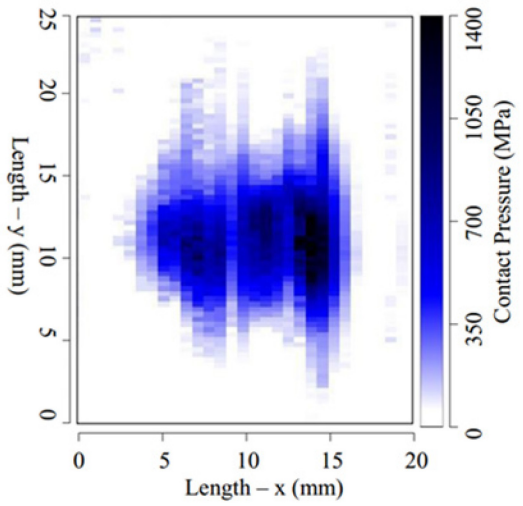
- Funding: $400,000
- Project Duration: May 2021 – June 2022

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

Coordinating an International Collaborative Research Initiative (ICRI) on Wear and Fatigue of Rails and Wheels

PROJECT DESCRIPTION

- ICRI was formed to undertake joint research on the wear and fatigue of rails and wheels. Teams collaborate on topics such as Friction Modelling, VTI Economics, Quantify Surface Fatigue, and Modeling Surface Damage initiatives. The most recent initiative is Risk Modeling, to complement its Economics Modeling activity.
- ICRI organizes an annual international workshop at which these and other topics are reviewed and revised. A publicly accessible web site (icri-rcf.org) makes all meetings and research available.
- While much of the technical work is undertaken through in-kind contributions, FRA funding supports the management of ICRI.



RAILROAD IMPACT

- RCF and wear cost the rail industry billions of dollars each year as a result of associated rail and wheel replacements, derailments, work stoppages, inspection, and maintenance.
- ICRI exists to identify and solve wheel/rail problems and advance technology developments that will improve rail safety and maintenance.
- The ICRI model is an efficient and economical way of undertaking research by pooling resources, leveraging work already underway, accessing test equipment, and promptly sharing field results.

PROJECT PARTNERS

- National Research Council Canada (NRC)
- Transport Canada
- 230+ members from 24 countries including 29 railroads, 36 suppliers, 34 universities, and six governments

COST & SCHEDULE

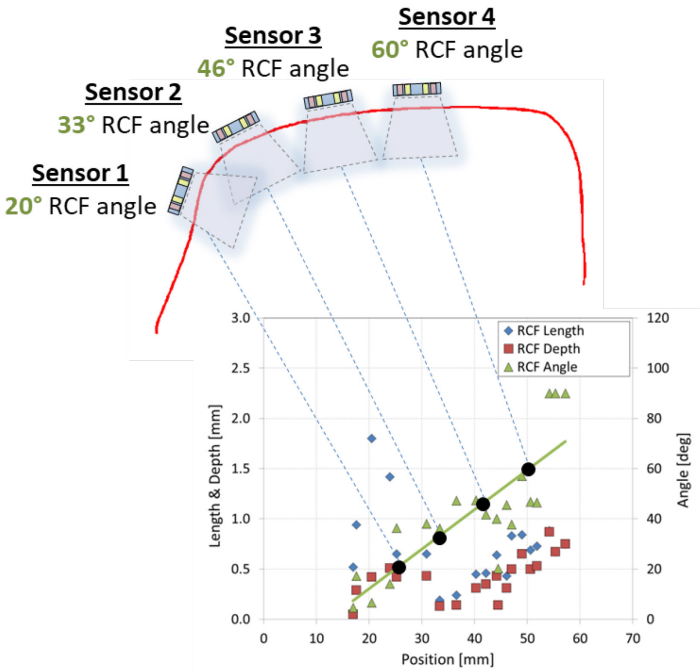
- Funding: $75,000 (matched by NRC and Transport Canada)
- Project Duration: September 2019 – March 2021
  - April 2020 Annual ICRI Workshop in Istanbul (canceled due to COVID-19 pandemic)
  - Webinars throughout the term of the project

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

Rolling Contact Fatigue (RCF) Qualification

PROJECT DESCRIPTION

- This project focuses on analyzing RCF in rail samples using metallographic techniques and an eddy current (EC) non-destructive testing method. The destructive measurement data sets are correlated with the non-destructive EC outputs. The objective is to build a sturdier RCF quantitative assessment tool for in-track inspection of rail defects in rails with variable operating conditions at different points in their respective life cycles.
- RCF analysis has been conducted on 25 rails, and the updated results from this analysis were presented in a March 2021 FRA report. An additional 15 rails will be analyzed over the next 18 months (2021 – 2022 period), with results presented at both the ICRI conference and in future FRA reports.



RAILROAD IMPACT

- **Safety:** Understanding rail subsurface RCF damage as a function of track curvature and tonnage accumulation will allow railroads to more safely manage RCF.
- **Economic competitiveness:** Accurate mapping of RCF is useful to railways for making grinding and rail replacement decisions and to RCF modeling experts for predicting rail life under variable conditions.

PROJECT PARTNER

- National Research Council Canada

COST & SCHEDULE

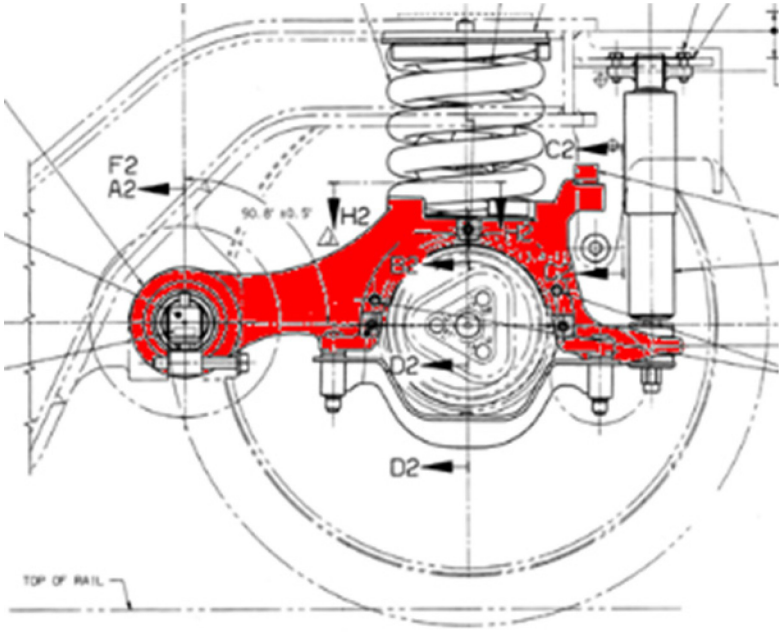
- Funding: 2017 – 2018: $95,000; 2019 – 2020 (18 months): $175,000; 2021 – 2022 (18 months): $150,000
- Project Duration: 2017 – 2022

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

Coil Spring Characterization and Modeling

PROJECT DESCRIPTION

- Procure a multiaxial test machine to test suspension springs under various loading conditions.
- Measure the axial, shear, and torsional stiffness of the spring.
- Study the best practice for modeling suspension springs in trucks.
- Investigate the need for modifying the methods in which the springs are modeled in multibody simulation programs.
- Characterize springs for Next Generation High-Speed Equipment and other cars with critical suspensions.



RAILROAD IMPACT

- Provide best practices on how to measure spring properties.
- Provide information on how to model springs in multibody simulation program.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Zwick Roell Group

COST & SCHEDULE

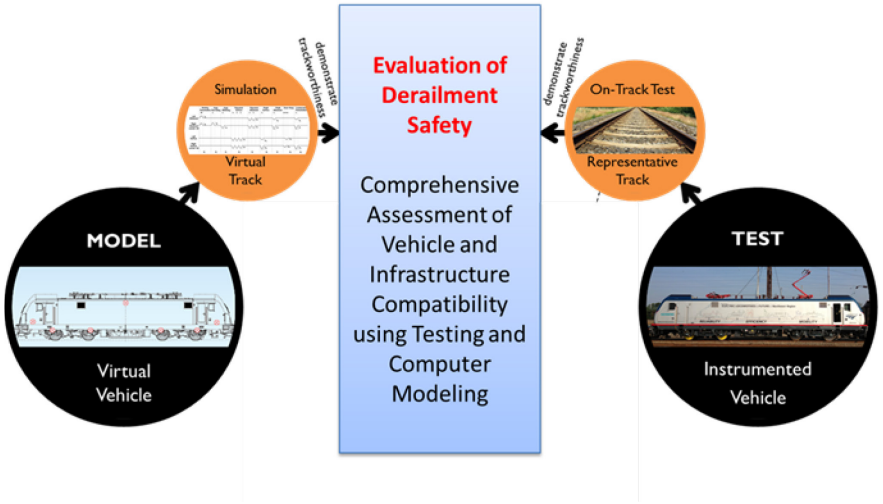
- Funding – testing to characterize springs: $200,000
- Project Duration: 2020 – 2022

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

Support of FRA Office of Railroad Safety

PROJECT DESCRIPTION

- Review test plans submitted for qualification testing and pre-revenue service acceptance testing.
- Develop and update new procedures for assessing safety of rail vehicles, including existing designs imported to North America, prior to use in revenue service and taking advantage of state-of-the-art computer modeling and testing.
- Analyze data collected during physical testing as well as data from simulations from vehicle qualification process.
- Assist in derailment investigations.
- Define characteristics of representative track.



RAILROAD IMPACT

- Review of qualification testing results identifies potential safety concerns which can be addressed before revenue service.
- Simulations included in qualification process provide a standardized procedure for vehicle manufacturers to examine the dynamics of a new design intended for the North American railroad operating environment.
- Derailment investigation can identify root causes of accident and potentially prevent future accidents.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $400,000
- Project Duration: May 2020 – June 2022

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

Advancement in Rail Integrity Inspection

PROJECT DESCRIPTION

Rail Flaw Library Research and Support:

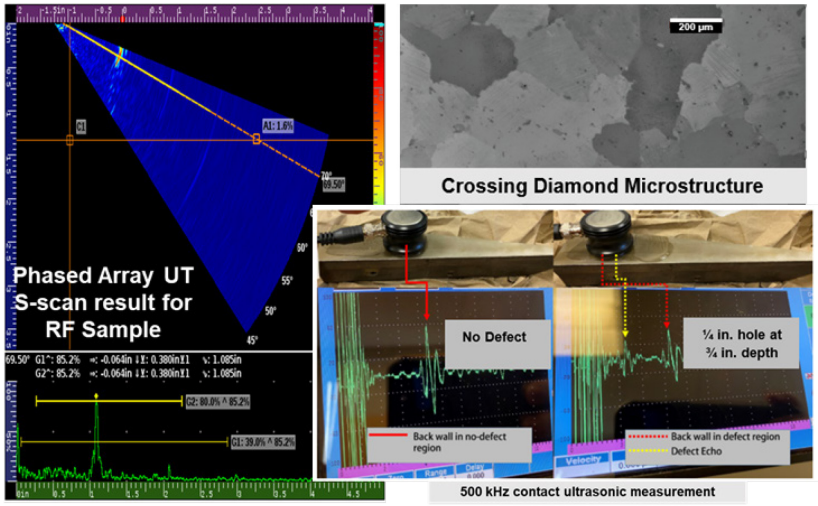
- Continue collecting naturally occurring rail flaws (unbroken) from FAST, TTC, and North American railroads.
- Provide technical, logistical, and general support to universities and researchers who want to access Rail Flaw Library.
- Acquire two conventional hand-held UT flaw detection systems for the FRA rail flaw library usage.

Rail Flaw Imaging Validation:

- Coordinate with at least two providers of advanced, phased array UT imaging techniques to evaluate and compare the performance of advanced phased array post-processing approaches used for rail flaw imaging.

Special Trackwork Inspection:

- Explore the advanced low-frequency UT and electro-magnetic NDE techniques for detecting defects in special trackwork components.
- Fabricate test sample for proof-of-concept evaluation testing.



RAILROAD IMPACT

- Support future research on evaluating and improving the performance of current and future rail inspection technologies that detect rail flaws as well as the methods for quantifying them.
- Rail Flaw Library will allow researchers direct access to the realistic rail flaw samples for validating their work on rail inspection technologies.
- Compare and contrast the performance of different, emerging advanced phased array UT approaches for rail flaw imaging.
- Continue exploring innovative advanced NDE technologies capable of inspecting special trackwork for critical internal defects.

PROJECT PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

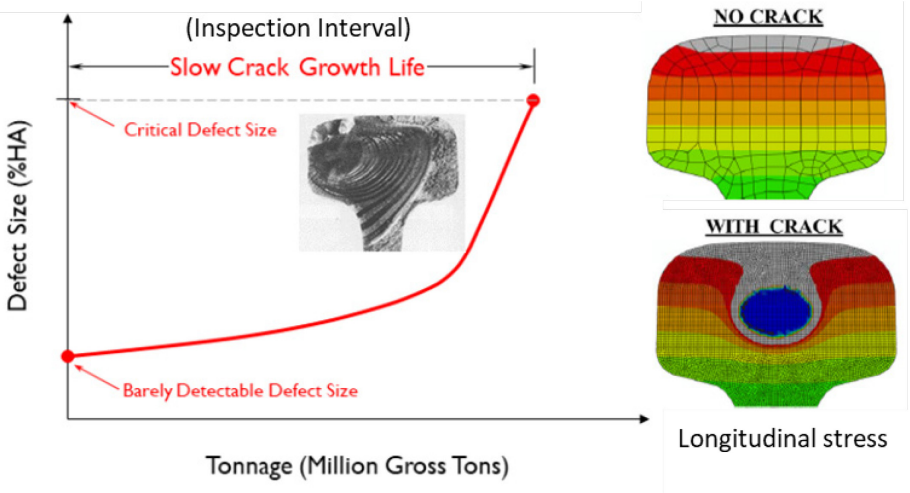
- Funding: $389,966
- Project Duration: October 2020 – September 2022

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Defect Growth Characterization in Modern Rail Steel, Phase III

PROJECT DESCRIPTION

- Determine safe inspection interval for modern rail steel (head-hardened).
- Detailed investigation of roller straightening process, including influence on residual stress and potential modifications to alleviate detrimental stress states in new rail (previous work shows high longitudinal tensile stress in rail head).
- Enhance the analytical detail fracture model for improved prediction of stress intensity factors and therefore fatigue life of rail.
- Investigate new methods to calculate fatigue life using full 3D finite element simulations.



RAILROAD IMPACT

- Improved safety through more accurate prediction of safe inspection intervals for modern rail.
- New methodology for obtaining residual stress state in different rail types and improved calculation of crack growth rates.
- Potential significant enhancement to roller straightening/rail forming process and subsequent improvement of rail fatigue life.

PROJECT PARTNERS

- Lehigh University
- Thornton Tomasetti, Inc.

COST & SCHEDULE

- Funding: $336,255
- Project Duration: September 2020 – September 2022

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Automated Railhead Flaw Characterization and Rail Remaining Life Prediction Technology

PROJECT DESCRIPTION

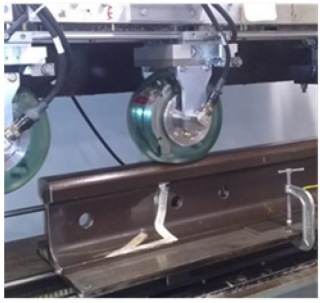
- Automated railhead flaw characterization and rail remaining life prediction technology
- Experimental ultrasonic track inspection data from Sperry Rail Service
- Machine learning and computer vision data-driven models to classify and characterize rail transverse defects based on both A-scan and B-scan data.
- Rail life remaining and remedial action planning
- Uncertainty quantification of flaw estimates and remaining service life predictions

RAILROAD IMPACT

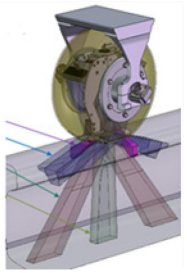
- Current rail NDE technology relies on human interpretation to characterize and classify rail head flaws.
- Increased flaw sizing reliability and inspection speed is enabled by pre-training data-driven models.
- Shifts flaw sizing burden from inspector to analysis and software development.
- Increased flaw sizing reliability (e.g., % rail head area) will decrease chance of derailments.
- Research builds on the most recent research of the rail integrity and fatigue life prediction for modern rails.
- Delayed remedial action plan based on remaining life.

Example Rail Defects

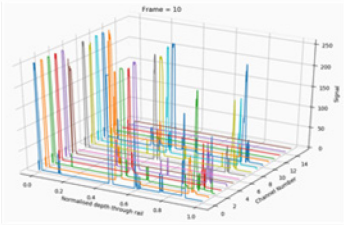
Ultrasonic Testing Rig



Transducer Arrangement



Example A-Scan Dataset



PROJECT PARTNERS

- Thornton Tomasetti, Inc.
- Siemens AG
- Sperry Rail Service
- Harvard University

COST & SCHEDULE

- Funding: $450,003
- Project Duration: September 2019 – March 2022

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Development of Rail Flaw Imaging Technology Based on Ultrasonic Tomography

PROJECT DESCRIPTION

- Project will continue work by the University of California, San Diego (UCSD) in ultrasonic imaging of internal rail flaws to develop a field-deployable prototype for hand verification and quantification of rail flaws.
- UCSD's SAFT flaw imaging prototype will be advanced to the stage of field deployment and reconstruction of 3D images of a rail's internal flaws.
- The performance of the rail flaw imaging prototype will be evaluated on flawed rail sections in the laboratory that are characterized by an independent method (e.g., breaking rail).

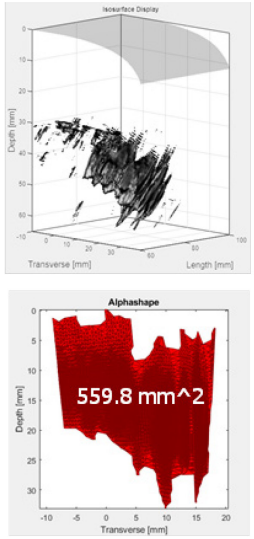


Image of natural TD

RAILROAD IMPACT

- Advanced rail inspection technologies are high priorities of FRA's Research, Development, and Technology program.
- The goal of an effective and safe rail inspection program is to enable maintenance decisions based on the actual severity of a flaw.
- An ability to quantitatively image an internal flaw with no or little operator interpretation will be an invaluable tool in the hands of railroad maintenance personnel.

PROJECT PARTNERS

- UCSD
- Participating railroads (BNSF committed; UP & NS potential)

COST & SCHEDULE

- Funding, Initial Phase: $138,965 (FRA); $50,000 (UCSD equipment cost share)
- Option 1: $140,000
- Option 2: $210,000
- Project Duration: July 2019 – December 2022

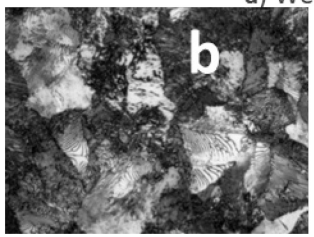
FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

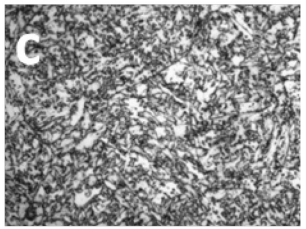
Fatigue Crack Growth Rate (FCGR) Material Characterization of Targeted Microstructures of Welded Rail

PROJECT DESCRIPTION

- Subside specimens (railhead) of flash-butt welded rails 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 the heat-affected zone (HAZ).
- Crack growth rate testing will be done on the weld, the region directly adjacent to fused region, and the region directly adjacent to the visible HAZ.
- Statistical analysis will help determine whether crack growth was due to differences in microstructure and/or different load ratios.
- Modeling of crack growth will be conducted.

a) Welded rail





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

- UCSD
- Participating railroads (BNSF committed; UP & NS potential)

COST & SCHEDULE

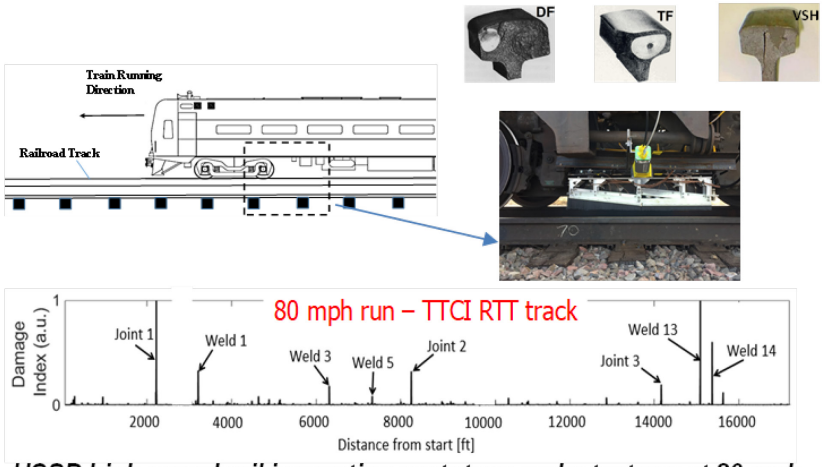
- Funding: FY21 $179,613.00 – Funded
- FY22 $173,834 – Option
- FY23 $146,553 – Option
- Project Duration: September 2021 – September 2024

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

High-Speed, Non-Contact Rail Inspection Prototype

PROJECT DESCRIPTION

- The prior experience of the University of California, San Diego (UCSD) in design, construction, and testing of non-contact, ultrasonic rail inspection systems will be utilized for the development of a high-speed rail inspection capability.
- Already performed three field tests at TTC at speeds up to 80 mph with good feasibility results for the detection of joints, welds, and internal flaws.
- Proposed work will improve current prototype to bring the probability of detection and the predictive failure analysis for internal rail flaws to acceptable levels.
- In addition, the project evaluates a controlled acoustic source, upgrades the prototype's hardware and software, and quantifies the benefits of redundancy.



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

PROJECT PARTNERS

- UCSD
- BNSF Railway and Union Pacific Railroad
- Transportation Technology Center, Inc.

COST & SCHEDULE

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

RAILROAD IMPACT

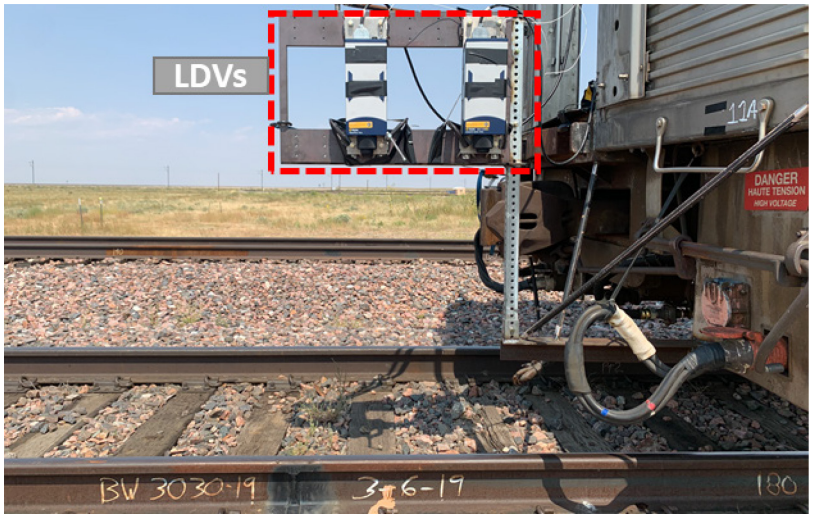
- Passive rail inspection technology would enable extremely high testing speeds, well beyond the ~ 25 mph maximum speed currently allowed by conventional (e.g., RSU-based) rail inspection cars.
- Inspecting rail at regular train speeds would simplify scheduling of rail inspections around normal traffic.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

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Rail Defect Detection by Non-Contact Vibration Measurements

PROJECT DESCRIPTION

- Develop a non-contact technology for the identification of 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 LDV measurements obtained from a moving platform, as well as to investigate how the presence of defects affects LDV measurements.
- Laboratory tests were performed to investigate speckle noise observed in moving LDV measurements, and filtering algorithms were developed to increase the signal-to-noise ratio.
- Advanced system identification algorithms, integrated with noise reduction and damage detection techniques, were evaluated to identify rail damage.
- Field tests were recently performed by TTCI to evaluate the performance of the proposed system to identify a welded rail joint.



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 to maximize the signal-to-noise ratio in the measurement signals.
- Ability to carry out inspections at operational railcar speeds.

PROJECT PARTNERS

- University of Texas at Austin – grantee
- Polytec, Inc. – test support
- BNSF Railway – test support
- Transportation Technology Center, Inc. (TTCI) – test support

COST & SCHEDULE

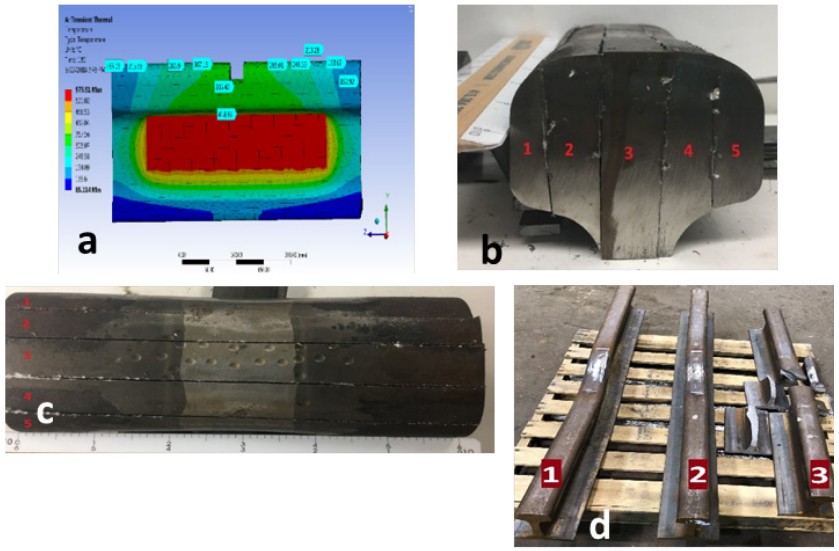
- Funding: $450,000
- Project Duration: May 2019 – November 2022

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Field Testing of Welding Repair of Railhead Defects

PROJECT DESCRIPTION

- Perform railhead repair on six short (18”) and three long (60”) weld samples.
- Perform hardness, ultrasound, and metallurgical lab testing on two short samples and inverted slow bend test on three long samples.
- Perform thermite railhead repair on four long (60”) samples.
- Perform hardness, ultrasound, metallurgical analysis, and inverted slow bend test on thermite-welded samples.
- Establish and compare the load deflection curves and the modulus of rupture for both invert slow bend-tested thermite and railhead repair weld specimens.
- Compare the microstructural features of each weld at the heat affected zone and the weld region.



a) FE analysis to establish the optimum preheat temperature
b) Rail sectioned for porosity inspection
c) Hardness measurements along the railhead
d) Slow bend test – AREMA standard

RAILROAD IMPACT

- Improve the quality of welded railhead repair.
- Provide fundamental data on both invert slow bend-tested of both thermite and railhead repair welds.
- Improve rail safety by understanding the failure behavior of railhead repairs.

PROJECT PARTNERS

- Tuskegee University
- EWI
- Nucor

COST & SCHEDULE

- Funding: $284,118
- Project Duration: October 2017 – December 2022

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • 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 on railway infrastructure, passenger safety, and freight accident prevention.
- Provide support and training for safety-related issues, including continuously welded rail (CWR) maintenance practices.

RAILROAD IMPACT

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

PROJECT PARTNERS

- ENSCO, Inc.
- Kandrew, Inc. Consulting Services

COST & SCHEDULE

- Funding: $499,128
- Project Duration: September 2018 – March 2023

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • 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

- Provides the 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 for proper rail stress management methodologies for field personnel.
- Create a platform to disseminate the results of FRA research on longitudinal rail stress and CWR management to industry, academia, and regulators.

PROJECT PARTNERS

- ENSCO, Inc.
- Kandrew, Inc. Consulting Services

COST & SCHEDULE

- Funding: $794,967 (Currently funded: $644,976)
- Project Duration:
  - Phase I: September 2020 – March 2022
  - Phase II: June 2021 – December 2023
  - Phase III: June 2023 – December 2024

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

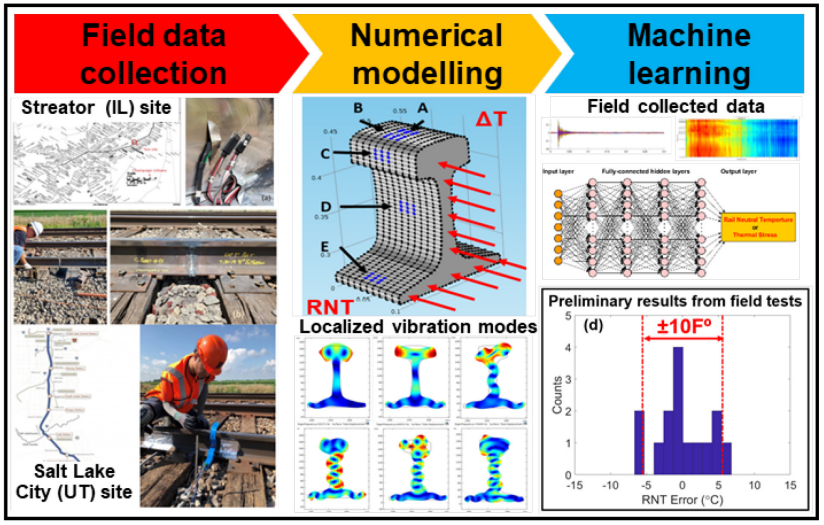
Rail Neutral Temperature Estimation Using Local Rail Vibration Measurements and Machine Learning

PROJECT DESCRIPTION

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

Methods:

- Collect local rail vibration data from two different instrumented revenue-service rail test sites.
- Study fundamental relationships between local rail vibration data and rail neutral temperature, rail temperature, longitudinal load, rail structure, and support conditions.
- Develop supervised machine learning algorithms to determine RNT in situ without the need for reference measurements, disruptions to traffic, nor modifications 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 to natural railhead, support condition temperature, and residual stress variations
- Applies to all rail and train traffic conditions

PROJECT PARTNERS

- University of Illinois at Urbana-Champaign and University of Utah
- BNSF Railway
- Utah Transit Authority

COST & SCHEDULE

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

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Longitudinal Stress Measurement Using Ultrasound, Phase II

PROJECT DESCRIPTION

In the Longitudinal Stress Measurement Using Ultrasound project, the University of Sheffield team was able to successfully:

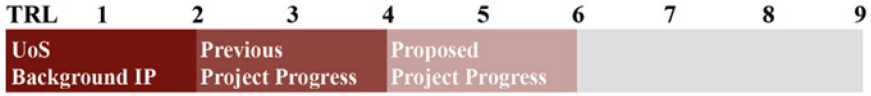
- Design and manufacture a device for measuring rail stress using ultrasound.
- Conduct calibrated measurements for rail stress in the lab and on track.

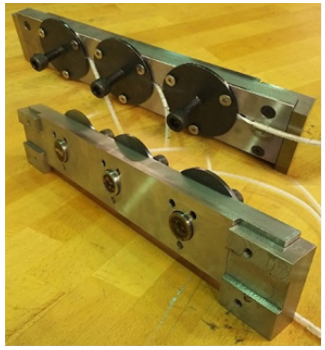
The proposed second body of work will consist of:

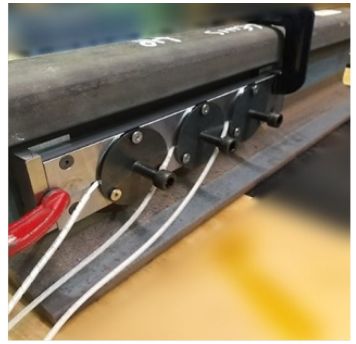
- Developing new sensors that can measure stress without calibration
- These sensors will produce a new angled shear-wave.
- Immediate on-track beta testing in the UK and add this new sensor to the existing prototype device.
- Final U.S. on-track testing and validation

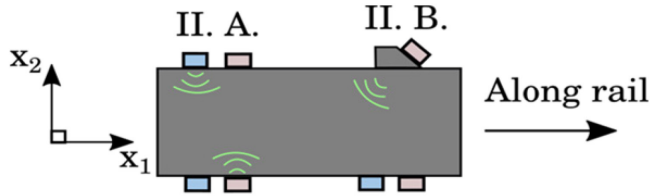
Outcomes:

- Calibration-free measurements of rail stress – no requirement to know the material properties.
- Measurements will be unaffected by rail traffic and daily and seasonal RNT fluctuations.









RAILROAD IMPACT

- Extension of rail life
- Lower track downtime, resulting in less service disruption
- Simplification and cost reduction of rail RNT maintenance
- Increase accuracy of rail RNT monitoring.
- Increase railroad safety by reducing the occurrence of bucking/pull-apart failures.
- The outcome of this project could be developed into a fast, hand-held device for determining RNT to be used by a non-specialist operator.
- A tool for better condition monitoring and pre-emptive maintenance

PROJECT PARTNER

- University of Sheffield, UK

COST & SCHEDULE

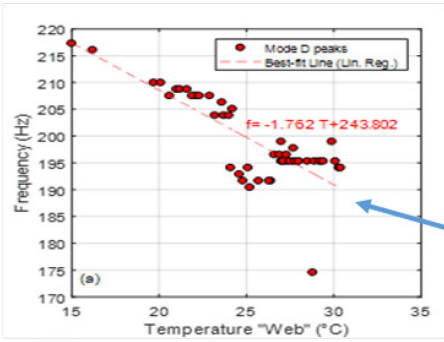
- Funding: FY21 – $150,120; FY22 – $150,000 – option; cost-sharing total – $120,000
- Project Duration: September 2021 – September 2023

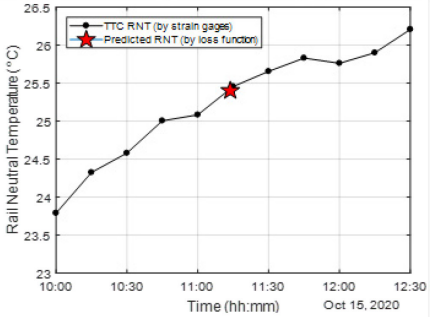
FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

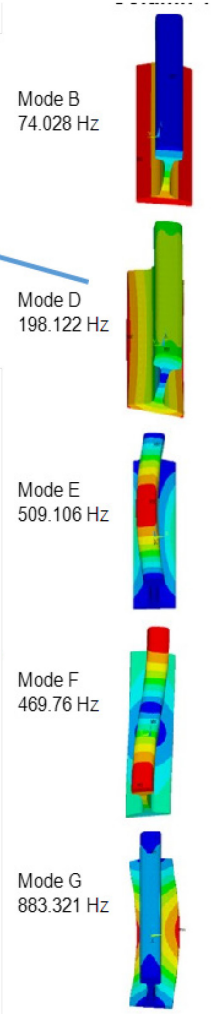
Image Processing and Machine Learning Algorithms to Measure Axial Stress in Rails

PROJECT DESCRIPTION

- Investigate a new technology able to determine the absolute stress of CWRs without disturbing the track structure, without prior knowledge of the RNT, and with one single measurement.
- Develop new inspection concept based on the non-contact detection of rail vibrations using high-speed cameras operating below 10,000 fps, and on image processing algorithms able to extract characteristics such as mode-shapes and frequencies of the vibrating rail. These characteristics are then used to infer the axial stress using existing models and advanced machine learning algorithms.
- Researchers performed feasibility laboratory tests on a rail segment.
- **Researchers performed two field tests, in Fall 2020 and Spring 2021,** at the Transportation Technology Center's High Tonnage Loop.







RAILROAD IMPACT

- Reliable technology able to determine axial stress and neutral temperature would drastically reduce 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 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
- Northeastern University
- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: $333,449
- Project Duration: July 2019 – July 2022

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

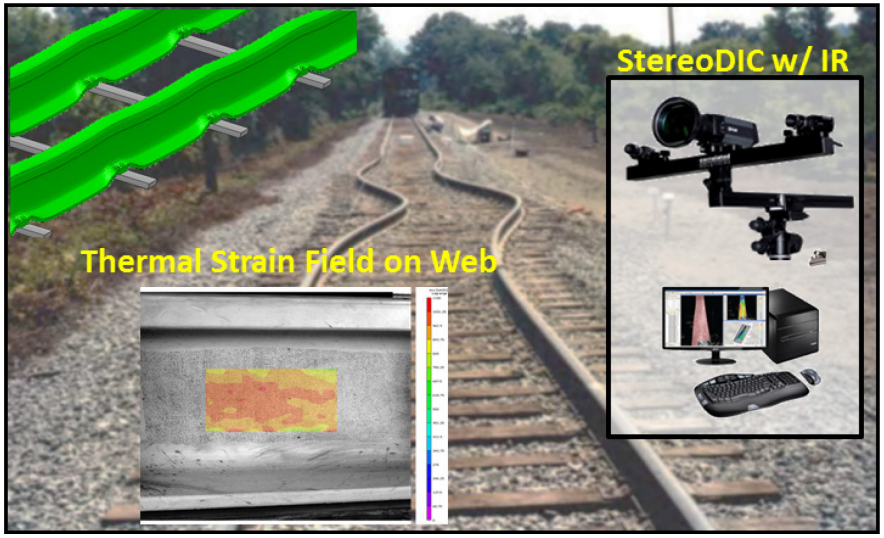
A Non-Contacting System for Longitudinal Rail Stress Measurements: Field Deployment and Validation

PROJECT DESCRIPTION

Spurred by the success of the current FRA-sponsored research on the topic, project partners field-deployed, tested and qualified the developed methodology and measurement system for estimating the RNT and the longitudinal stress in the rail.

High-Level Tasks:

1. System assembly, field deployment, and validation
2. In-track testing in various track and operating conditions
3. Process optimization and system demonstration



RAILROAD IMPACT

- Improve safety through early detection of potential rail failure and 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, Columbia
- Correlated Solutions Inc.
- CSX Transportation

COST & SCHEDULE

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

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Enhanced Acoustic Birefringence Method for Measuring Longitudinal Rail Stress

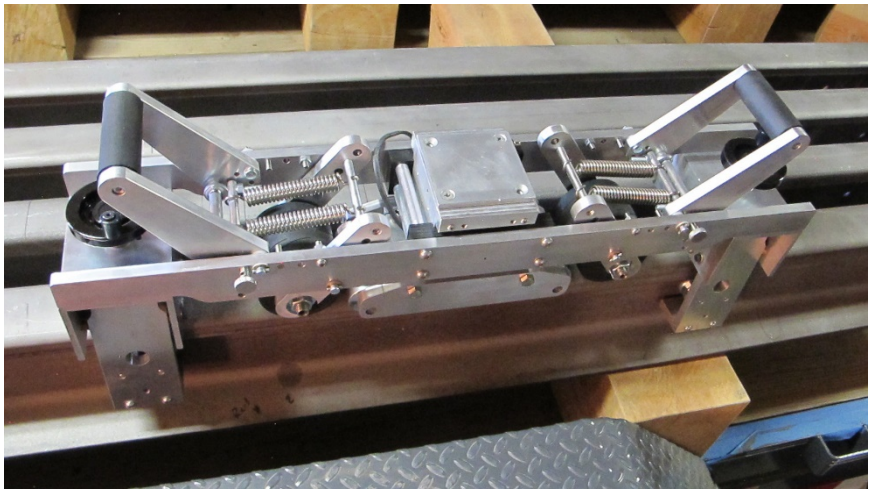
PROJECT DESCRIPTION

Develop a portable device for determining RNT within 5°F using acoustic birefringence (AB) to measure the rail stress.

- Initial test at TTC to verify linear relationship between AB and rail stress for in-situ rail. (Completed; linear relationship was confirmed between AB and TTC strain gauge readings.)
- Develop prototype portable instrumentation and sensor for extended field testing and validation. (In progress: The rolling transducer and rail alignment guide for testing loose and in-situ rail has been completed. Development of the field instrumentation has commenced.)
- Test additional rails to determine if families of calibration constants can be applied to related rail types (e.g., by profile, year, batch, etc.) to allow RNT measurements on any rail without needing a prior stress-free reference measurement.
- Determine final RNT measurement accuracy of prototype portable device at TTC in blind test/demonstration.

RAILROAD IMPACT

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



PROJECT PARTNERS

- Analogic Engineering, Inc.
- Dr. Robert Erikson, University of Wyoming College of Engineering and Applied Science
- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: $370,245
- Project Duration: September 2019 – December 2022

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

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

PROJECT DESCRIPTION

Overview:

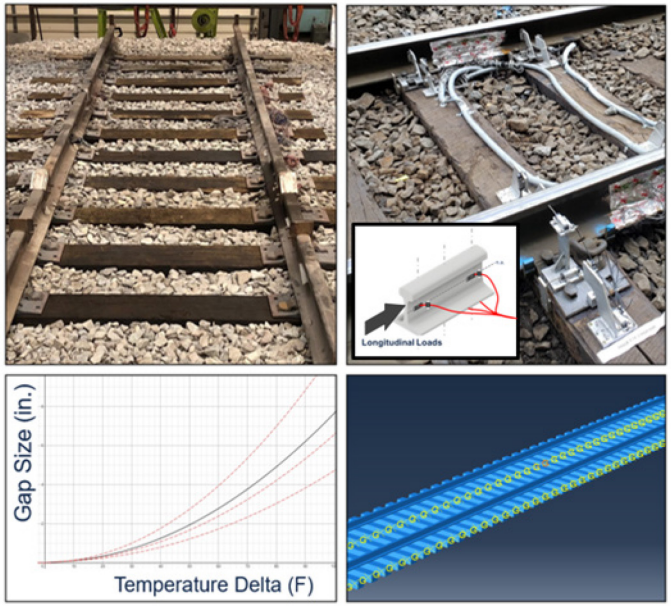
- Provide quantitative assessment of variables influencing axial stress influence zones and guide future rail stress adjustment practices.

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 for this project.
- Field Experimentation: Determine revenue service stress state to augment existing research; to be conducted on industry partner railroads.

Phase 1

Phases 2 & 3



RAILROAD IMPACT

- Improved rail integrity and maintenance guidance for unclipping rail during rail destressing
- Improved understanding of long. rail stress transfer and its influence on changes in rail neutral temperature 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 Railway, and Union Pacific Railroad
- Kandrew, Inc. Consulting Services

COST & SCHEDULE

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

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Design of Rail Neutral Temperature Test Facility

PROJECT DESCRIPTION

- Design a permanent test facility for researching new technologies for non-destructive testing of RNT.
- Plan for installation at the Transportation Technology Center.
- Can test new technologies for track and measurement devices.
- Able to control test conditions and provide full instrumentation.
- Take advantage of standard operations of railroad traffic for loading cases.

RAILROAD IMPACT

- Prevention of RNT/longitudinal stress issues in rail remains a problem that needs effective and cost-efficient non-destructive technologies.
- Additions to the knowledge base of behavior for longitudinal stresses can improve preventative measures to reduce or eliminate rail failures.
- Able to bring new measurement technologies to full development faster.
- Able to test new track technologies for prevention of track buckling and rail breaks.

PROJECT PARTNERS

- Purdue University
- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: $173,665
- Project Duration: September 2020 – September 2022

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Advancement in Longitudinal Rail Force Technologies and Management

PROJECT DESCRIPTION

- **RNT Workshop:**
  - Develop a workshop to document the best RNT management practices from industry and FRA.
  - Workshop to develop more buckling-resistant track.
- **Monitoring RNT and Curve Movement under Heavy Axle Loads**
- **Onsite Testing Support for Universities, Small Businesses and Others at Transportation Technology Center**
- **Track Stability Test Facility Design Support:**
  - This task will support design (by others) of a facility to test RNT and track buckling in operating track. The potential exists for installation of a track segment that has independent rail force loading capability while still being associated with an operating track, such as the High Tonnage Loop at the TTC.
- **Rail Adjustment and Longitudinal Restraint Studies**
- **Curve Monitoring Technology Evaluation**

RAILROAD IMPACT

- Workshop panel to advise, coordinate, and focus industry and FRA RNT research and goals.
- Measure rail movement and RNT changes simultaneously in a curve and tangent track at the FAST facility.
- Design a facility for RNT and track stability testing in operating track.
- Design considerations on longitudinal rail restraint during rail adjustment.

PROJECT PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: $449,629
- Project Duration: September 2020 – September 2022

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Near-Real-Time Processing of Targeted Ground Penetrating Radar (GPR) Data for Ballast Condition

PROJECT DESCRIPTION

- Support introduction of new track inspection approaches and advancement of existing track inspection technologies with a focus on data interpretation and analysis.
- The system utilizes an autonomous GPR system to model the fouling depth layer and map trackbed layers for a fixed length of track either side of a trigger event location.
- Trigger events include track geometry exceptions generated by the DOTX-220 track geometry system, manually generated triggers during a run, and pre-defined trigger waypoints (uploaded to the system via a CSV file).
- Exception reports are automatically uploaded to a portal with email alerts sent to responsible persons.

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 and maintenance practices.

PROJECT PARTNERS

- Balfour Beatty Infrastructure U.S., Inc.
- Zetica Rail

COST & SCHEDULE

- Funding: $409,960
- Project Duration: September 2020 – September 2022

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGERS: Hugh B. Thompson II • (202) 493-6383 • hugh.thompson@dot.gov
James Payne • (202) 493-6005 • james.payne@dot.gov

Support for Testing with FRA Inspection Fleet

PROJECT DESCRIPTION

- FRA owns several inspection vehicles which are used to assure and improve the safety of the rail transportation system under the Automated Track Inspection Program.
- The FRA Office of Research, Development, and Technology uses the DOTX-218/DOTX-220 consist for the development and demonstration 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 systems installed on the DOTX 218/DOTX 220 consist, including a 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 US, Inc.
- Zetica Rail
- Harsco Corp.

COST & SCHEDULE

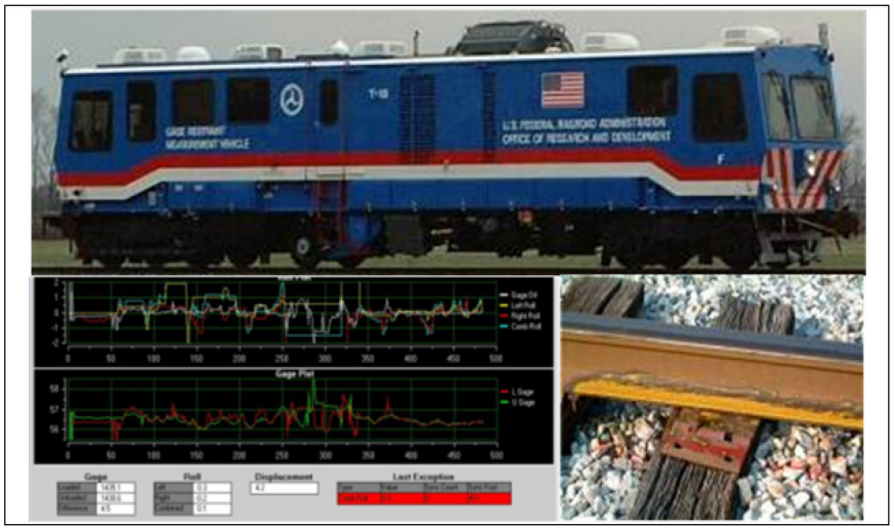
- Funding: $714,848
- Project Duration: August 2018 – July 2022

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

Innovative Track Inspection Technologies

PROJECT DESCRIPTION

- Support for the introduction of new track inspection approaches and advancement of existing track inspection technologies with focus on data interpretation and analysis.
- Research into 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 (GRMS), Ground Penetrating Radar (GPR), 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

COST & SCHEDULE

- Funding: $786,988
- Project Duration: August 2018 – July 2022

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

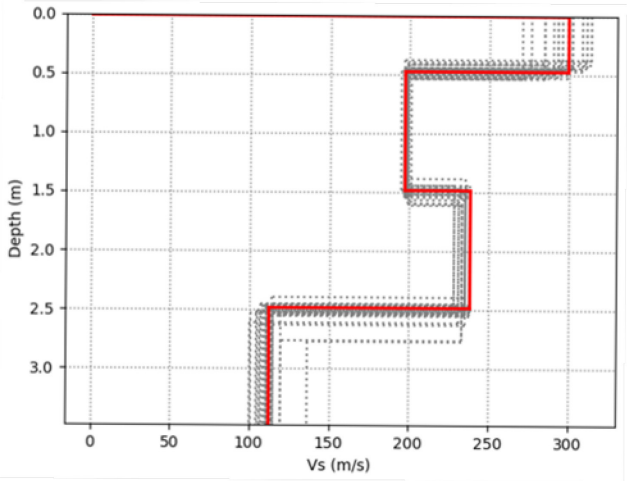
Seismic Ballast Inspection Tool (SeiBIT)

PROJECT DESCRIPTION

- Develop a portable, automated seismic instrument to non-invasively determine the strength of ballast and sub-grade materials (i.e., SeiBIT – the **Sei**smic **B**allast **I**nspection **T**ool).
- Design an easy-to-use wireless system with automated software that uses the well-known MASW method (i.e., multi-channel analysis of surface waves).
- Construct and provide three systems for field testing by research partners.

RAILROAD IMPACT

- Provides real-time stiffness measurement in the field without needing highly trained personnel to conduct surveys or interpret the results



PROJECT PARTNERS

- Earth Science Systems, LLC
- BNSF Railway
- University of Massachusetts at Amherst
- Volpe National Transportation Systems Center
- University of Illinois at Urbana-Champaign

COST & SCHEDULE

- FRA Funding: $299,978
- Project Duration: November 2020 – May 2022

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

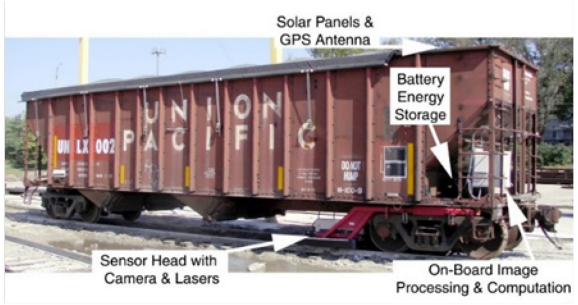
Vertical Track Deflection Measurement System – Continued Soft Track Risk Applications and General Development

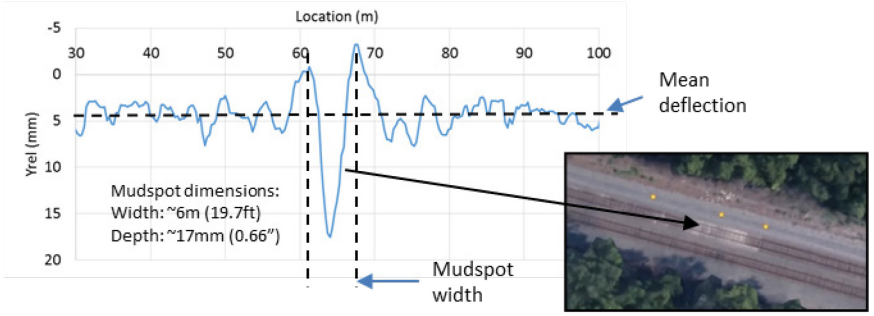
PROJECT DESCRIPTION

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

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 PARTNER

- Harsco Rail

COST & SCHEDULE

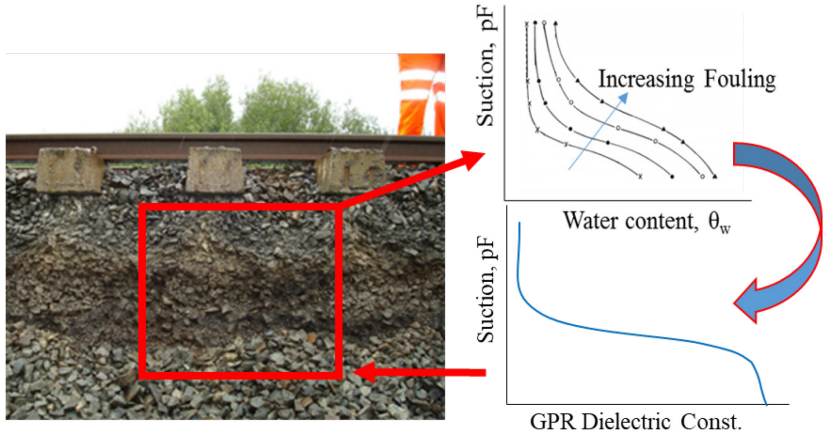
- Funding: $150,000
- Project Duration: September 2021 – September 2022

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

Fouled Ballast Suction Characteristics to Improve GPR Inspections

PROJECT DESCRIPTION

- The type and degree of fouling will affect switch circuit controllers (SWCCs), permittivity, and strength, but the ability of permittivity to detect the important changes in fouling material characteristics is currently unknown. Therefore, project partners will:
  - Measure SWCCs and complex dielectric permittivity for different ballast with increasing degrees of fouling.
  - Measure the strength of these fouled ballast materials as a function of water content, density, and degree of fouling.
  - Identify and validate relationships between track conditions and complex dielectric permittivity.



RAILROAD IMPACT

- Improved understanding of unsaturated and electromagnetic characteristics of fouled ballast, including the role of different fouling materials, water content, density, and shear strength
- Improved understanding of the GPR response of fouled ballast during field measurements
- Increased safety and efficiency for rail industry
- Improved nondestructive detection of fouled ballast using technology deployed by the rail industry.

PROJECT PARTNERS

- BNSF Railway
- University of Arkansas

COST & SCHEDULE

- Funding: $154,665
  - Obtain and prepare BNSF ballast samples ($1,475).
  - Measure suction water characteristic curves and complex permittivity of fouled ballast ($62,282).
  - Measure fouled ballast strength of target samples based on measurable complex permittivity changes ($66,128).
  - Identify quantifiable conditions using complex dielectric permittivity and validate findings ($24,780).
- Project Duration: September 2020 – January 2022

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

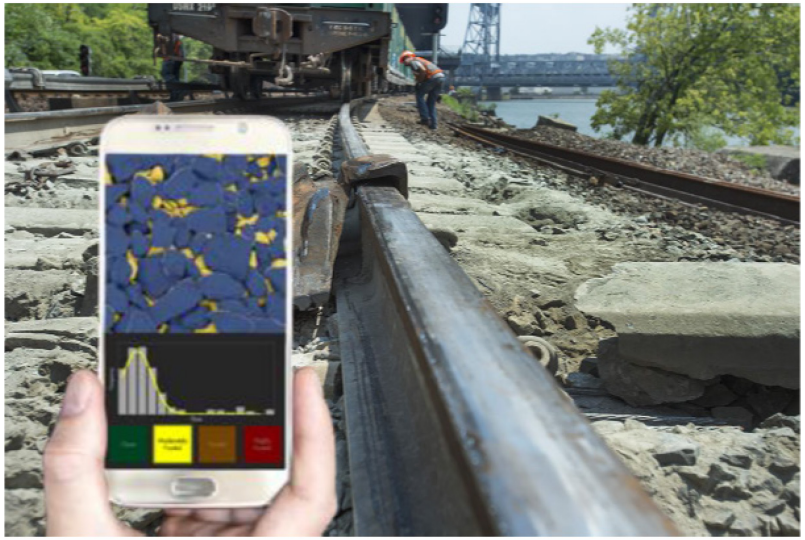
Crushed Aggregate Gradation Evaluation System

PROJECT DESCRIPTION

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

RAILROAD IMPACT

- Development of an objective system for both 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.



PROJECT PARTNER

- Oceanit

COST & SCHEDULE

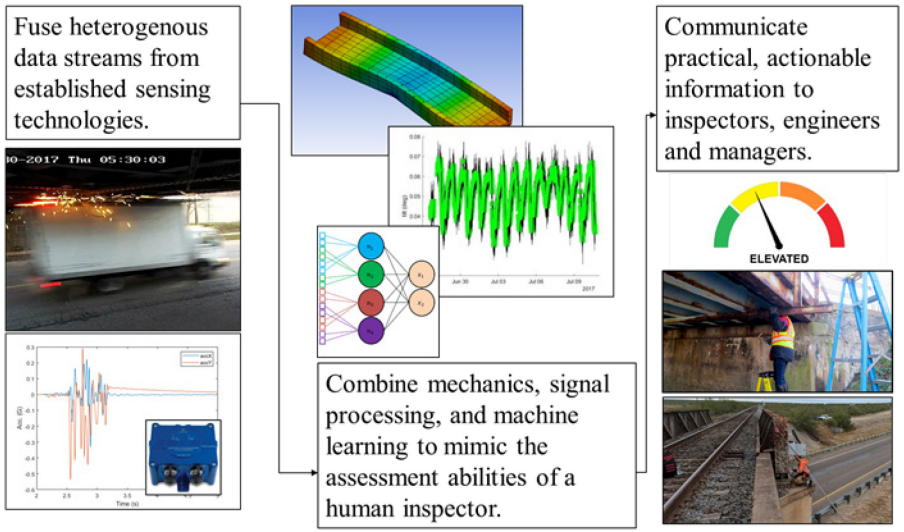
- Funding: $300,000
- Project Duration: July 2021 – June 2023

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

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, promotes safe service operation on and around a bridge, and improves bridge managers' decision-making.

PROJECT PARTNERS

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

COST & SCHEDULE

- Project Duration: May 2020 – May 2023

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

Relationship of Inspection Methods to Ballast Degradation Modes

PROJECT DESCRIPTION

- Update existing mechanics-based track degradation models so the model inputs align outputs with inspection technologies either currently used or currently in development.
- Perform detailed testing with inputs from both track-based and wayside equipment to determine the reliability of track degradation models and compare mechanics-based approaches with advanced statistical approaches – such as machine learning.
- Improve understanding how lateral track strength is related to track variables such as ballast density, ballast fine levels, track modulus, ballast condition, and shoulder width.

RAILROAD IMPACT

- Knowledge of future track geometry degradation identifies more at-risk track sections and improves overall track safety and reliability.
- Aligning model inputs with track-based inspection technologies ensures track degradation models can be implemented on a large-scale basis.
- Understanding of lateral track strength and its predictive variables reduces the risk of lateral misalignment and track buckles.

PROJECT PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

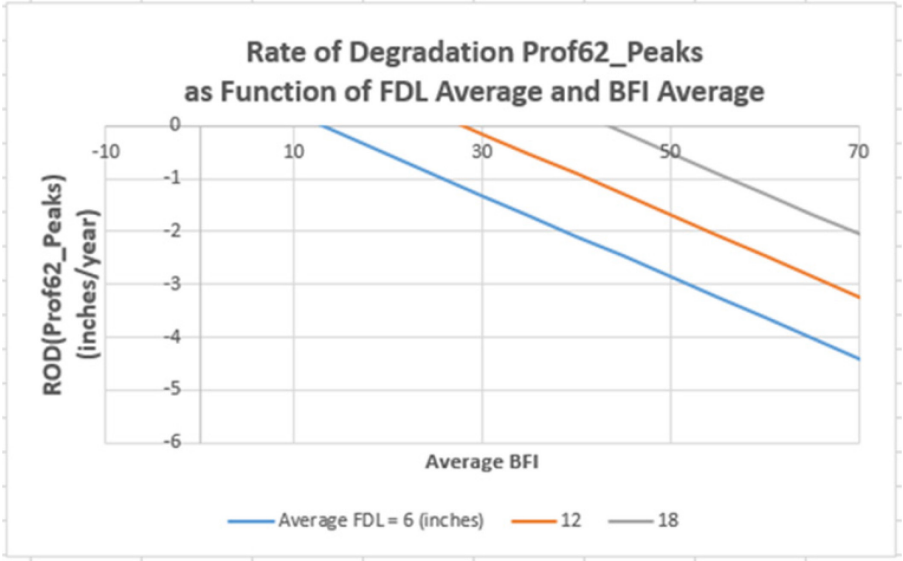
- Funding: $333,886
- Project Duration: September 2020 – September 2022
  - Track geometry deterioration testing at FAST and at two revenue service locations is planned for fall 2021 and spring 2022.

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

Relationship Between Track Geometry Defects and Measured Track Subsurface Conditions: Phase II

PROJECT DESCRIPTION

- Follow-up to Phase I, which developed relationships between ground penetrating radar (GPR) inspection parameters and profile track geometry defects.
- Phase I used Amtrak data; Phase II extended to Class I freight data (BNSF).
- Specific focus on the extending previously developed relationship between ballast condition as defined by GPR and development of track geometry defects to full set of geometry defects over a range of conditions.
  - Six BNSF sites to include fouled and clean locations.
- Develop broad set of algorithms to identify track locations with potential for development of track geometry defects that will grow to unsafe levels.



RAILROAD IMPACT

- GPR is being used on an increasing basis by railroads to identify ballast condition.
  - Key GPR parameters include ballast fouling index and ballast layer thickness.
- The ability to use GPR and geometry car inspection data to identify high rate of defect development sites would be a valuable tool for railroads.
  - Provide information on where high-risk track geometry could develop.

PROJECT PARTNER

- University of Delaware, Railroad Engineering and Safety Program

COST & SCHEDULE

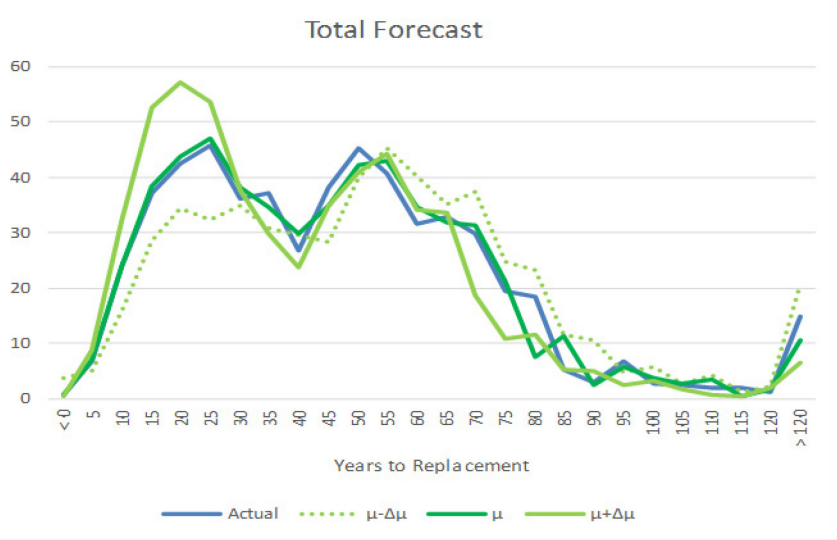
- Funding: $303,879
- Task 1-2-3 Report submitted November 2020
- Final report expected December 2021

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

Development of a Multi-Dimensional, Time-Based 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 artificial intelligence model to determine growth rate probabilities and projected time to defect development.
- Develop artificial intelligence 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 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.
- Reduce severe geometry defects and associated derailments.

PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $238,551
- Project Duration: September 2020 – August 2022

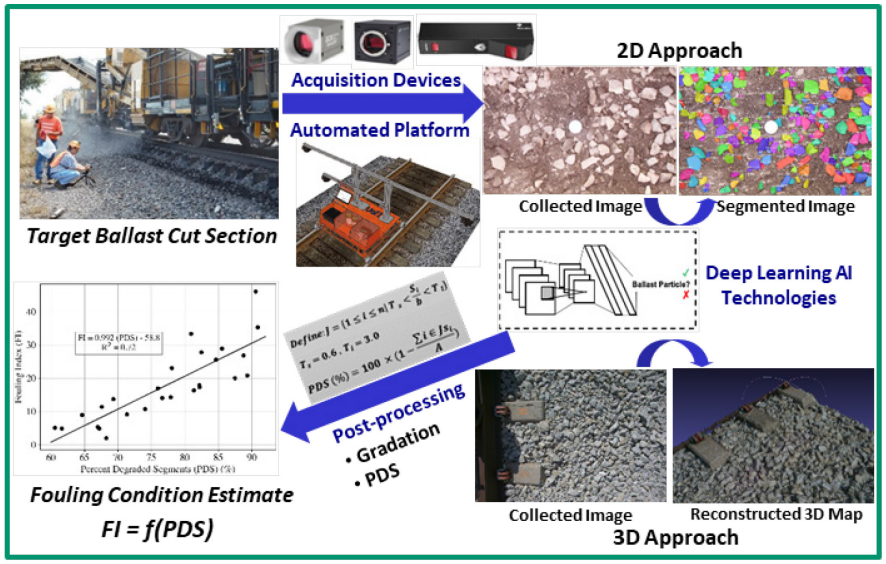
U.S. Department of Transportation
Federal Railroad Administration

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 platform.
- Portable and efficient tool to acquire consistent images and scans from longitudinal rail shoulder cross sections.
- Nondestructive automated evaluation approach, capable of performing inspection continuously along the track.
- Percent degraded segments extracted from images linked to Selig's Fouling Index.



RAILROAD IMPACT

- Real-time (or near-real-time) detection and/or prediction of track-related defects using innovative AI technologies (user independent).
- System provides automated, consistent and objective imaging-based evaluation of ballast condition.
- Inspection results can be paired with other automated ground penetrating radar and track settlement data to establish correlations and provide ground truth.
- Improve rail network safety and reliability.

PROJECT PARTNERS

- Loram Maintenance of Way, Inc.
- BNSF Railway
- Canadian National Railway
- Amtrak

COST & SCHEDULE

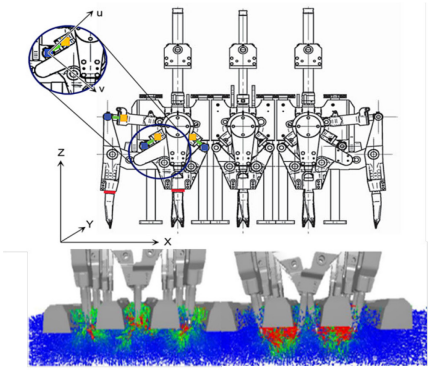
- Funding: $398,694
- Project Duration: September 2020 – June 2022

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

- Study the impact of tamping on rail safety at the ballast particle level by using SmartRocks, together with Plasser American's latest Smart Tamping Tool. The results of this research are expected to greatly improve rail safety by optimizing tamping strategies based on existing ballast conditions.



RAILROAD IMPACT

A sensor data and DEM fusion-driven tamping strategy to improve rail safety in terms of:

- Better compacted ballast during tamping
- Less damage to the ballast particles, therefore slower ballast degradation
- Better ballast stability after tamping (i.e., stretched tamping intervals)

PROJECT PARTNERS

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

COST & SCHEDULE

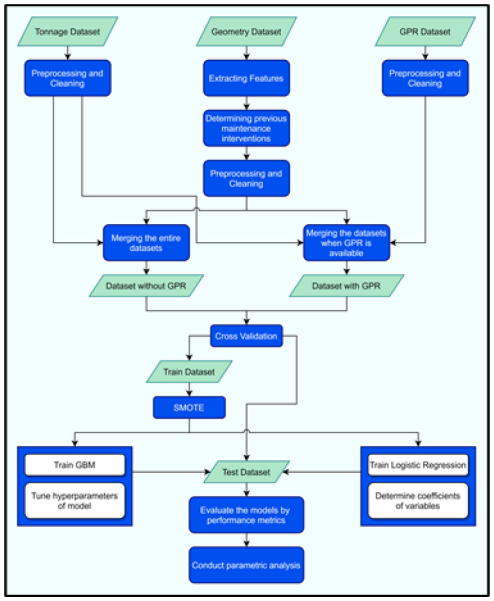
- Funding: $349,538
- Project Duration: April 2021 – April 2023

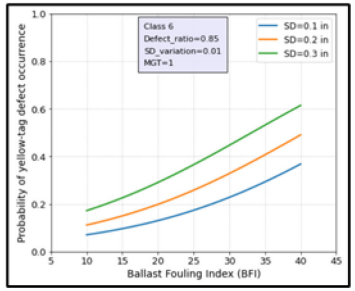
FRA PROJECT MANAGER: Hugh B. Thompson II • (202) 493-6383 • hugh.thompson@dot.gov

Probabilistic Approach to Evaluate Ballast Life Using Large Datasets

PROJECT DESCRIPTION

- Develop a probabilistic methodology based on the large datasets collected by the railroads.
- Assess the availability of data collected from regular geometry car measurements and develop a means to use both the large historical data and the most recent data to produce an assessment of the need to conduct remedial measures (maintenance, repair, replacement).
- Identify section of track on which to apply the proposed methodology. This will require the development of a means to automatically assign the data and probability distribution parameters to each of the track sections in the GIS-based system – and to conduct the appropriate analysis.
- ***All tasks have been completed.***





RAILROAD IMPACT

- Improve safety, as 33% of all rail accident fatalities are the result of substructure failure.
- Ballast fouling was a contributing factor in recent rail accidents that resulted in oil fires.
- A probabilistic approach considers uncertainty associated with determining maintenance needs of ballasted track.
- Model can predict ballast life, potentially reducing the need for remediation or catching a problematic section of track prior to imminent need to remediate.

PROJECT PARTNERS

- University of Massachusetts
- Loram Maintenance of Way, Inc.

COST & SCHEDULE

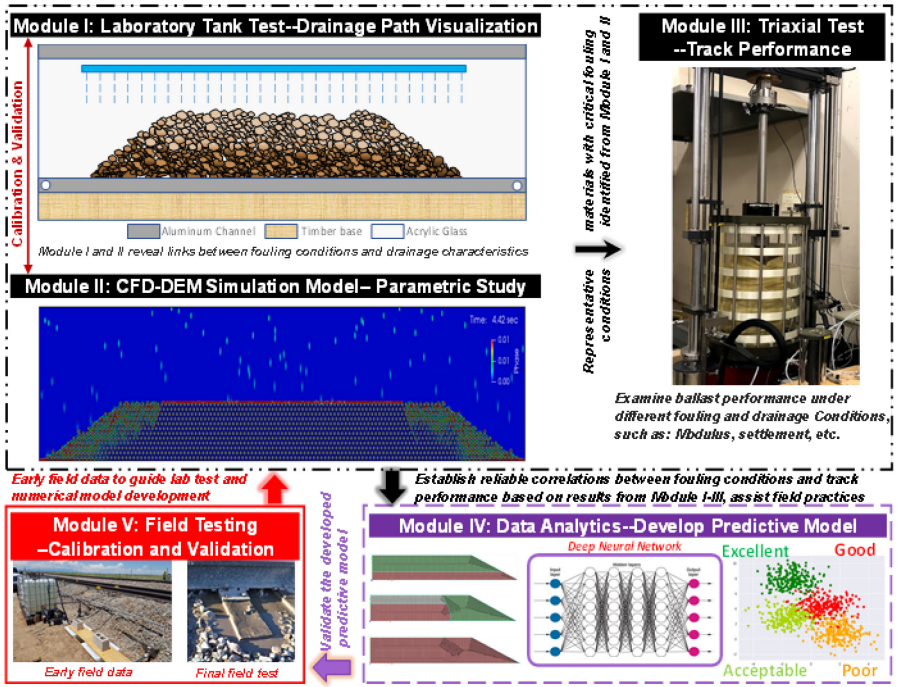
- Funding: $253,925

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 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, and undercutting.
- Develop a practical, predictive model to assist in field track maintenance decision making.



RAILROAD IMPACT

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

COST & SCHEDULE

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

PROJECT PARTNERS

- University of South Carolina
- CSX Transportation
- Transportation Technology Center, Inc.
- BNSF Railway
- Loram Maintenance of Way, Inc.
- Rail Transport Service GmbH
- HNTB Corp.

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

SECTION TWO

ROLLING STOCK

Analysis of Diesel Multiple Unit Fuel Tanks under Dynamic Loads

PROJECT DESCRIPTION

- Develop test method for blunt and raking impact loads.
- Design dynamic test setup for blunt impact.
- Design quasi-static test setup and construct test fixture for raking impact.
- Test diesel multiple unit (DMU) fuel tanks under blunt impact and raking loads.
- Model and analyze fuel tank designs through computer simulation.

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 crashworthiness performance of passenger fuel tank designs
- Evaluation of performance under dynamic loading conditions and recommendations for improved fuel tank protection strategies
- Collaborate with APTA PRESS C&S Fuel Tank Working Group to support standard development/revisions.

PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $230,000
- Project Duration: May 2020 – May 2021

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

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

PROJECT DESCRIPTION

- Validate safety and reliability performance of L-WHRS.
- Quantify L-WHRS ability to generate pollution-free electric power from locomotive exhaust gases.
- Develop and test an energy storage system coupled with the L-WHRS to store recovered.

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 useful energy.
- L-WHRSs represent a “free,” independent source of pollutant-free electric power that can augment locomotive electric power availability.
- Available power can eliminate the need to idle the locomotive engine or require a shore power connection for maintaining a climate-controlled cab.

PROJECT PARTNERS

- ThermaDynamics Rail LLC
- Norfolk Southern Railway

COST & SCHEDULE

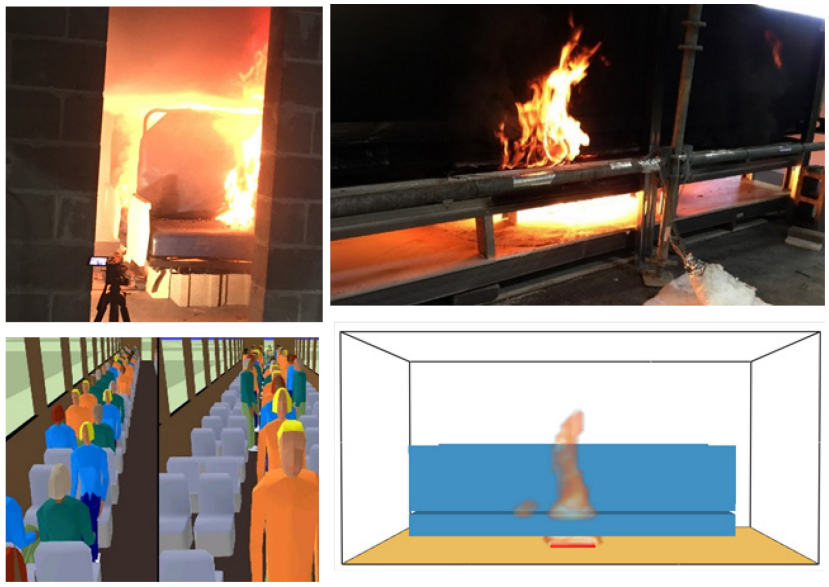
- Funding: $400,000
- Project Duration: October 2018 – December 2021

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 the FRA in reviewing fire hazard analyses submitted by passenger rail operators.
- Review and comparison of U.S. and foreign fire safety requirements for passenger railcar.



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 railcars.
- 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

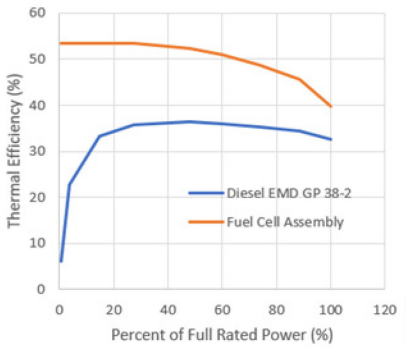
- Funding: $515,000
- Project Duration: September 2019 – August 2024

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

Alternative Fuels Research – Hydrogen and Fuel Cells for Rail Applications

PROJECT DESCRIPTION

- Evaluate the merit of utilizing a hydrogen fuel cell in railroad applications.
- Review and summarize relevant domestic and international codes, standards, and regulations with potential applicability for storing hydrogen on board as a locomotive fuel.
- 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 Model provides a tool to assess the efficiency and emissions of alternative fuels in rail.

PROJECT PARTNER

- Sandia National Laboratories

COST & SCHEDULE

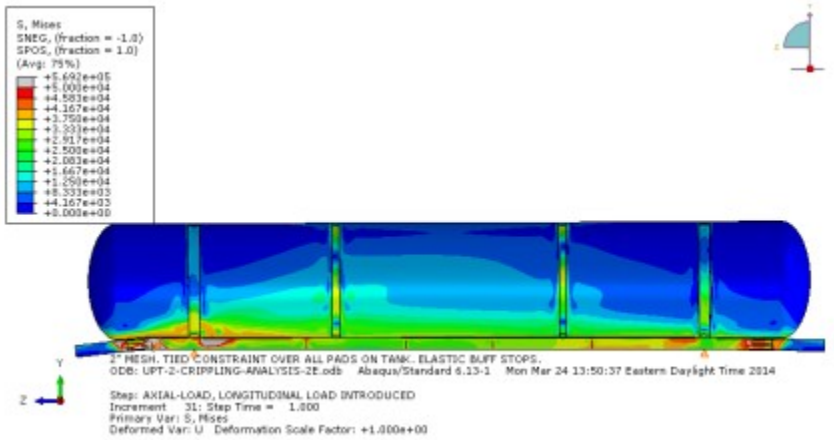
- Funding: $685,000
- Project Duration: August 2020 – December 2025

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

Evaluation of the Safety and Efficiency Alternative Fuel for Locomotives

PROJECT DESCRIPTION

- Develop crashworthiness standards for alternative fuel tender cars (liquefied natural gas [LNG], compressed natural gas, hydrogen, etc.)
- Evaluate structural performance, puncture resistance, and fitting integrity with simplified analyses of natural gas fuel tenders.
- Evaluate safe speeds in accident scenarios.
- Impact testing of M-1004 LNG tender car
- Evaluate the merit of utilizing hydrogen fuel cell in railroad application.
- Assess safety requirements for hydrogen fuel tender cars.



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 railroad industry in development of specifications for next generation of natural gas fuel tender.

PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $1,650,000
- Project Duration: May 2013 – May 2022

U.S. Department of Transportation
Federal Railroad Administration

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

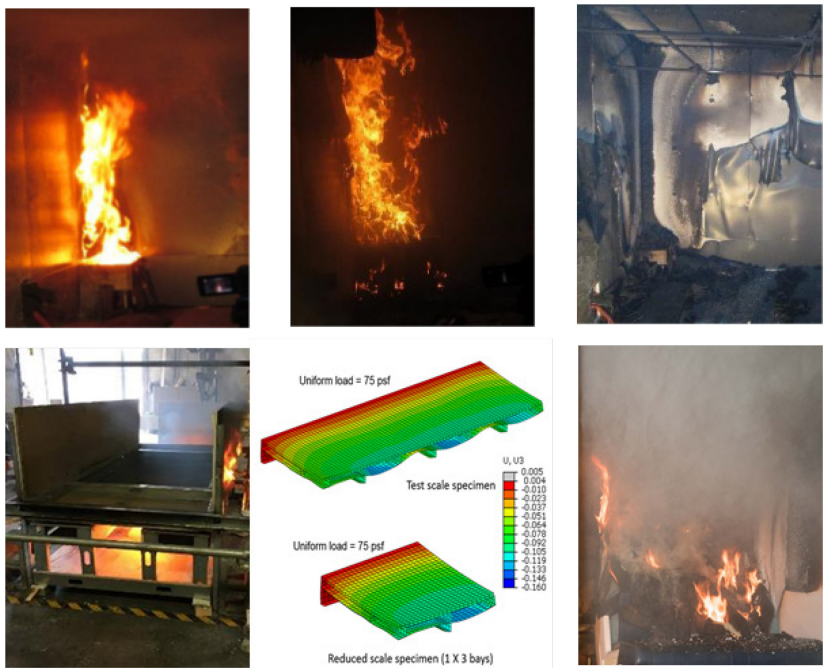
Fire Engineering Research

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

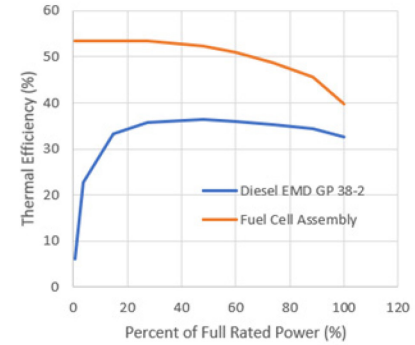
- Funding: $490,000
- Project Duration: September 2021 – September 2022

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

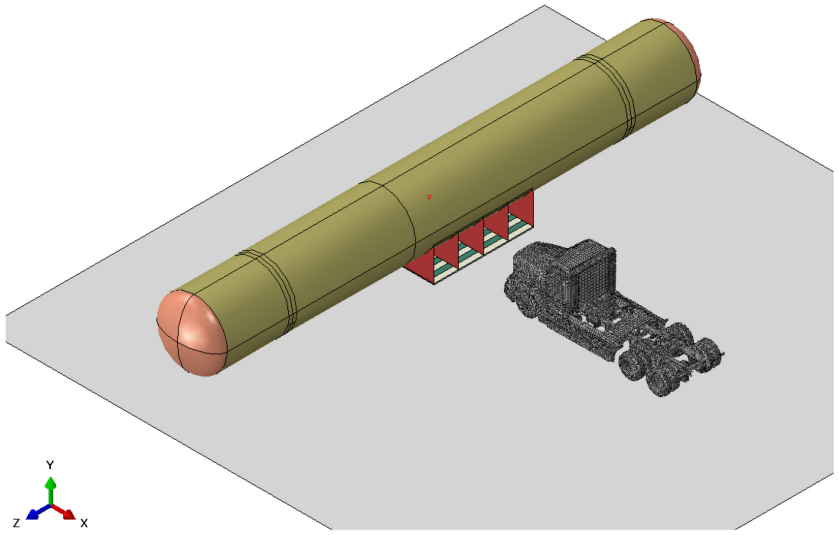
- Funding: $250,000
- Project Duration: August 2020 – December 2022

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, hydrogen, etc.).
- Review and evaluate structural performance, puncture resistance, and fitting integrity of new equipment natural gas fuel tenders.
- Evaluate the merit of utilizing hydrogen fuel cell in railroad application.
- Assess safety requirements for hydrogen fuel tender cars.
- Analyze new LNG tender in grade crossing scenario outlined in draft Association of American Railroads standard, AAR Natural Gas Fuel Tender Specifications, M-1004.



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.
- 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.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Massachusetts Institute of Technology

COST & SCHEDULE

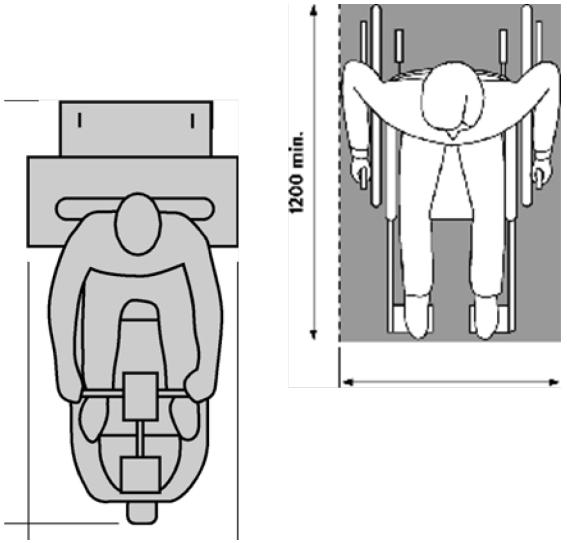
- Funding, FY20: $200,000
- Project Duration: May 2021 – April 2022

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: $280,000
- Project Duration: April 2017 – December 2022

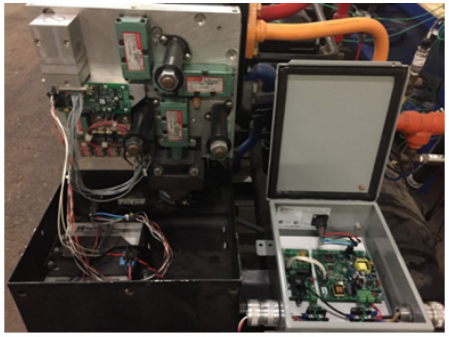
U.S. Department of Transportation
Federal Railroad Administration

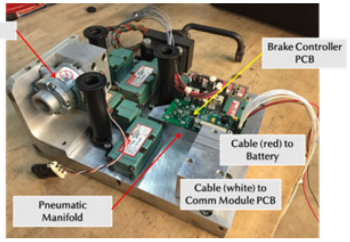
FRA PROJECT MANAGER: Melissa Shurland • (202) 493-1316 • melissa.shurland@dot.gov

Next Generation Brake Technology for Rolling Stock: 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

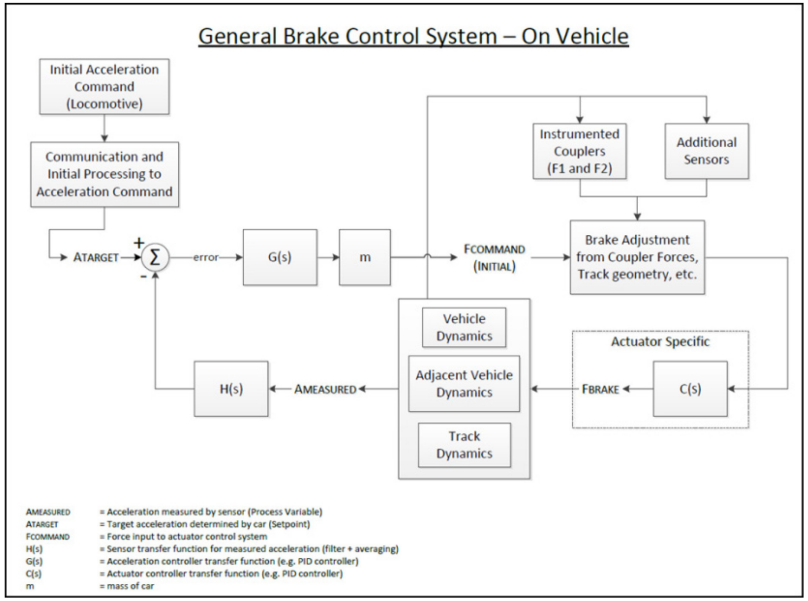
- Funding: $200,000
- Project Duration: September 2020 – August 2022

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

Next Generation Brake Technology for Rolling Stock – Electric Train Brake Concept (ETBC)

PROJECT DESCRIPTION

- FRA has conceptualized a new brake system that proposes electric actuators and a modern control system to offer improved train dynamic performance and constant/steady deceleration.
- Current effort is focused on investigating the feasibility of the new ETBC, including the identification of technology for the development of the concept, covering:
  - Actuator hardware, including power needs
  - Sensor hardware
  - Control and communications architecture
- Future effort could include prototype demonstrations, laboratory and field testing of a prototype system, economic and safety analysis, etc.



RAILROAD IMPACT

- Provide research platforms to develop, improve, and demonstrate new technologies.
- Make available a train braking system that reacts on each car simultaneously to reduce in-train braking forces.
- Improve railroad safety in braking operations.

PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: $271,261
- Project Duration: August 2019 – May 2021

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

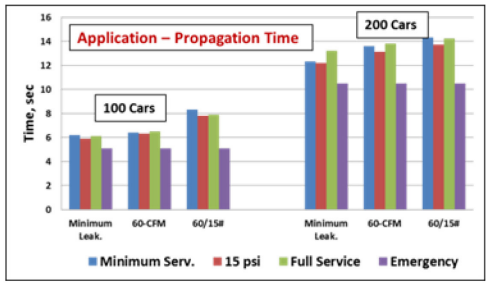
Review of Very Long Train (VLT) Operations

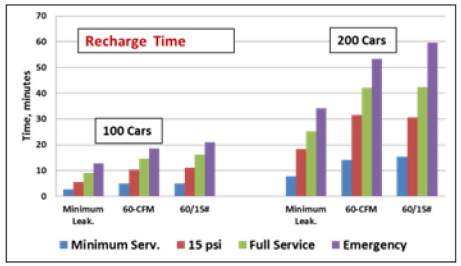
PROJECT DESCRIPTION

There have been notable increases in the length and weight of trains on the North American rail network, with many trains exceeding 200 cars. It was considered 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 II, rack tests have been completed and an interim report has been reviewed by the TRC. Phase III, the standing train test plan, is currently in development.





	Time from brake release (min) / Number of cars released			
False Gradient (psi) →	0	-2	-3	-4
100 Cars - Minimum Leakage	10.5	7.9	6.5	4.3/50
100 Cars - 60-CFM	20.1	11.5	8.3/49	6.5/63
100 Cars - 60-CFM / 15-psi Gradient	23.8	14.0	10.8/48	7.8/50
200 Cars - Minimum Leakage	29.7	20.7	16.0/60	13.7/105
200 Cars - 60-CFM	64.8	37.5	28.5/143	21.5/151
200 Cars - 60-CFM / 15-psi Gradient	71.5	37.7	28.8/148	21.5/151

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)
- Transportation Technology Center, Inc.
- Wabtec Corp.
- New York Air Brake Corp.
- Sharma & Associates, Inc.
- Rail labor unions

COST & SCHEDULE

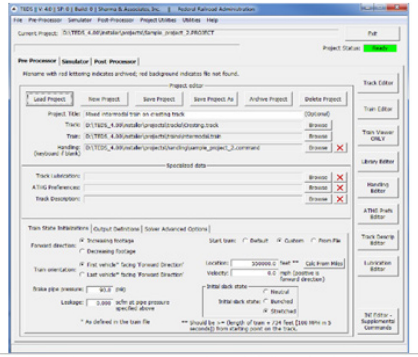
- Funding, FY22: $273,500
- Project Duration: September 2020 – September 2022

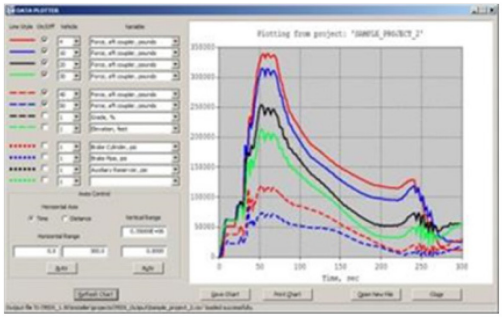
FRA PROJECT MANAGER: Monique Ferguson Stewart • (202) 493-6358 • monique.stewart@dot.gov

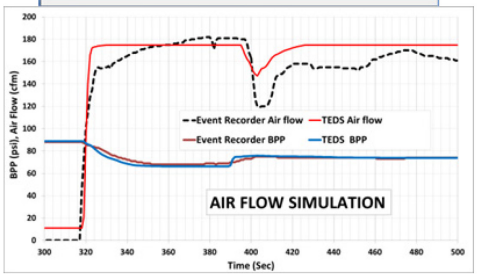
Train Energy and Dynamics Simulator (TEDS)

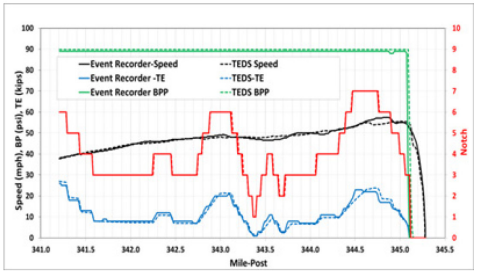
PROJECT DESCRIPTION

- 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 can simulate 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

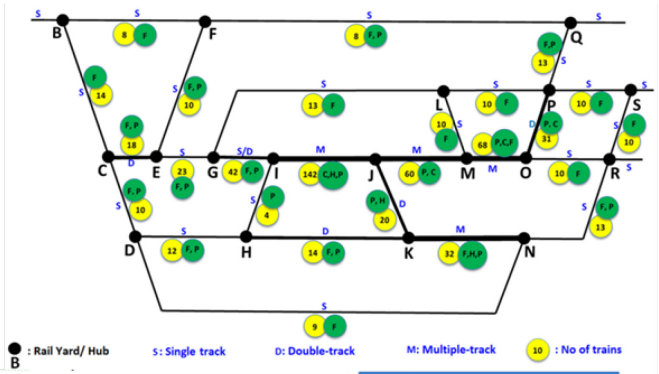
- Funding, FY22: $150,000
- Project Duration: September 2020 – September 2025

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

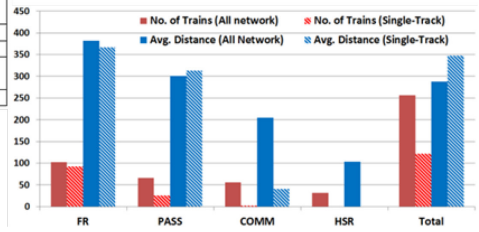
Effects of Technology Implementations on Network Operations

PROJECT DESCRIPTION

- Develop a methodology to quantify network-level benefits for train operations resulting from the implementation of new technologies.
- Use OpenTrack network simulations software for various network operational characteristics:
  - Different types of corridors: Single-track, double-track, and multiple-track corridors
  - Types of traffic: Dedicated vs. shared-use corridors
  - New technology implementation
  - 1800 miles of main tracks have been developed with 216 daily trains operating along different sections of the network – with a variety of signaling and braking characteristics.



Parameter	Value	Note
Length of corridors	4887 miles	Only main tracks
Length of all tracks	6,234 miles	Including 2nd and 3rd tracks, plus sidings and yard tracks
No. of sidings and yards	150	
No. of switches	758	Including crossovers and crossings
No. of signals	1,782	Including signals and transponders along main tracks and yards
Length of horizontal curves	1,162 miles	



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

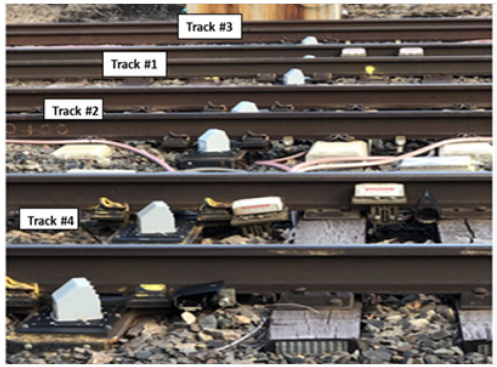
- Funding, FY22: $149,000
- Project Duration: September 2018 – September 2021

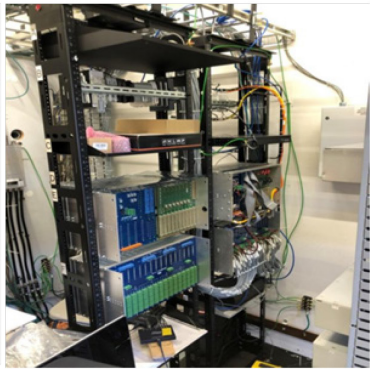
FRA PROJECT MANAGER: Monique Ferguson Stewart • (202) 493-6358 • monique.stewart@dot.gov

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 – September 2021

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

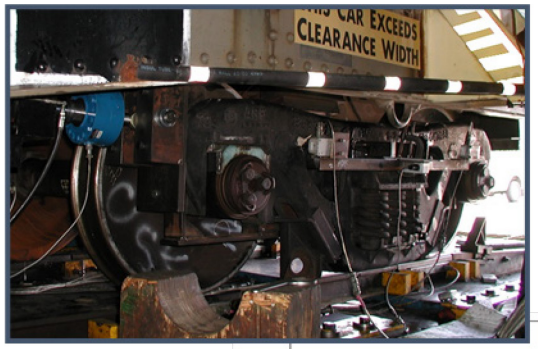
- Funding, FY19–23: $371,000
- Project Duration: September 2019 – June 2023

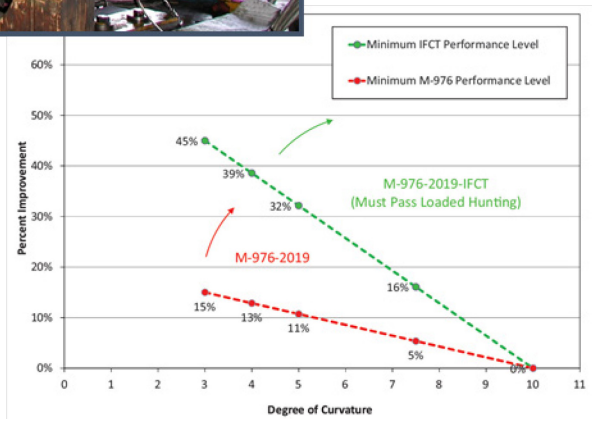
FRA PROJECT MANAGER: Monique Ferguson Stewart • (202) 493-6358 • monique.stewart@dot.gov

Improved Freight Car Truck Performance and Safety

PROJECT DESCRIPTION

- Phase I:
  - Task 1 – Perform a literature search to identify relevant truck performance information already in the public domain.
  - Task 2 – Use vehicle dynamics modeling to identify improvements, especially stiffness characteristics, required to achieve improved hunting and curving performance in three-piece trucks.
- Phase II:
  - Task 1 – Use modeling results and on-track testing to identify the load environment of components designed to improve truck performance.
  - Task 2 – Suggest methodologies to eliminate or mitigate the risks of fatigue failures.
- Phase III:
  - Perform lab/on-track fatigue testing to demonstrate the feasibility of improved performance truck.





RAILROAD IMPACT

- A typical, current, freight car truck wedge design provides adequate warp restraint in the empty car and quasi-static loaded car condition, but sometimes falls short in dynamic loaded car conditions like loaded hunting.
- An improved freight car truck using methods, such as warp restraint, will improve high-speed stability (hunting stability) and curving performance.
- Improved freight car trucks can help reduce component fatigue failures that can result in safety issues, such as dragging or loose equipment.
- Improved truck performance can also help address other issues, such as centerplate liner damage and wheel-rail wear.

PROJECT PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding, FY20, Phase I: $240,360
- Project Duration: September 2020 – September 2022

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

Technologies and Testing to Prevent Water Ingress to Railroad Bearings

PROJECT DESCRIPTION

- Research into the water tightness of railway bearings will test the ability of the current baseline bearing rubbing lip seals versus frictionless seals to prevent water ingress over the service life of the bearing.
- This project will also determine if water ingress will occur in the revenue service bearing seals through environmental fluctuations.
- Finally, recommendations will be made to correctly identify fretting corrosion, as differentiated from water damage, and mitigate it in revenue service.

RAILROAD IMPACT

- The primary objective of this research is to improve safety and reduce accidents from bearing defects by researching methods of water ingress causing bearing degradation and recommending solutions to prevent water ingress.

PROJECT PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: $400,000
- Project Duration: September 2018 – April 2022

U.S. Department of Transportation
Federal Railroad Administration

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

Diagnosis and Detection of Bearing Grease Degradation and Defects

PROJECT DESCRIPTION

- The bearing grease research project will investigate the properties of grease degradation related to bearing defects across all bearing and grease types over the life cycle of in-service bearings.
- This research will also determine the best location in the bearing to sample bearing grease, as determined by the worst grease condition.
- Finally, this research will also demonstrate if it is possible to identify the grease metrics associated with bearing failure modes based on grease sampling and state-of-the-art statistical methods.

RAILROAD IMPACT

- Improve safety by investigating the properties of bearings at the end of service life, focusing on defect-related lubrication degradation.
- Reduce accidents by proposing methods to diagnose bearing defects through grease analysis.

PROJECT PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: $458,000
- Project Duration: September 2018 – April 2022

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

Wheel Failure Research Program

PROJECT DESCRIPTION

- The objective of the effort is, through collaboration with industry, the reduction of wheel failures, including vertical split rims and shattered rims.
- An industry-wide stakeholder working group (SWG) focuses on evaluating current failure modes and characteristics as well as future steps to minimize contributions to failures.
- The SWG develops research strategies, including analysis of historical data, testing failed wheels, and modeling studies to mitigate failures and reduce risks to improve safety.
- Previous phases have focused on identifying issues to be researched and metallurgical testing of failed wheels.
- Phase III focuses on an FEA-based investigation of factors contributing to crack propagation within wheels.

RAILROAD IMPACT

- Increase understanding of current wheel failure mechanisms and facilitate mitigation.
- Reduce derailments causing severe equipment and track damage.
- Reduce public safety risks and costs associated with such incidents.

PROJECT PARTNERS

- ENSCO, Inc.
- Engineering Systems, Inc.
- Association of American Railroads
- Wheel suppliers
- SimuTech Group

COST & SCHEDULE

- Funding, Phase III: $520,000
- Project Duration: September 2020 – January 2022

U.S. Department of Transportation
Federal Railroad Administration

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

Compliance Testing for Locomotive LED Sample Fixtures, Phases III and IV

PROJECT DESCRIPTION

- The railroad industry is beginning to introduce LED lighting for locomotive headlights. In response, this project intended to set test procedures for the evaluation of new locomotive LED headlights and auxiliary lights.
- Light fixture samples that satisfied requirements set forth in Phases I and II LED sample testing were evaluated further.
- The focus of Phase III testing was a subjective evaluation of LED headlamp performance under dynamic field-testing conditions.
- Phase IV environmental testing evaluated the performance of LED headlamps in the presence of freezing rain and ice accumulation.
- All testing has been completed and a summary of findings has been presented to FRA and the Association of American Railroads (AAR).

RAILROAD IMPACT

- Phases III and IV testing will provide the AAR Headlight-Auxiliary Light Standard Technical Advisory Group with a better understanding of the real-world performance of LED headlamps.
- This task is intended to help AAR update locomotive headlight standards and recommended practices.

PROJECT PARTNERS

- AAR Headlight-Auxiliary Light Standard Technical Advisory Group
- ENSCO, Inc.
- Engineering Systems Inc.
- Norfolk Southern Railway and Union Pacific Railroad

COST & SCHEDULE

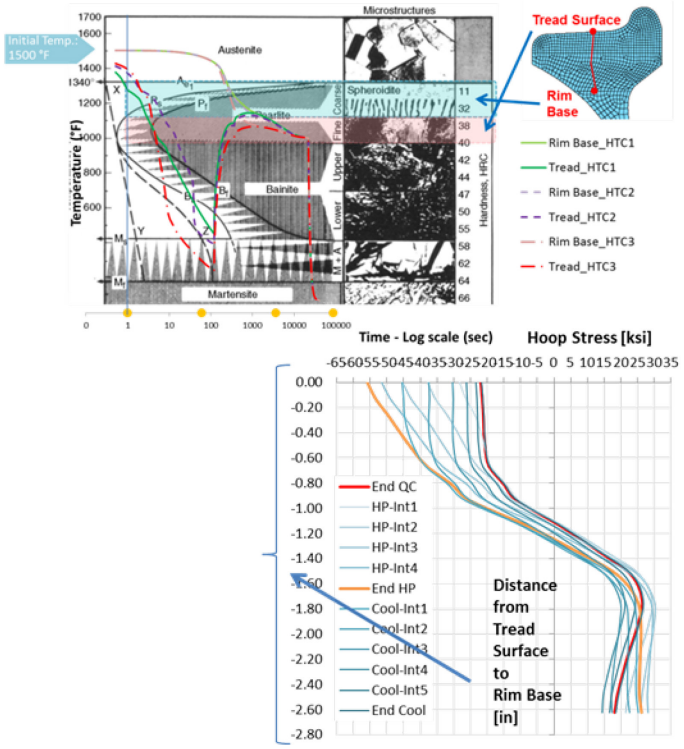
- Funding: $265,000
- Project Duration: July 2019 – July 2020

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

Framework for the Development of Wheel Life Model

PROJECT DESCRIPTION

- Railway vehicles, using steel wheels rolling on steel rails, constitute the most fuel-efficient transportation system for moving large volumes of goods over long distances. Over time, tonnage carried per wheel has increased, thus subjecting the wheel-rail contact area to much higher stresses. These higher stresses exacerbate rolling contact fatigue.
  - Conduct literature review to document damage resistance models of freight wheels, contact stress environment, and residual stress analysis for manufacturing processes to validate against any published data.
  - Identify contact load environment based on field tests and revenue service grouped by degree of curvature.
  - Develop wheel and rail contact model using the boundary element method (CONTACT©) and embed preliminary transient thermal FEA model simulating tread braking.
  - Investigate new shakedown and ratcheting areas for a framework for a wheel life model.



RAILROAD IMPACT

- Improve methodology and analysis for wheel fatigue life evaluation.
- Reduce risk to public attributed to wheel failure by use of reliable analysis tools for predicting failure mechanisms.
- Improve railroad operational safety against wheel failure related derailments.

PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

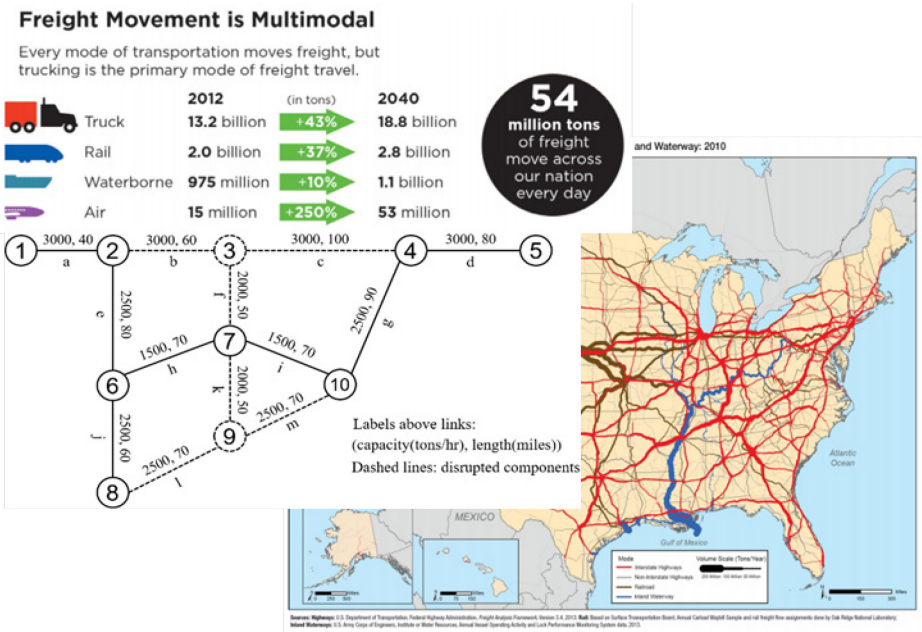
- Funding: $224,804
- Project Duration: September 2018 – March 2020

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

Topology-Based Freight System Resilience Evaluation and Network Improvement

PROJECT DESCRIPTION

- Review the state of practice and relevant literature.
- Analyze the resilience, topology, and effectiveness of freight transportation networks.
- Evaluate and optimize the resilience and other effective measures of the freight transportation system.
- Develop decision support methods for:
  - Scheduling restoration actions to optimize short-term network resilience from a disruption.
  - Choosing and scheduling long-term improvement plans to optimize network resilience under multiple disruption scenarios, using short-term results.
- Demonstrate the proposed methods in a pilot study.



RAILROAD IMPACT

- Optimize routes and resource allocation in response to the disruptions.
- Prioritize restoration of bottleneck nodes and links to improve system effectiveness after disruption.
- Improve system efficiency, resilience, and reliability, subject to resource constraints and uncertain disruptions.
- Optimize phased development plans for interrelated system recovery and improvements.

PROJECT PARTNERS

- University of Maryland
- Western New England University

COST & SCHEDULE

- Funding: $89,000
- Project Duration: June 20 – June 2021

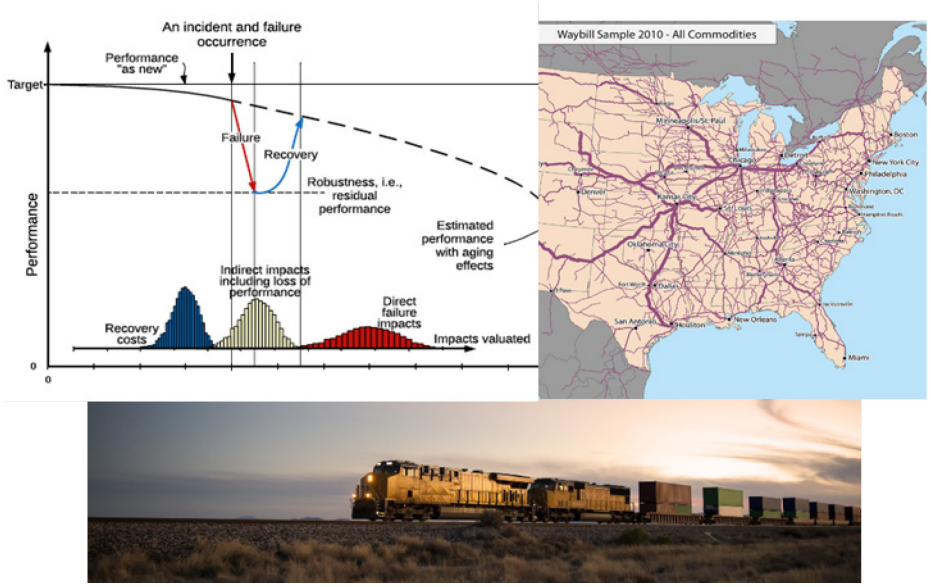
U.S. Department of Transportation
Federal Railroad Administration

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

Framework for the Development of Wheel Life Model

PROJECT DESCRIPTION

- Needs: Shifting freight from roads to rails has many benefits, including enhancing road safety, longevity of road infrastructure, 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 – May 2022

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 numbers 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

Emergency Responders: Extrication Video

PROJECT DESCRIPTION

- There is a gap in trainings that cover rescue operations on locomotives.
- FRA acknowledged this gap and sponsored the previous Locomotive Emergency Response Training (LERT).
- FRA received multiple requests to create a module with a focus on extrication procedures.
- FRA envisions this training program to follow a similar scope as developed in the LERT and the ongoing development of Rail Safety Training Course for Law Enforcement video.
- The primary goal of this program is to bring a clear understanding of rescue and extrication practices of train crews involved in highway-rail grade crossing collisions, derailments, or other railroad emergencies.
- Training will be delivered in video format viewed online.

RAILROAD IMPACT

- Responding crews are not armed with the prerequisite knowledge to help them in rescue operations and in avoiding potential hazards.
- The primary goal of this program is to bring a clear understanding of rescue and extrication practices of train crews involved in highway-rail grade crossing collisions, derailments, or other railroad emergencies – providing responders with unique information.
- The information provided in the video will supplement emergency response training with railroad related information required to help responders perform their duties accurately and efficiently.

PROJECT PARTNER

- KEA Technologies, Inc.

COST & SCHEDULE

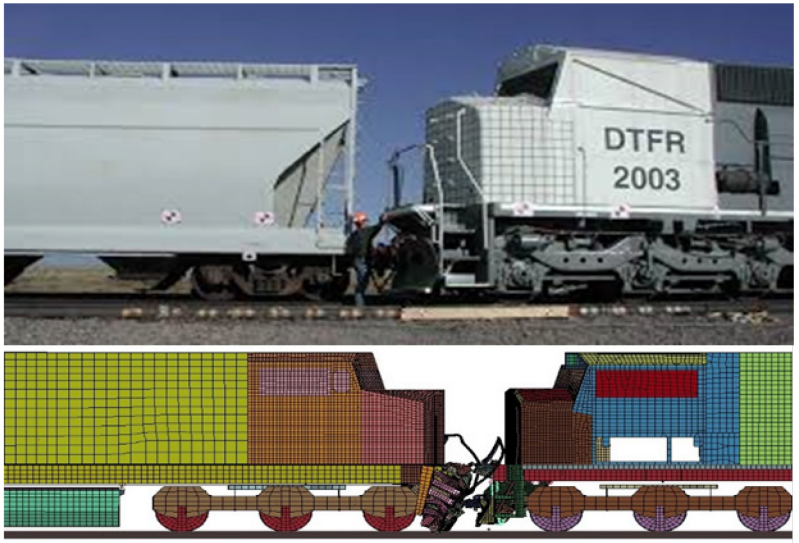
- Funding: $150,000
- Project Duration: December 2018 – May 2020

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 FRA accident database for the identification of modern locomotive 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

- The 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 going forward.

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 III

PROJECT DESCRIPTION

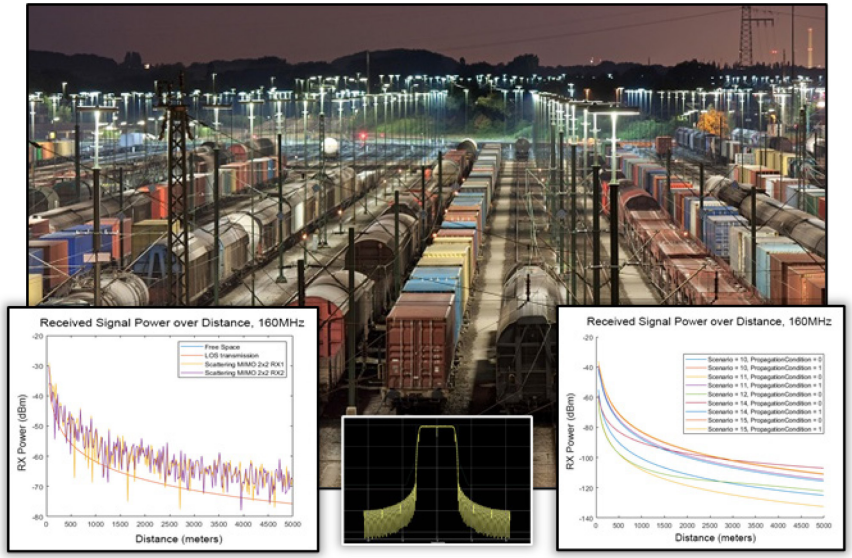
- The RF spectrum is saturated and its resources are congested, causing problems for rail applications in high-density rail traffic areas.
- Research at the University of Nebraska-Lincoln (UNL) indicates that dense urban areas like Chicago have RF spectrum shortages that severely reduce performance of PTC systems and other rail applications.
- However, some RF frequency bands, such as 160 MHz, are underutilized and thus of considerable interest to the rail industry to alleviate the issues of congested RF bands.
- This project is conducting a comprehensive study for RF performance expectations and an RF transceiver design for 160 MHz to overcome current challenges and enable this band for a variety of railroad applications.
- This team is working closely with the Next Generation Equipment Committee, the Association of American Railroads, the American Association of State Highway and Transportation Officials, Amtrak, Union Pacific, BNSF, etc.

PROJECT PARTNER

- UNL Advanced Telecommunications Engineering Laboratory

COST & SCHEDULE

- Funding: $173,000
- Project Duration: July 2020 – March 2022



RAILROAD IMPACT

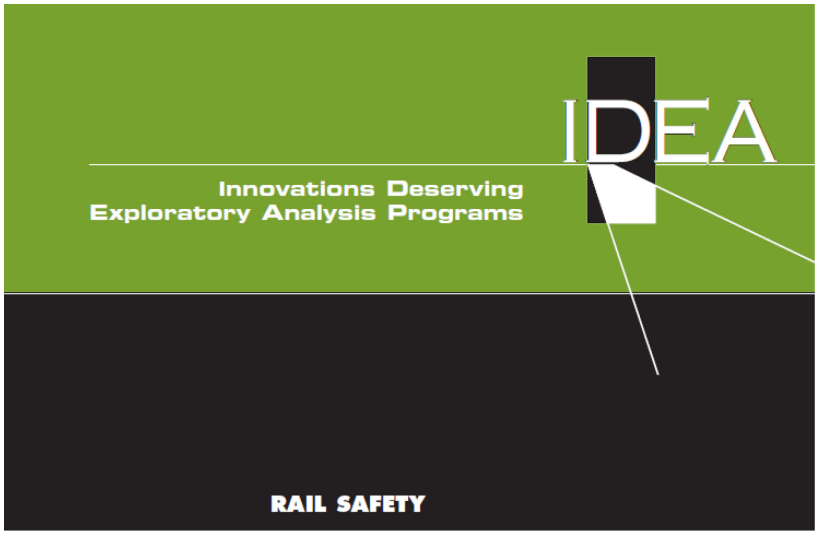
- 160 MHz is underutilized, but licenses are owned across North America. This study evaluates the suitability of this band for unified voice + data applications as well as providing additional operating channels for congested rail traffic areas.
- This study succeeded in maximizing performance of the RF radio design, supporting point-to-point and point-to-multipoint services.
- 160 MHz is suitable for onboard signaling and long-range wayside communications.
- UNL developed computer simulation models and a framework that are available to the rail industry for further evaluation or customization.

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 44, “Laser-Based Non-Destructive Spike Defect Inspection System”
- Rail Safety IDEA 45, “Development of a Fatigue Load for Railway Bridges”
- Rail Safety IDEA 47, “Adaptive Prestressing System for Concrete Crossties”
- Rail Safety IDEA 48, “Autonomous Detection of Compressed Air Leaks on Trains”



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, FY21: $400,000
- Project Duration: June 2021 – December 2024

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

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.

PROJECT PARTNERS

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

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.

COST & SCHEDULE

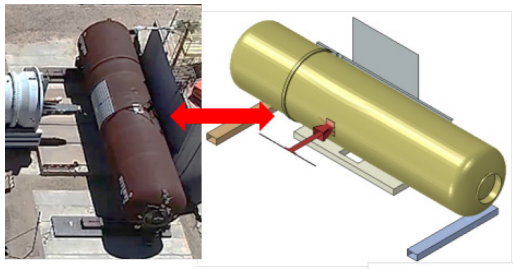
- Funding, FY21: $750,000
- Project Duration: July 2015 – July 2022

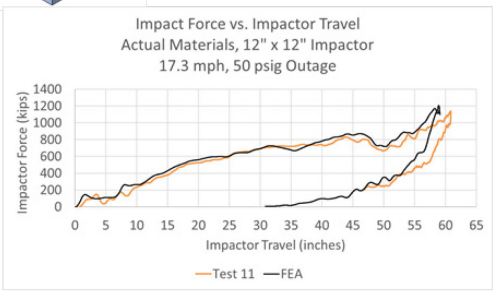
FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

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

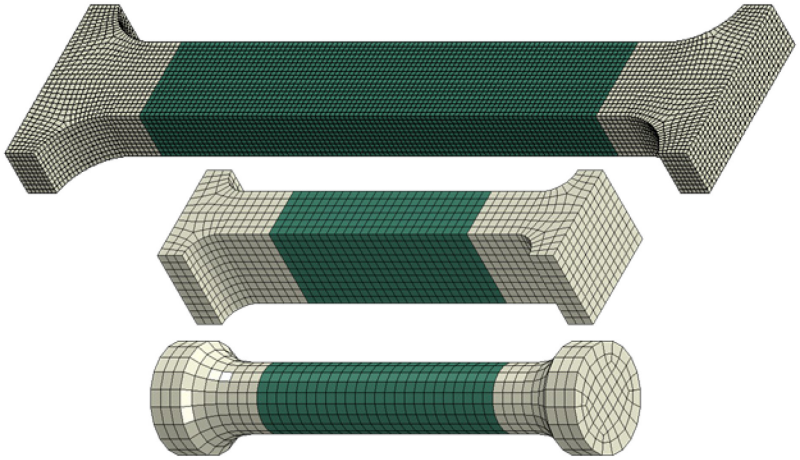
- Funding, FY20: $300,000
- Project Duration: May 2020 – May 2022

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

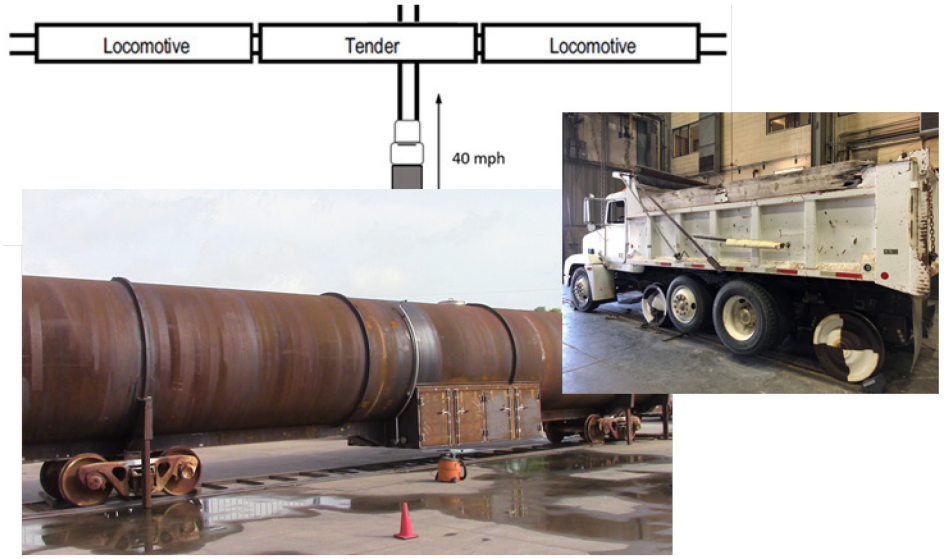
- Funding, FY20: $175,000
- Project Duration: May 2020 – May 2022

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

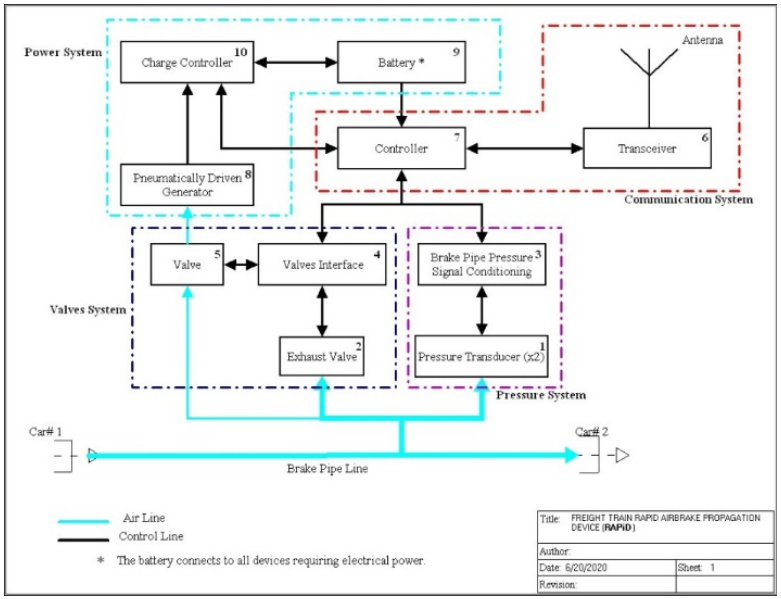
- Funding: $875,000
- Project Duration: August 2018 – September 2022

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

Freight Train Rapid Air Brake 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 2022

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

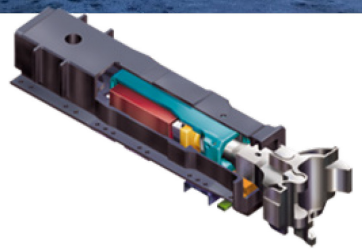
Tank Car Operating Environment

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

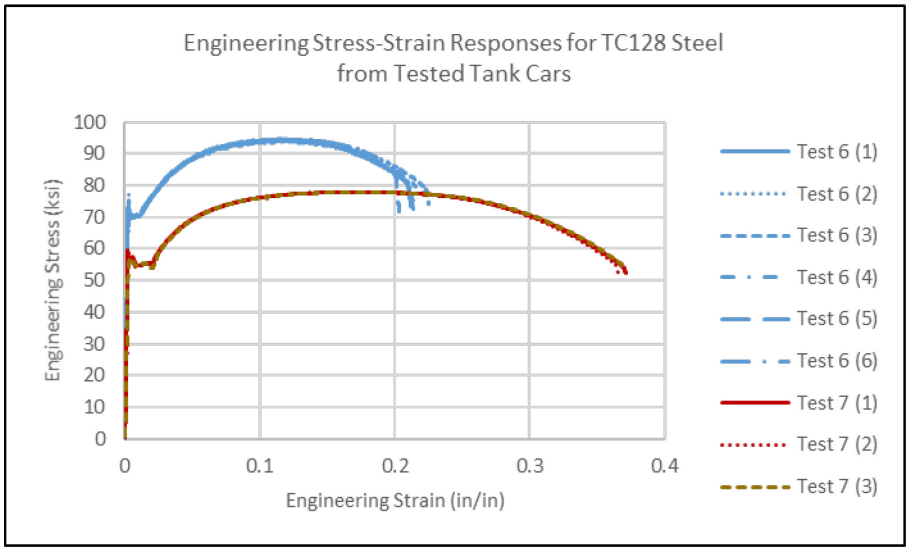
- Funding: $310,000
- Project Duration: September 2018 – September 2022

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

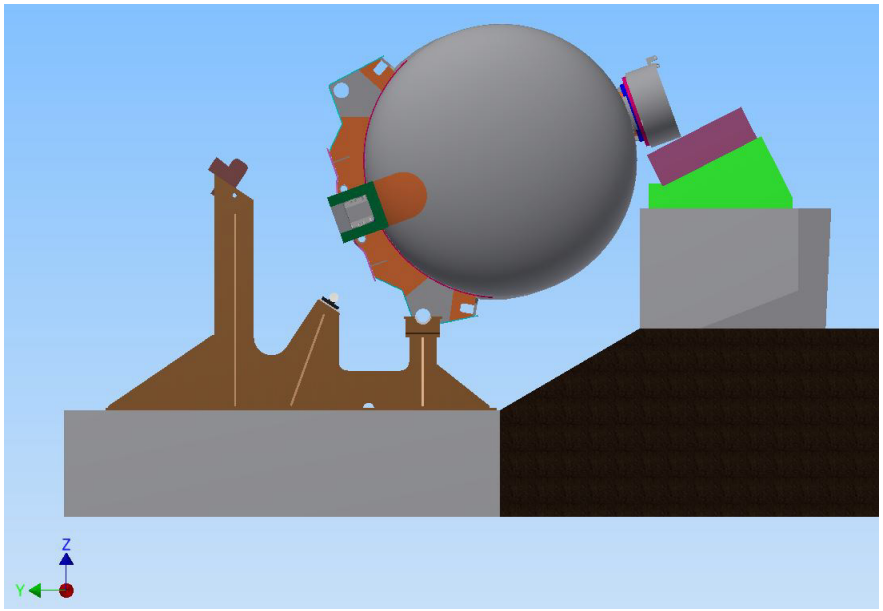
- Funding, FY20: $150,000
- Project Duration: August 2018 – May 2022

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 – December 2022

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

Fire Performance of UN-T75 Portable Tank

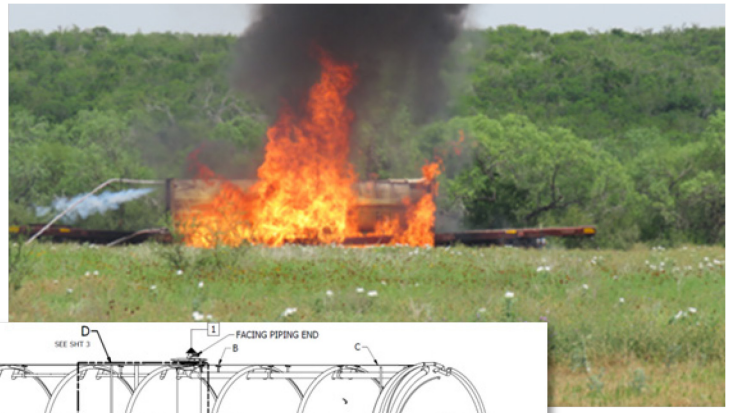
PROJECT DESCRIPTION

PHASE I:

- Conducted a full-scale fire test on a UN-T75 portable tank (see photo)
- 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, FY21: $230,000
- Project Duration: September 2017 – September 2022

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

Performance of Pressure Relief Valve under Fire Conditions

PROJECT DESCRIPTION

- Tank cars are required to have a pressure relief valve (PRV) to protect the tank car under derailment fire conditions.
- However, the performance of PRVs under fire conditions had not previously been evaluated/confirmed.
- The intent of this project was to document, by scale testing under nominal fire conditions, PRV performance with respect to opening pressure, reclosing, and evacuating the tank.
- Initial tests with water as lading were conducted at UL's test facilities in IL.
- Tests with ethanol (flammable lading) were conducted at BAM's test facilities outside Berlin, Germany.
- The PRDs survived the fire and functioned normally when subjected to moderately high temperatures for 30 to 60 minutes.
- Results will be used to validate detailed analytical models being developed by agencies such as Transport Canada.
- This effort required significant cooperation across multiple international entities in the U.S., Canada, Germany, and UK.

RAILROAD IMPACT

- Helps the industry better understand the risks associated with hazardous materials transportation, as PRV performance under derailment fire conditions is critical to safety.
- Quantification of PRV performance will help industry with designs and standards of PRDs that are appropriate for flammable liquid service.

PROJECT PARTNERS

- Sharma & Associates, Inc.
- Transport Canada
- Underwriters Laboratories
- BAM
- TransQuip
- Fort Vale

COST & SCHEDULE

- Funding, FY20: $1,200,000
- Project Duration: 2017 – 2020

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

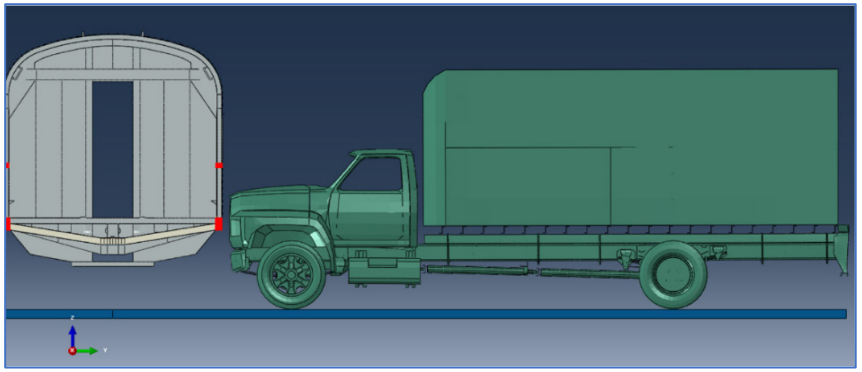
Passenger Equipment Structural Crashworthiness

PROJECT DESCRIPTION

- Develop design strategies for improving the structural crashworthiness of passenger rail cars 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 rail car 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: $30,000
- Project Duration: August 2018 – December 2020
  - 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, December 2020



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

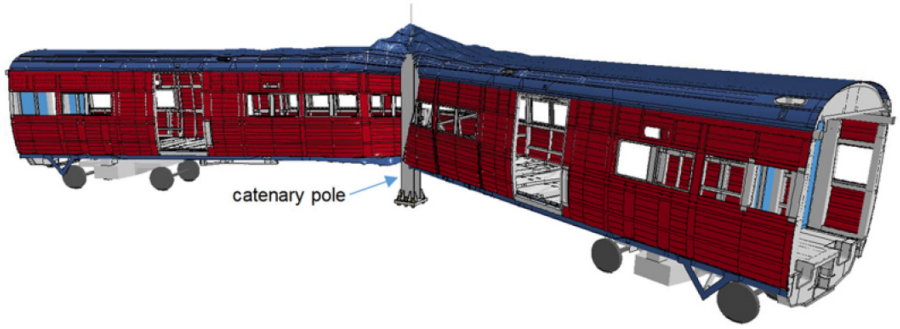
Resilient Wayside Structures and Passenger Car Survivability

PROJECT DESCRIPTION

- Passenger fatalities and injuries can occur during derailments due to interaction with wayside structures such as catenary poles, bridge abutments, and discontinuities in the third rail.
- Apply design considerations for roadside (highway) structures to railroad wayside structures to reduce stiffness and strength, incorporate energy absorbing mechanisms, and allow failure to occur in a controlled and predictable manner.
- Develop a proof-of-concept breakaway base connection design to reduce the hazards presented by catenary poles to demonstrate design practicality through experimental testing and additional high-fidelity numerical modeling.
- Experimental test program will involve static friction tests, static lateral load tests, and dynamic impact tests.
- Roadmap for market delivery will also be identified through the development of a robust commercialization strategy.

COST & SCHEDULE

- Funding: $389,709
- Project Duration: April 2020 – February 2022
  - Development of experimental test plan – completed
  - Experimental characterization of breakaway mechanism – completed
  - Proof-of-concept pendulum impact testing – completed
  - Identification of materials for slip interface – completed
  - Additional slip tests and dynamic impact tests, December 2021
  - Numerical analysis of OLE support structure, February 2022
  - Commercialization planning, throughout project
  - Final report to be issued in 2022.



RAILROAD IMPACT

- Damage mitigation concept that modifies existing anchor bolt base connection designs would be both effective in enhancing passenger safety and likely attractive to passenger railroads.
- Commercialization planning will also involve the development of a preliminary connection design package, including drawings/sketches, material specifications, and recommended design guidance.
- Design package will serve to facilitate discussions with industry on market delivery/integration and practical use on projects.

PROJECT PARTNERS

- Protection Engineering Consultants
- Southwest Research Institute

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

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 is planned for November 2021 to assess the performance of the retrofit components in a moderate-speed collision for a range of impacted equipment.
- Activities to also include a full-scale train-to-train impact test as well as development of locomotive crashworthiness standards.

COST & SCHEDULE

- Funding: $1,109,326
- Project Duration: August 2018 – February 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, summer 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

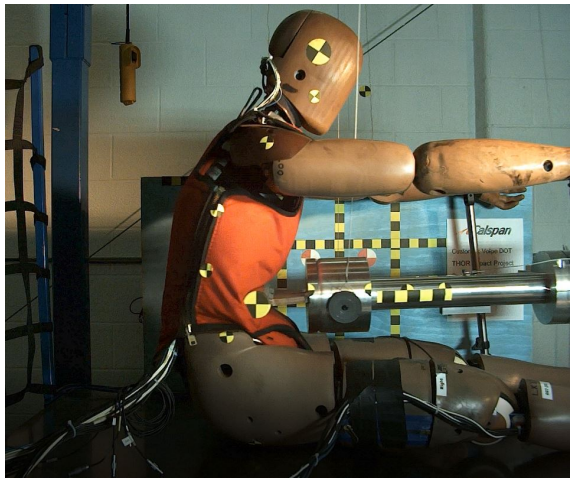
Interior Occupant Protection

PROJECT DESCRIPTION

- The Volpe Center contracted with Calspan Corp. to conduct abdomen impact testing on the THOR-50M anthropomorphic test device (ATD) to evaluate the biofidelity, repeatability, and sensitivity to multiple impact conditions.
- Volpe is providing technical support on FRA contracts with MGA Research to conduct research testing of passenger seats (open-bay configuration) and workstation tables to evaluate compliance with revised APTA seat and table safety standards.
- Volpe is providing support on planned occupant experiments using wheelchair/ATD containment devices and strategies in crash energy management locomotive train-to-train testing.
- Propose revisions to APTA safety standards to address the crashworthiness of passenger seats, cab seats, and workstation tables in passenger railcars.
- Evaluate 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: $358,000
- Funding for Standards Support and Equipment Evaluation: $75,000
- Project Duration: May 2020 – May 2022
  - Volpe/Calspan THOR-50M abdomen impact test report, Sept. 2020.
  - Volpe THOR-50M FE model validation paper, Jan. 2021
  - MGA/Volpe seat test report, Feb. 2021
  - MGA/ Volpe table test report, May 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
  - Draft APTA Cab Seat Standard, Dec. 2021



RAILROAD IMPACT

- Work 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.
- Work 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
- MGA Research
- Calspan Corp.

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: $25,000
- Project Duration: May 2021 – May 2022
- 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

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.
- Test articles under construction; testing completed March 2021.

COST & SCHEDULE

- Funding: $176,966
- Project Duration: September 2018 – March 2021
  - Present research findings to APTA or RSAC, December 2021.
  - Issue report describing project and results December 2021.

RAILROAD IMPACT

- At least 25 fatalities attributed to glazing malfunction in the last 44 years.
- Subsequent to 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

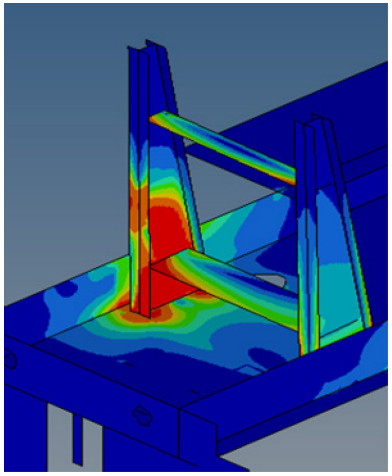
Improving Survivability for Locomotive Crews

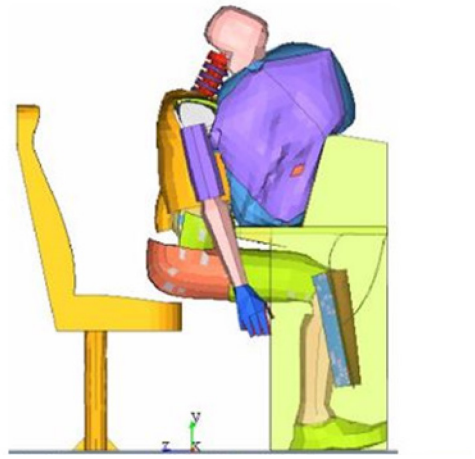
PROJECT DESCRIPTION

- Modern locomotives are built to crashworthiness standards defined in Title 49 of the Code of Federal Regulations, Part 229, and Association of American Railroads S-580 standards.
- Locomotives manufactured before 1990, specifically narrow-nose locomotives, were not designed to crashworthiness standards and lack crew protection in case of train collisions.
- Collision post-design alternatives compliant with current standards and amenable to a retrofit with no impact on locomotive functionality will be developed and tested in the next phase of work.
- Locomotives compliant with existing standards can preserve the space occupied by an engineer in the leading cab in a train collision up to moderate speeds, but do not provide protection against injuries resulting from secondary impacts resulting from abrupt locomotive deceleration.
- Novel combination airbag/knee bolster arrangement can be adapted to existing engineer desk geometry; this has been tested as part of this program to mitigate secondary impacts and has been shown to limit secondary impact forces to tolerable levels.

COST & SCHEDULE

- Funding: $217,674
- Project Duration: August 2013 – November 2020
  - Report on collision post-tests in review
  - Issue report on SIPS tests with improved airbag, September 2021.





RAILROAD IMPACT

- Will have no impact on locomotive functionality, bring legacy locomotives into compliance with crashworthiness requirements, and minimize the injury and fatality risk to crew in a collision.
- Secondary Impact Protection System (SIPS) will be shown to limit forces and accelerations imparted to cab occupants due to secondary impacts to industry-acceptable levels in the event of a moderate-to-severe collision scenario.

PROJECT PARTNER

- 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 used 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: $78,000
- Project Duration: May 2021 – May 2022
  - 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

Coupler Torsional Strength Research

PROJECT DESCRIPTION

- Rollover in severe passenger train accidents and derailments can cause a harsh environment for train occupants to survive as well as damage to the rail equipment.
- Couplers play a key role in the inter-car rollover behavior in derailments.
- The coupled connection between the rolling and adjacent car(s) can prevent the rolling car from overturning completely. During these incidents, a torsional load is supported by the coupler and its structural attachments to the carbody.
- This research will provide engineering analysis, test fixture design and fabrication, and destructive testing to evaluate the torsional strength and critical failure locations of couplers typically used on passenger railcars in the U.S.
- Finite element analysis will be performed to determine the critical structural locations in a coupler/coupler, carrier-to-draft sill mechanism.
- Results will be used to inform the design of the test fixture, and tests will be performed to measure the applied torque at which couplers fail and determine modes of failure.

COST & SCHEDULE

- Funding, FY19: $388,095
- Project Duration: September 2019 – November 2021
  - Intermediate reports delivered on accident investigations, finite element analysis and preliminary test plan, end 2020.
  - Publish final report documenting all activities, March 2022.

RAILROAD IMPACT

- Existing regulations and industry standards include limited requirements for coupler performance and generally address the strength of a coupler arrangement in terms its ability to sustain a prescribed vertical upward and downward load on the coupler (without failure) and its carrier (without permanent deformation).
- This work will develop information regarding the torsional strength characteristics of common coupler arrangements which can be considered for adoption in relevant industry standards to potentially provide improved rollover resistance.

PROJECT PARTNER

- Sharma & Associates, Inc.

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

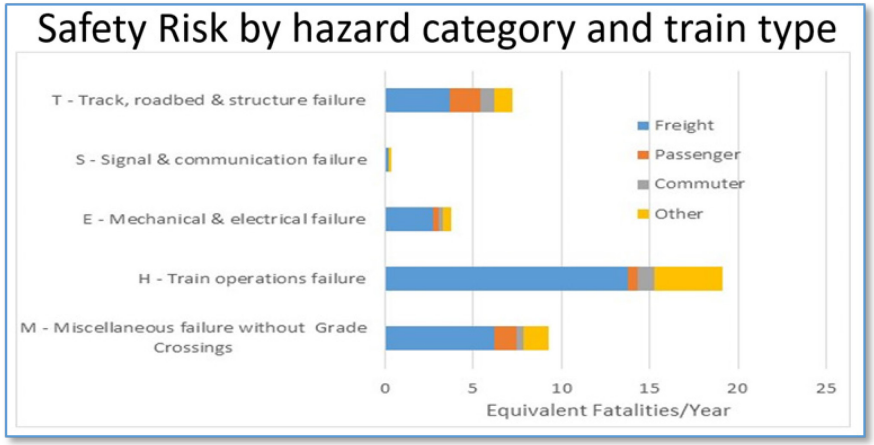
Extended Development of FRA Safety Risk Model

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: $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 involving 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 I

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 I of this project seeks to develop a cost-effective solution to this door safety problem associated with legacy trains.

COST & SCHEDULE

- Funding: $150,000
- Project Duration: June 2021 – December 2021

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 I

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: $299,329
- Project Duration: June 2021 – December 2021

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

SECTION THREE

TRAIN CONTROL & COMMUNICATION

PTC Reliability, Availability, and Maintainability (RAM)

PROJECT DESCRIPTION

This project is focused on an industry-wide assessment of Interoperable Train Control (ITC)-compliant Positive Train Control (PTC) system RAM with respect to operational impacts. The project is intended to address the following industry objectives:

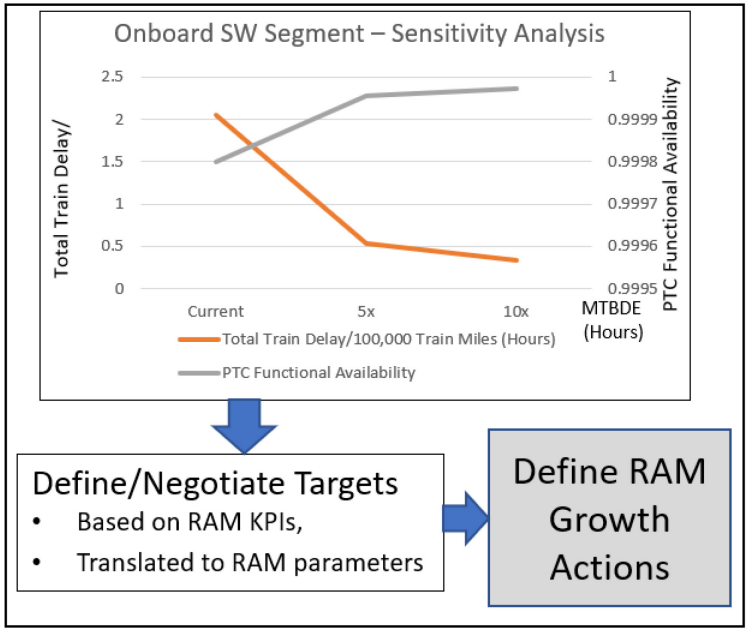
- Quantify the impact of PTC on operations.
- Identify main contributors to reduced operational availability.
- Develop PTC system and operational impact targets.
- Develop PTC RAM targets allocated to RAM segments.
- Prepare RAM growth recommendations.
- Prepare a high-level RAM program plan.

Project Scope Approach:

- Develop a comprehensive RAM study, conducting an extensive analysis and modeling of PTC elements to accurately reflect the impact of PTC on railroad operations.
- Quantify RAM parameters, e.g., the frequency that PTC-related impact events occur and the time it takes to restore operations, based on field data collected from railroads.
- Feed RAM parameters to the models to identify the main contributors to impact in operation, and develop sensitivity analysis and develop recommendations for RAM growth actions based on operational targets.

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Class I railroads



RAILROAD IMPACT

- The primary goal is to identify the main contributors to railroad safety and efficiency due to PTC-related impact events and propose actions to minimize or eliminate them.
- As a long-term objective, the project should also establish the foundation for continuous RAM growth actions.

COST & SCHEDULE

- Funding: $1,747,451
- Project Duration: September 2018 – December 2021

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

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.
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 submitted to AAR for use at its discretion.

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- FRA Office of Research, Development, and Technology
- FRA Office of Railroad Safety
- AAR member railroads

COST & SCHEDULE

- Funding: $2,304,683
- Project Duration: Sept. 2019 – Dec. 2021

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

Automated Train Operations (ATO) Sensor Platform Rapid Prototype

PROJECT DESCRIPTION

The sensor platform (SP) rapid prototype (RP) project is a demonstration to validate SP concepts and requirements; it also supports further definition of SP performance parameters. The SP RP 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 RP 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.

RAILROAD IMPACT

- The objective of the ATO SP RP 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 RP project findings will inform the modification of existing ATO SP specifications.

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- BNSF Railway
- Canadian National Railway
- Canadian Pacific Railway
- CSX Transportation
- Kansas City Southern Railroad
- Norfolk Southern Railway
- Union Pacific Railroad

COST & SCHEDULE

- Funding: $854,650
- Project Duration: August 2020 – July 2022

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

Automated Train Operations (ATO) Sensor Test Bed Spec Development

PROJECT DESCRIPTION

The ATO Safety Sensor Test Bed Specification Development (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.

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.

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- BNSF Railway
- Canadian National Railway
- Canadian Pacific Railway
- CSX Transportation
- Kansas City Southern Railroad
- Norfolk Southern Railway
- Union Pacific Railroad

COST & SCHEDULE

- Funding: $479,347
- Project Duration: September 2019 – March 2022

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 such as 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 as 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

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

Track Data Auditing System (TDAS)

PROJECT DESCRIPTION

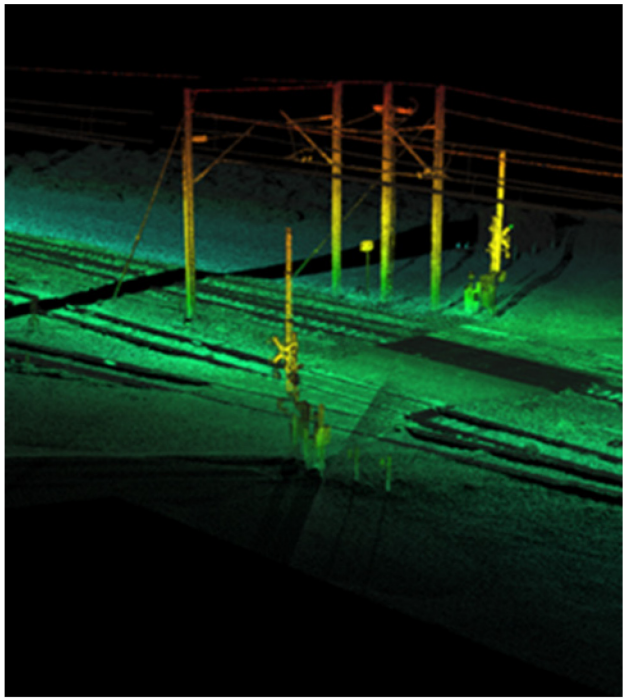
The TDAS program focuses on the documentation and development of standards and best practices for the auditing of track data for Positive Train Control (PTC) critical assets, including advancing the level of automation of the auditing process.

The scope of work for the current phase of the TDAS program includes tasks to test and evaluate commercial off-the-shelf (COTS) implementations of the data collection subsystem that can address a subset of requirements:

- Through field testing, evaluate COTS data collection systems to verify they meet core requirements, and validate the requirements previously established.
- Develop data comparison subsystem and related algorithms.

RAILROAD IMPACT

- The TDAS program aims to establish requirements and standards for the auditing of PTC critical assets from the perspective of audit process management, data collection, and verification of PTC critical assets. The program also seeks to provide a path for increased automation for track data auditing while allowing for flexible implementation, and support vendor development of TDAS subsystems.



LiDAR data visualization of PTC critical assets

COST & SCHEDULE

- Funding: $656,608
- Project Duration: September 2019 – December 2021

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

- Transportation Technology Center, Inc.
- 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

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

Quasi-Moving Block (QMB) Train Control

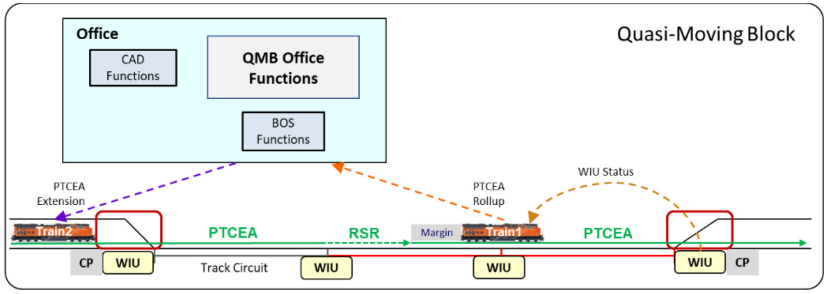
PROJECT DESCRIPTION

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.

RAILROAD IMPACT

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



PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Class I railroads
- Passenger and commuter railroads
- Meteorcomm LLC

COST & SCHEDULE

- Funding: $2,016,761
- Project Duration: September 2019 – June 2022

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

Positive Train Control (PTC) Interoperability Support

PROJECT DESCRIPTION

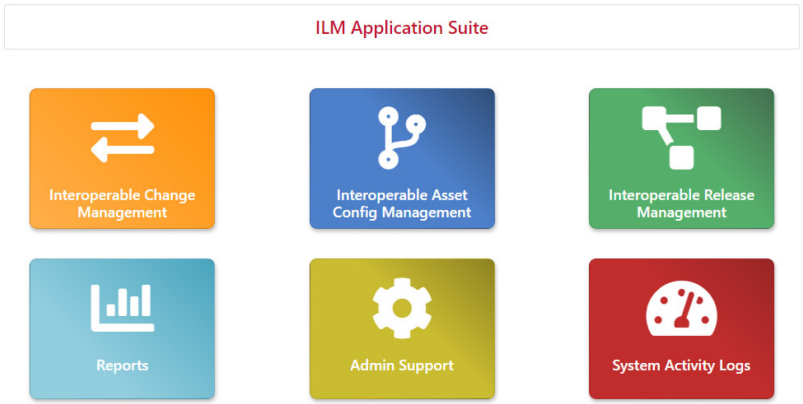
The continued evolution of PTC has been and will continue to be an important element of the industry strategy for the enhancement of safe and efficient rail transportation. Managing change and configuration in the PTC environment requires close coordination due to multiple railroads, multiple system segments, components and interfaces, multiple vendors, and many configuration items.

The primary objective is to develop the operational concepts and key requirements, and support industry development of, the PTC Interoperable Lifecycle Management System (ILMS) that will be used for:

- Management of authorized industry PTC releases, including identification of authorized versions of interoperable configuration items (ICIs), coordinating changes and new versions of ICIs, and scheduling the introduction of new releases and retirement of old releases.
- Identification of changes from release-to-release to support testing efforts.
- Provision for management of requirements, test plans, and procedures, including support for tracing requirements between different implementations of individual ICIs and identifying potential incompatibilities.

RAILROAD IMPACT

- Supporting the industry in specifying, developing, and implementing the PTC ILM functions necessary for maintaining functional and compatible interoperable PTC throughout its lifecycle.



PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Railinc Corp.
- Class I railroads

COST & SCHEDULE

- Funding: $720,676
- Project Duration: May 2020 – May 2022

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

- Transportation Technology Center, Inc.
- FRA Office of Research, Development, and Technology
- AAR member railroads

COST & SCHEDULE

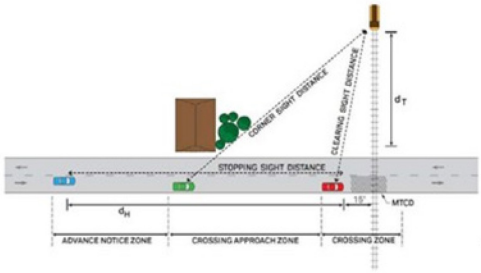
- Funding: $971,685
- Project Duration: August 2020 – September 2022

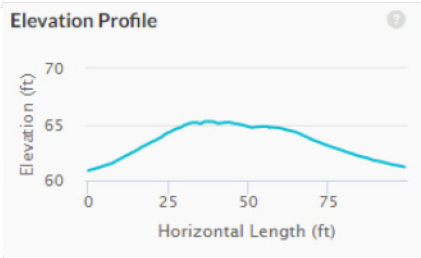
FRA PROJECT MANAGER: Jared Withers • (202) 493-6362 • jared.withers@dot.gov

Unmanned Aircraft Systems (UAS) Technology Exploratory Study

PROJECT DESCRIPTION

- The objective of this project is to investigate potential use of UAS technology to quickly create accurate 3D profiles of humped grade crossings and perform line-of-sight analyses (using LiDAR, photogrammetry, and other methods).
- Project includes measuring crossings that have previously been modeled using other proven but less portable methods (including the rail geometry car system) and comparing strengths and weaknesses.
- Project includes comparison to existing FRA LiDAR crossing profile data, development of grade crossing inventory procedures for collected data, and exploration of data processing software options.
- Grade Profile Research Report: Using an Unmanned Aerial Vehicle to Produce Accurate Grade Crossing Profile Data





RAILROAD IMPACT

- Vehicle driver safety at grade crossings
- Each year, about 14% of grade crossing accidents involve a tractor-trailer, and a substantial number of those are a result of the vehicle getting stuck on the tracks due to the low ground clearance across the crossing (humped crossing).
- Accurate measurements of grade crossing profiles would aid in the identification and remediation of humped crossings.
- Accurate measurements of the line-of-sight on vehicular approach would aid in the identification and remediation of locations with insufficient sight distance.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $190,000
- Project Duration: March 2019 – November 2021

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

Rail Trespass Prevention Summits

PROJECT DESCRIPTION

- To plan, coordinate, and execute a series of trespasser prevention summits with representatives from each of the top 10 counties for trespasser casualties, engaging with local community leaders, law enforcement, railroads and the public. It will involve supporting coordination, facilitation, and documentation of the summits.
- These summits are one of the action items listed in FRA's *National Strategy for Trespass Prevention on Railroad Property* (https://www.fra.dot.gov/eLib/Details/L19817).

RAILROAD IMPACT

- Provides FRA partners with information on the latest trespass prevention strategies
- Fosters an exchange of information on trespassing mitigation between all stakeholders
- Provides railroads and industry stakeholders with a concise message of FRA's strategic plan
- Facilitates development of site-specific strategies for trespass mitigation at the top ten counties with the most trespass casualties nationwide, thereby improving rail safety

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- County and local governments
- Railroads
- State DOTs

COST & SCHEDULE

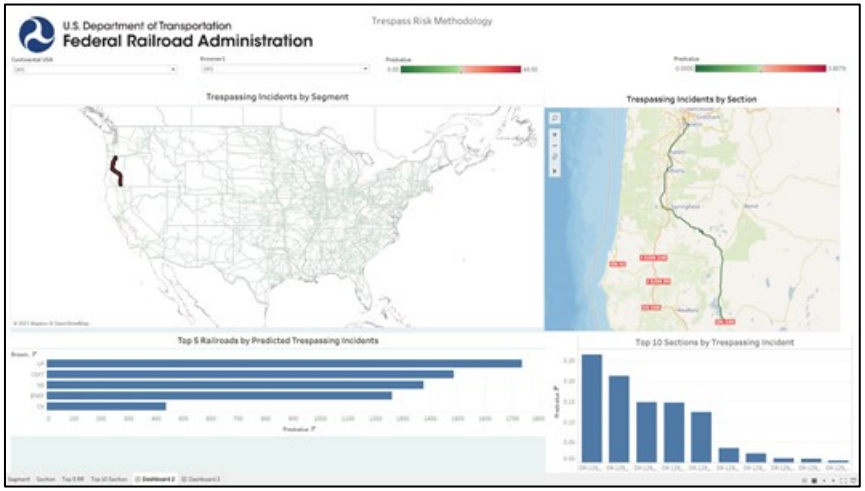
- Funding: $150,000
- Project Duration: August 2019 – November 2021
  - Schedule affected by COVID-19; original summits planned for Spring 2020; virtual summits began in September 2021.

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

Trespass Risk Methodology

PROJECT DESCRIPTION

- This project builds on the trespass risk methodology developed in the West Palm Beach trespass study and other recent industry models to develop a method to assess the trespass risk on rail rights-of-way (ROWs) using currently available data.
- Data sources such as accident/incident data, suicides, trespass observations, locomotive video data, debris strikes, and others will be considered.
- More than 500 trespass fatalities and nearly as many injuries occur each year on the nation's rail network. FRA, railroads, and State and local agencies use all available data to identify areas of greatest risk and implement mitigation strategies. However, no standard methodology exists to estimate trespass risk.



RAILROAD IMPACT

- Information exchange with State DOTs and railroads on cutting-edge methodologies for trespass prevention.
- Provide tools for stakeholders to assess trespass risk and implement mitigation strategies.
- Increase public safety.
- Reduce trespass deaths. (There were 525 ROW trespass fatalities and 557 injuries in 2020.)

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $230,000
- Project Duration: March 2019 – November 2021

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

Artificial Intelligence for Trespassing

PROJECT DESCRIPTION

- Continue research on the use of Artificial Intelligence (AI) tools for rail right-of-way (ROW) incursions (trespass and grade crossing violations).
- This work includes continued collaboration with Rutgers University on its AI detection system and support installation and evaluation at the E. Main St. crossing in Ramsey, NJ.
- The ultimate objective is to develop an automated detection capability for currently available video feeds from both stationary cameras and locomotive cameras.
- Automated processing and identification of trespassing and crossing violations would yield a significant safety dataset currently not being collected from many rail cameras.

RAILROAD IMPACT

- Develop techniques or technologies for automated trespass detection and disseminate to rail stakeholders to increase safety around rail ROWs.
- Reduce the number of pedestrians that trespass onto railroad ROWs.
- Increase public safety.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Rutgers University
- Michigan Technological University

COST & SCHEDULE

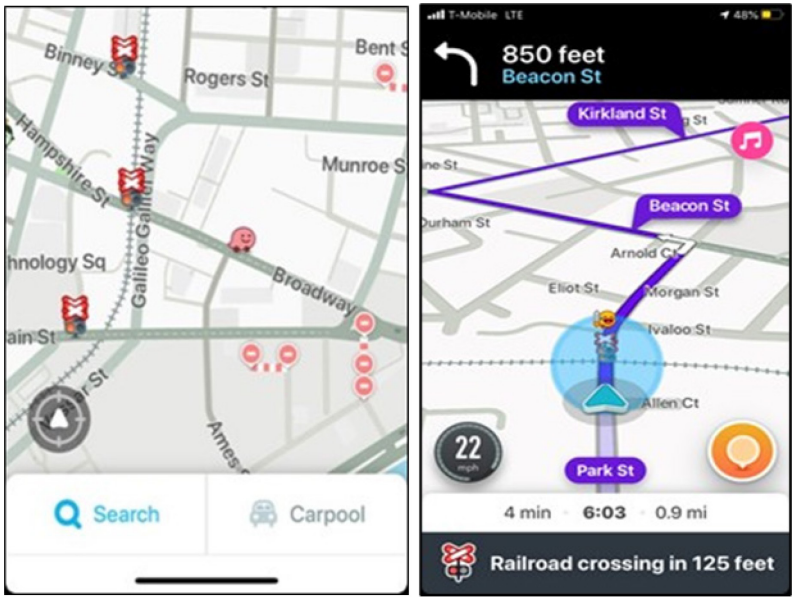
- Funding: $250,000
- Project Duration: November 2019 – November 2021

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

Waze Notifications Research

PROJECT DESCRIPTION

- To research the status and effectiveness of using Waze to improve safety at highway-rail grade crossings in the U.S.
- Research general vehicle safety implications at/near grade crossings from:
  - Waze app user traffic reporting
  - Dynamic crossing warnings via mobile app:
    - Long Island Rail Road (LIRR Pilot Project: Warns users when they approach an LIRR grade crossing. An audio and visual message alerts drivers: “Railroad crossing: Do not turn onto tracks.” (2018 –)
    - Norfolk Southern Railway (NS) Pilot Project: Warns users when they approach a grade crossing in several states (2019 –)



RAILROAD IMPACT

- Demonstrate potential benefits of implementation and evaluation of dynamic warnings via app-based mapping services; application nationwide.
- Identify locations with vehicular congestion near or at grade crossings for remediation.
- Partnerships with State DOTs and railroads
- Information exchange with rail safety partners on cutting edge technologies and/or strategies
- Increase driver safety at/near grade crossings.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- LIRR
- NS
- Waze

COST & SCHEDULE

- Funding: $150,000
- Project Duration: May 2020 – November 2021

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

Trespass Close Call Data

PROJECT DESCRIPTION

- This project is to support the FRA Office of Research, Development, and Technology by collecting and analyzing rail trespassing close call data.
- Current FRA trespass incident data consists of reports of incidents resulting in a casualty. Although very informative, this data does not provide enough information on non-incident trespass activities for determination of hotspots or contributing factors along rail lines.
- Many railroads and State DOTs collect close call data, consisting of observations of trespassing close to moving trains but that did not result in an incident. There are several research projects collecting this data. However, there is no current process to collect and analyze the close call data obtained by these various approaches.

RAILROAD IMPACT

- Facilitate implementation and evaluation of innovative safety technologies.
- Foster an exchange of information on rail trespassing between all stakeholders.
- Reduce the number of pedestrians who trespass onto railroad rights-of-way.
- Increase public safety.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

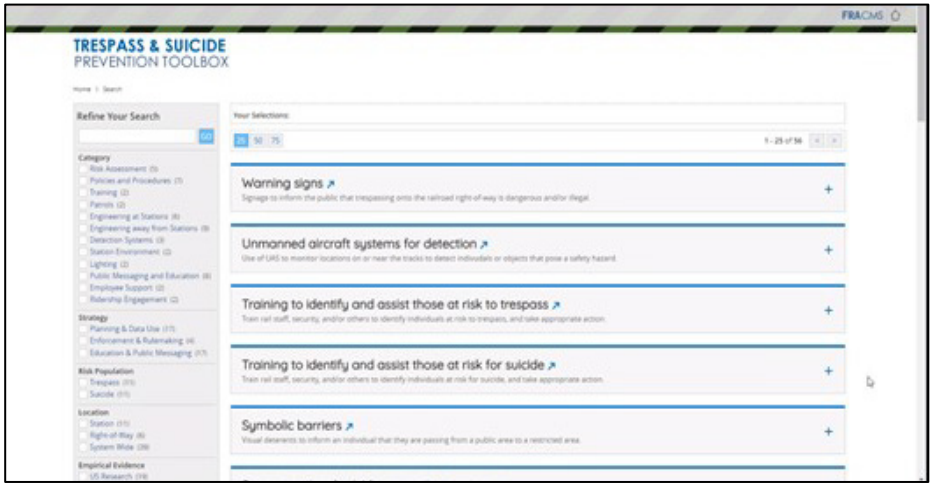
- Funding: $75,000
- Project Duration: May 2020 – November 2021

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

Trespass Toolkit

PROJECT DESCRIPTION

- The objective of this project is to support the development of a web-based, rail right-of-way trespass toolbox currently under development by the FRA Office of Research, Development, and Technology.
- Rail stakeholders have long desired a central repository of results of trespass mitigation measures implemented throughout the country.
- This "toolkit" will contain guides, noteworthy practices, and research results on implementation of a wide range of trespass mitigation treatments. It will be modelled after the existing RESTRAIL Toolbox widely used in Europe.



RAILROAD IMPACT

- Provide FRA partners with information on cutting-edge technologies and/or strategies for trespass and suicide prevention.
- Foster an exchange of information on rail trespassing and suicide mitigation among all stakeholders.
- Facilitate implementation and evaluation of innovative safety technologies.
- Facilitate development of site-specific strategies for rail trespass and suicide mitigation, thereby improving rail safety.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

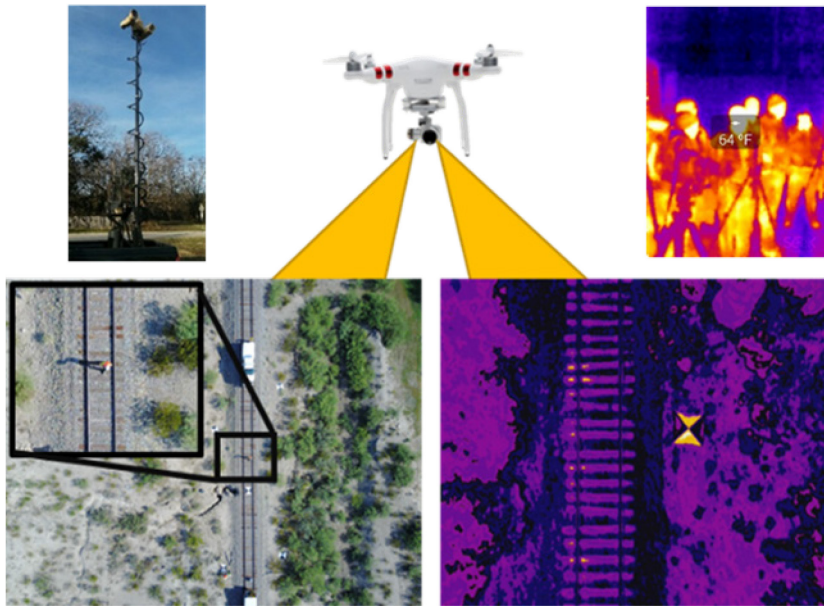
- Funding: $50,000
- Project Duration: May 2020 – November 2021

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

Railroad Artificial Intelligence Intruder Learning System (RAIILS)

PROJECT DESCRIPTION

- This project investigates the effectiveness of Artificial Intelligence (AI) technology to detect intruders on rail properties.
- A comprehensive literature review highlighting past and current advancements in AI algorithms and their applicability to railway sensing will be compiled.
- In conjunction with feedback from rail industry representatives, ground-based and unmanned aerial vehicle-based systems equipped with AI algorithms will then be developed for the purpose of automatically detecting trespassers.
- The prototype system will be tested at locations made available by industry partners.



RAILROAD IMPACT

- Multi-source remote sensing removes the need for manual inspection of railroad property.
- AI-based detection will enable automatic notification of trespassers in real time.
- Improved, automated detection has the potential to improve safety outcomes while reducing cost.

PROJECT PARTNERS

- Michigan Technological University
- Lake State Rail Co.
- Michigan Department of Transportation

COST & SCHEDULE

- Phase 1, April 2019 – October 2019: $103,808
- Phase 2, October 2019 – September 2021: $199,857

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

Full Moving Block (FMB) Train Control

PROJECT DESCRIPTION

As part of the FRA-sponsored research on Higher Reliability/Capacity Train Control (HRCTC), several enhanced methods of operation, leveraging elements of current Positive Train Control (PTC) systems, were identified and predicted to provide benefits over conventional methods of train control.

The stages of train control defined on the HRCTC program are:

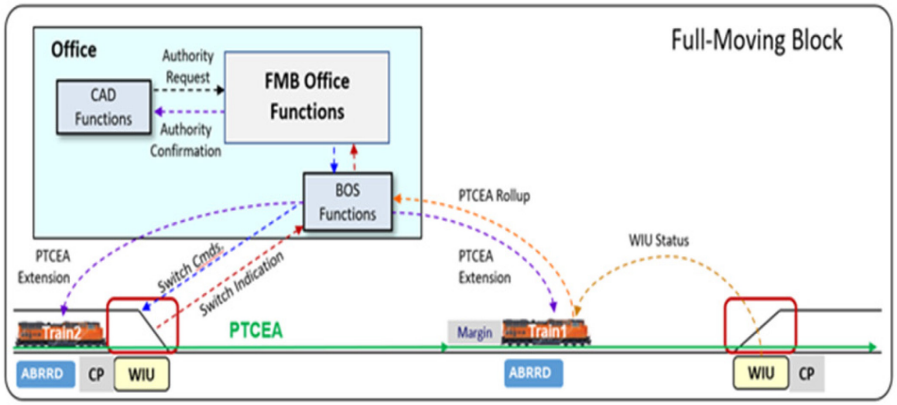
- Overlay PTC (currently being deployed to comply with the Rail Safety Improvement Act of 2008)
- Enhanced Overlay PTC
- Quasi-Moving Block PTC
- Full Moving Block PTC

Each of the above train control modes builds upon its predecessor. FMB incorporates the benefits of its predecessors and increases those benefits and provides additional benefits.

The objective of this projects is to develop FMB requirements for railroad operations, including development of supporting operational concepts, a preliminary safety analysis, and migration considerations.

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Class I railroads
- Several commuter railroads



RAILROAD IMPACT

- FMB offers greater capacity and reliability than other train control methods by eliminating unnecessary constraints associated with fixed block train control systems.
- FMB employs the train control architecture necessary to approach the theoretical minimum headways and maximum capacity on railroad main lines.

COST & SCHEDULE

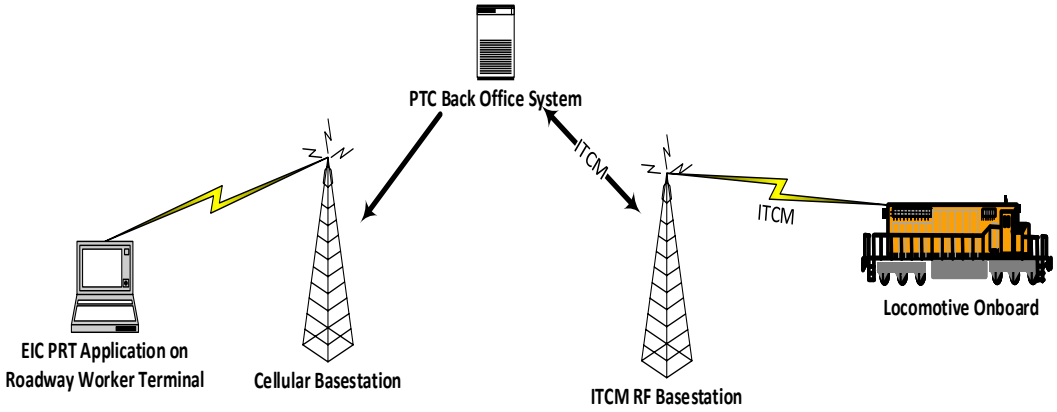
- Funding: $681,554
- Project Duration: May 2020 – September 2022

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

Employee-in-Charge Portable Remote Terminal (EICPRT)

PROJECT DESCRIPTION

- Transmit electronically from an Employee-in-Charge (EIC) terminal through the back office server to the onboard computer.
- Allows an EIC to grant permissions for train crews to enter a work zone
- Provides enforcement of Positive Train Control (PTC) instructions (e.g., speed limits)
- Use of the EIC terminal application for electronic control of working limits does not supersede the maintenance-of-way (MOW) operating rules or required verbal communication.



RAILROAD IMPACT

- PTC enforcement of EIC instructions, thereby protection is maintained.
- EICPRT mitigates EIC working outside of MOW protected time.
- EICPRT prevents instructions to the locomotive by third-party (spoofing) through its interface.

PROJECT PARTNERS

- Association of American Railroads
- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: $3,200,400
- Project Duration: September 2012 – December 2020

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

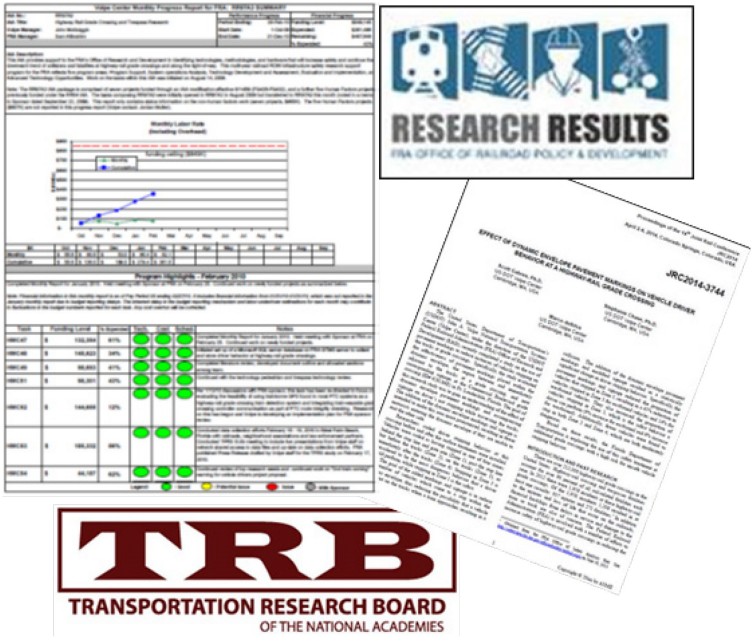
Grade Crossing and Trespass Research Program Support

PROJECT DESCRIPTION

- Provide program management and quick response, conduct special studies not covered in any existing task, and 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

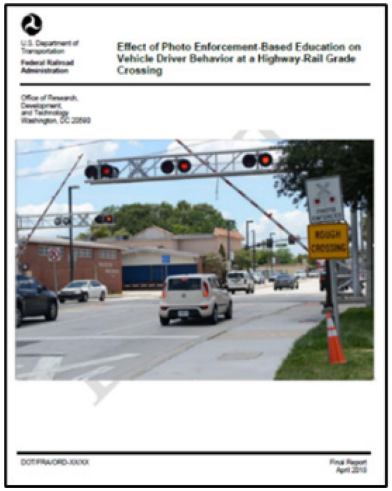
- Funding: $100,000
- Project Duration: July 2021 – July 2026

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

Grade Crossing Toolkit

PROJECT DESCRIPTION

- To support the development of a highway-rail grade crossing safety measures toolkit, like the rail right-of-way (ROW) trespass mitigation measures toolkit currently under development by the FRA Office of Research, Development, and Technology.
- This 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. 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

- Provide FRA's partners with information on cutting-edge technologies and/or strategies for grade crossing safety.
- Foster an exchange of information on grade crossing safety countermeasures between all stakeholders.
- Facilitate implementation and evaluation of innovative safety technologies.
- Facilitate 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 – July 2022

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 a focus on improving recovery time.
- Results will be specific to crossings, but the approach could be more generally applied to other rail incidents (e.g., derailments, trespass). 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 will aim to use 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
- Increased public and first responder safety
- Quick response capability in support of the FRA Office of Research, Development, and Technology

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

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

U.S. Department of Transportation
Federal Railroad Administration

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 just a 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.

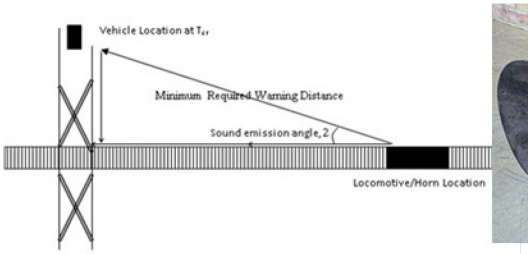
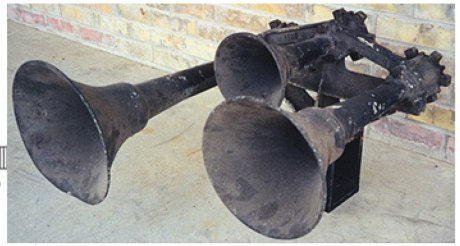
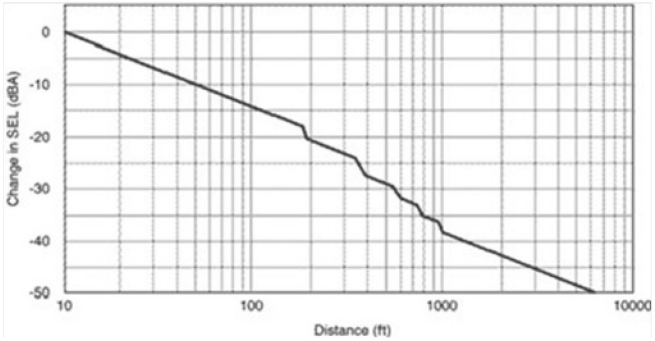


Figure 1. Critical Grade Crossing Geometry





RAILROAD IMPACT

- Auditory warnings represent an important adjunct to visual warnings in alerting a 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

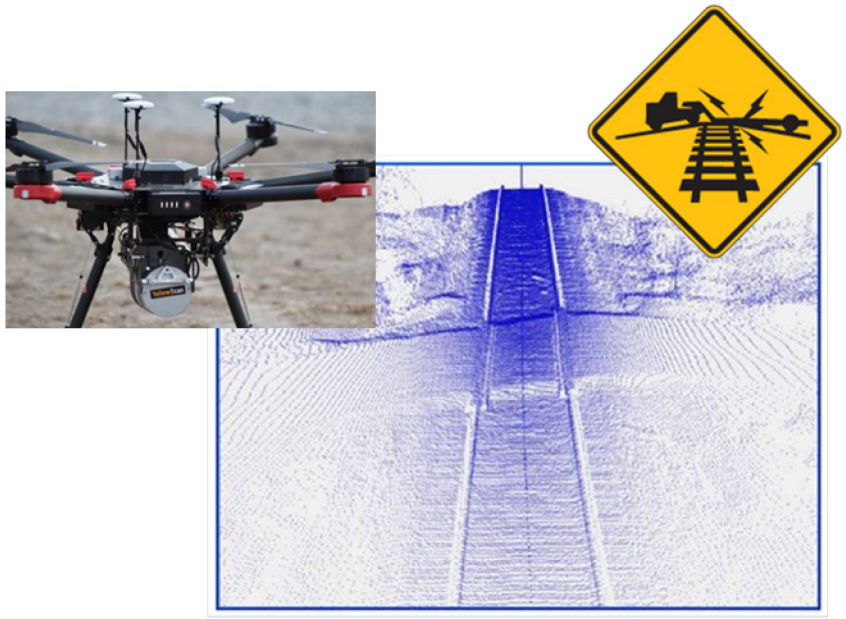
- Funding: $150,000
- Project Duration: July 2021 – July 2022

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

Unmanned Aerial Systems Technology – Exploratory Study

PROJECT DESCRIPTION

- Investigate the potential use of drone technology to quickly create accurate 3D profiles of humped grade crossings (using LiDAR, photogrammetry, and other methods).
- Project includes measuring crossings that have previously been modeled using other proven but less portable methods (including the rail geometry car system) and comparing strengths and weaknesses.
- Project includes comparison to existing FRA LiDAR crossing profile data, development of grade crossing inventory procedures for collected data, and exploration of data processing software options.



RAILROAD IMPACT

- Commercial vehicle driver safety at grade crossings
- Each year, roughly 14% of grade crossing accidents involve a tractor-trailer, and a substantial number of those result from a vehicle getting stuck on the tracks due to low ground clearance (i.e., a humped crossing).
- Accurate measurements of grade crossing profiles would aid in the identification and remediation of humped crossings.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- U.S. Federal Highway Administration

COST & SCHEDULE

- Funding: $190,000
- Project Duration: March 2019 – February 2021

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

Right-of-Way Trespass CRISI Grant Evaluation

PROJECT DESCRIPTION

- Evaluate the implementation of drone and other technologies for rail right-of-way (ROW) trespassing by the Florida Department of Transportation (FL DOT).
- Under an FRA Consolidated Rail Infrastructure and Safety Improvements (CRISI) grant, FL DOT launched a pilot program using drone technology, a closed-circuit television with remote monitoring, and GIS spatial analysis to aid partnerships among local law enforcement agencies to combat trespassing in Volusia, Seminole, Orange, and Osceola counties.

RAILROAD IMPACT

- Demonstrate potential benefits, including documenting best practices and lessons learned, of implementation and evaluation of drone technology to detect trespassers on railroad property. Application could be nationwide.
- Partnerships with State DOTs and railroads
- Information exchange with rail safety partners on cutting-edge technologies and/or strategies
- Increase public safety.
- Support analysis for potential legislative processes.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- FL DOT

COST & SCHEDULE

- Funding: $50,000
- Project Duration: November 2019 – September 2021
  - Delayed due to COVID-19

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

SECTION FOUR

HUMAN FACTORS

Automation, Operating Personnel Information Management, and Control

PROJECT DESCRIPTION

This research area examines the safety implications of new technology and automation from a human-centered design perspective. It includes safety issues associated with (a) rail technology assessment and human performance, (b) new technology concept demonstration and the human-machine interface, and (c) human-systems integration as an acquisition and implementation process for new technology.

Sample Acquisitions:

1. *Augmented Reality Head-Up Display (HUD):* Prototype HUD augmented reality (AR) for locomotive operations that will reduce locomotive engineer workload and improve situation awareness and train handling performance.
2. *Enhanced Manual Locomotive Mode:* Prototype operating mode to drive train from higher level than traditional manual mode; more control and visibility into system operation.
3. *Human-Machine Interfaces of New Technologies and the Railroad (AI and External Perception):* Prototype AR technologies that provide greater situational awareness and greater feedback to engineers for enhanced decision-making capabilities.

COST & SCHEDULE

- Funding, FY20: 540,000
- Project Duration: October 2018 – September 2021

RAILROAD IMPACT

- Primary goal is to ensure that 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

- MIT Human Systems Laboratory
- KEA Technologies
- GE Research
- University of New Mexico

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

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: $379,176
- Project Duration: May 2018 – May 2025

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

FRA Office of Railroad Safety Support

PROJECT DESCRIPTION

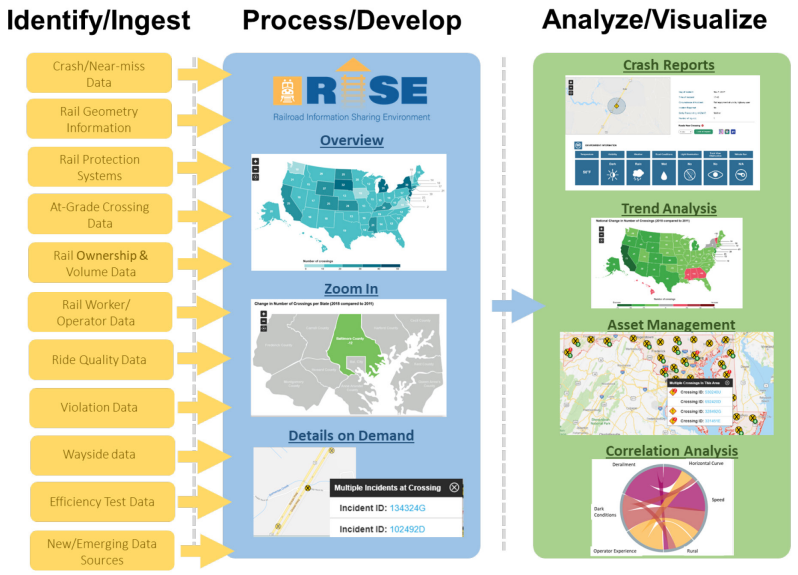
Support FRA's Office of Railroad Safety (RRS) by providing subject matter expertise, consultation, research, data, and tools to improve railroad safety. RRS works closely with RD&T to provide insight into research needs.

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

- University of Maryland, Center for Advanced Transportation Technology
- 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 impact motorists' 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 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: $1,135,041
- Project Duration: October 2018 – January 2022

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 on 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 that can 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, 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 C³RS and short line railroads:* Develop a model of C³RS 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 C3RS pilot project: $100,000
- Funding: $3,045,000
- Project Duration: September 2019 – May 2025

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

Contact Us

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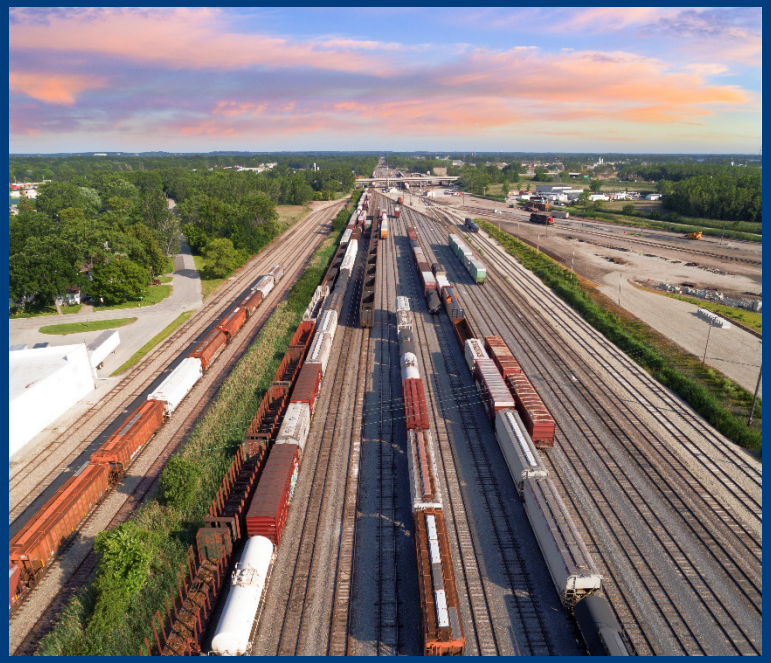

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Federal Railroad Administration