FEDERAL RAILROAD ADMINISTRATION

RAIL MOVING AMERICA FORWARD

FRA OFFICE OF RESEARCH, DEVELOPMENT, and TECHNOLOGY

CURRENT RESEARCH PROJECTS

U.S. Department of Transportation
Federal Railroad Administration

2021 TRB Annual Conference

RESEARCH SECTIONS

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

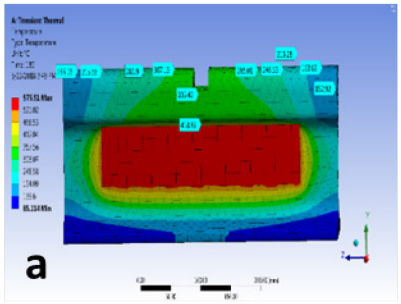
SECTION ONE

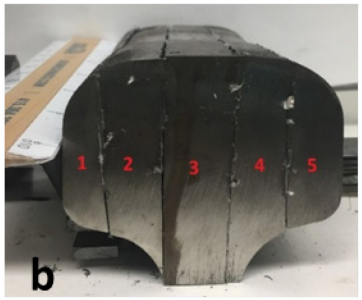
TRACK

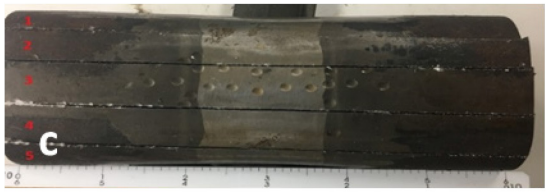
Field Testing of Welding Repair of Railhead Defects

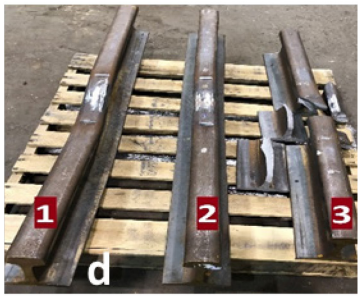
PROJECT DESCRIPTION

- Develop a welded railhead repair technique to increase the weld efficiency and durability of rail.
- Find the suitable welding wire and optimize the welding parameters including preheat, cooling rates, and heat input.
- Achieve a defect-free welded section and confirm it through nondestructive and destructive evaluation.
- Analyze the microstructure to avoid undesired microstructure, including martensite and bainite in the heat affected zone.
- Accomplish adequate mechanical strength according to AREMA standard.









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 and enhance the endurance of rail.
- Improve rail safety and the mechanical strength of welded railhead attained from current repair practices.
- Reduce railroad maintenance costs.

PROJECT PARTNERS

- Tuskegee University
- Transportation Technology Center, Inc.
- EWI
- Nucor Steel

COST & SCHEDULE

- Funding: $ 284,118
- Project Duration: October 2017 – September 2021

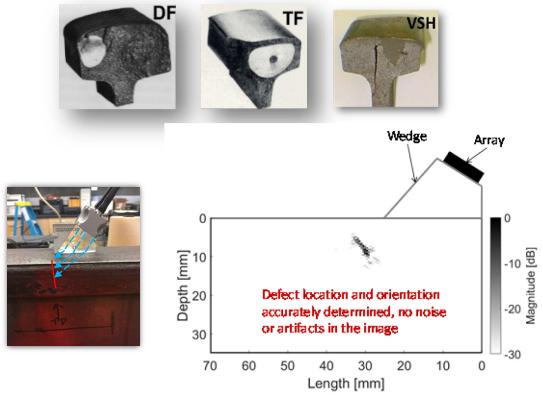
FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Development of Rail Flaw Imaging Technology Based on Ultrasonic Tomography

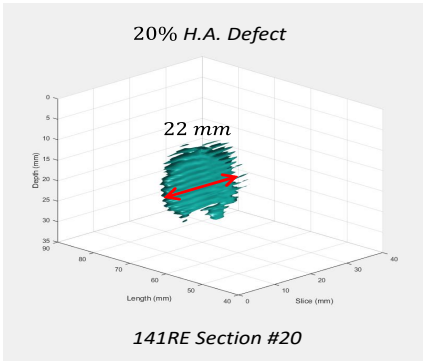
PROJECT DESCRIPTION

- 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).

SAFT Rail Flaw Imaging



3D Rail Flaw Imaging Reconstruction



RAILROAD IMPACT

- Advanced rail inspection technologies are high priorities of FRA's R&D program.
- The ultimate 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

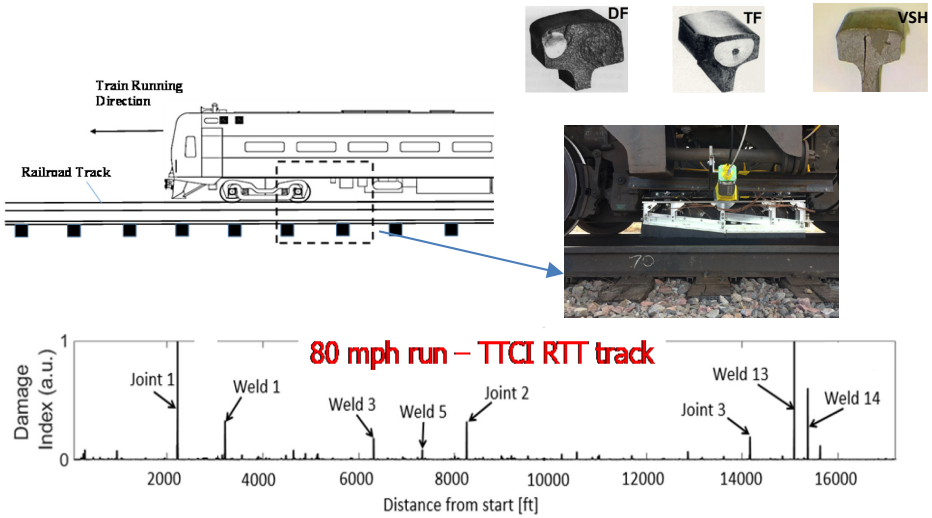
- Project Duration: 3 years (July 2019 – December 2022)
- Initial phase (funded): $138,965 (FRA), $50,000 (UCSD equipment cost share)
- Option 1 (funded): $140,000
- Option 2 (funded): $210,000

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

Non-Contact Rail Inspection Prototype (Passive-Only System for High-Speed Rail Inspection)

PROJECT DESCRIPTION

- The prior experience of the University of California, San Diego 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 POD and the PFA for internal rail flaws to acceptable levels
- Project includes: evaluate controlled acoustic source, upgrade prototype's hardware and software, quantify benefits of redundancy.
- Union Pacific (UP) Railroad and BNSF Railway have committed their participation to the project.



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 (committed)
- Transportation Technology Center, Inc.

COST & SCHEDULE

- Project Duration: September 2020 – September 2022
- Year 1 (funded): $256,925
- Year 2 (optional): $229,542

RAILROAD IMPACT

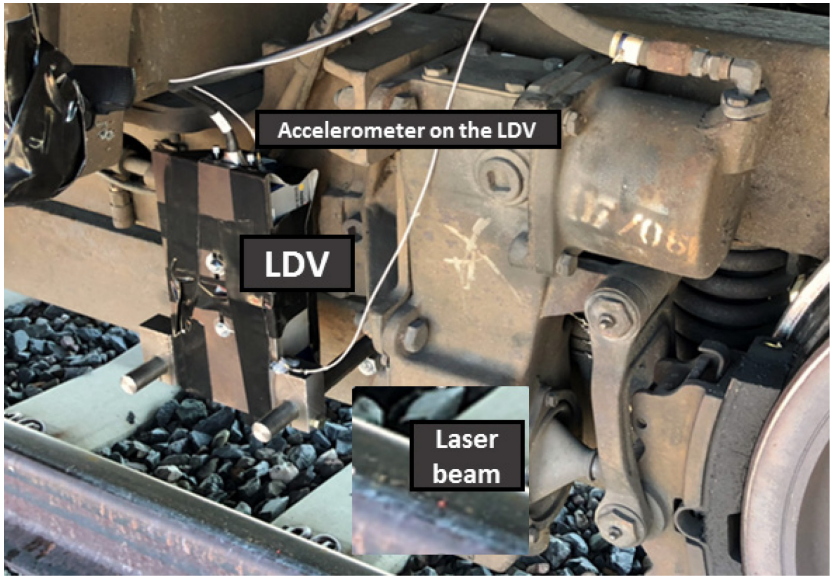
- Passive rail inspection technology would enable extremely high testing speeds, well beyond the ~ 25 mph maximum speed currently allowed by conventional (e.g., RSU-based) rail inspection cars.
- Inspecting the rail at regular train speeds would simplify scheduling of rail inspections around normal traffic.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

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

Rail Defect Detection by Non-Contact Vibration Measurements

PROJECT DESCRIPTION

- The goal is to develop a non-contact technology for the identification of defects in rail.
- Laser Doppler vibrometers (LDVs) are proposed to record the dynamic vibrations and propagating waves induced by the wheel-rail contact from a moving platform.
- Preliminary field tests were carried out (a) to test the efficiency of the proposed LDV application and (b) to observe rail vibrations under moving rail car excitations.
- Rail vibrations recorded from field tests are integrated into finite element models to examine the change in rail vibrations and propagating waves due to rail damages.
- Laboratory tests were performed to investigate speckle noise observed in moving LDV measurements and filtering algorithms were developed to boost the signal-to-noise ratio.
- Advanced modal system identification algorithms integrated with noise reduction and damage detection techniques will be evaluated to identify damages.



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 next-generation, infrared-based laser Doppler vibrometer to maximize the signal-to-noise ratio in the measurement signals.
- Ability to carry out inspections at operating railcar speeds.

PROJECT PARTNERS

- University of Texas at Austin
- Transportation Technology Center, Inc.

COST & SCHEDULE

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

U.S. Department of Transportation
Federal Railroad Administration

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

Automated Railhead Flaw Characterization and Rail Remaining Life Prediction Technology

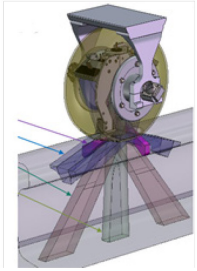
PROJECT DESCRIPTION

- Automated railhead flaw characterization and rail remaining life prediction technology.
- Experimental ultrasonic track inspection data from Sperry Corp.
- 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.

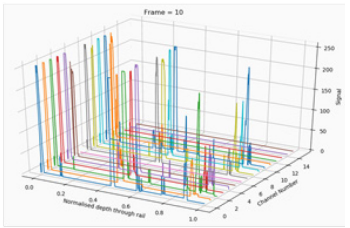
Example Rail Defects

Ultrasonic Testing Rig

Transducer Arrangement



Example A-Scan Dataset



RAILROAD IMPACT

- Current rail NDE technology relies on human interpretation to characterize and classify rail head flaws.
- Increased flaw sizing reliability and inspection speed 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.
- Building on the most recent research of the rail integrity and fatigue life prediction for modern rails.
- Delayed remedial action plan based on remaining life.

PROJECT PARTNERS

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

COST & SCHEDULE

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

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@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 different approaches used for rail flaw imaging.

Special Trackwork Inspection

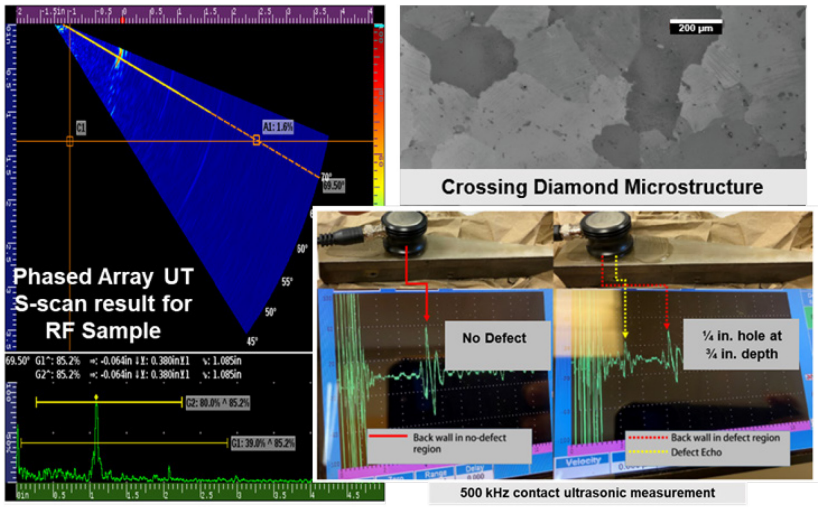
- Explore the advanced low-frequency ultrasonic and electro-magnetic NDE techniques for detecting defects in special trackwork components.
- Fabricate test sample for evaluation testing.

PROJECT PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: $229,974
- Project Duration: October 2020 – December 2021



RAILROAD IMPACT

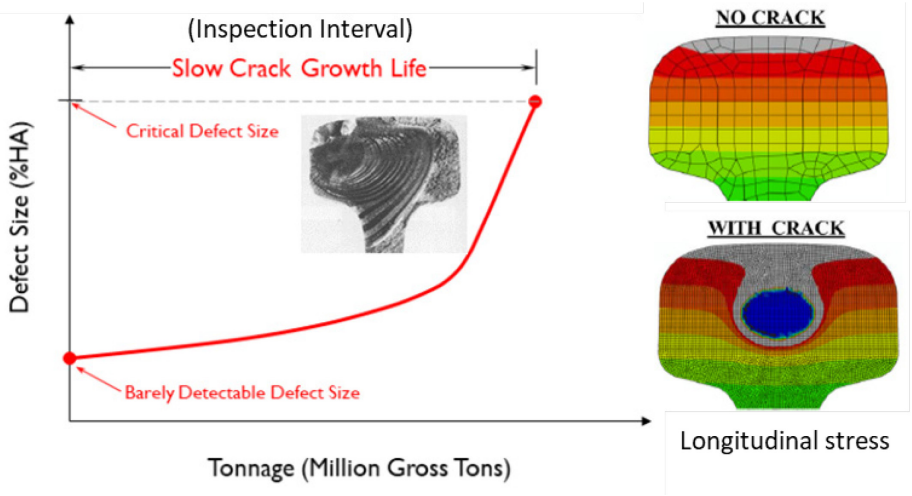
- Support future research directed toward evaluating and improving the performance of current and future rail inspection technologies for use in detecting rail flaws as well as the methods for quantifying them.
- Rail Flaw Library will allow researchers direct access to the realistic rail flaw samples 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 the special trackwork for critical internal defects.

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).
- Enhancement of the analytical detail fracture model for improved prediction of stress intensity factors and therefore fatigue life of rail.
- Investigation of 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

- Project Duration: September 2020 – September 2022
- Funding: $181,237 (to date)
- Additional Funding: $155,018 (Option 1)

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 focused 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, test, and analysis support to resolve safety-related problems and emergencies, determine causal factors, and reduce future problems.
- Supports data gathering for high speed/high cant deficiency qualification and revised safety standards reflecting sound science and engineering expertise.
- Facilitates ongoing technical evaluation required for demonstration and deployment of new technologies for improved safety and operational efficiency.
- Training material for CWR management developed in 2020 will serve as a resource for the rail industry.

PROJECT PARTNERS

- ENSCO, Inc.
- Kandrew Consulting, Inc.

COST & SCHEDULE

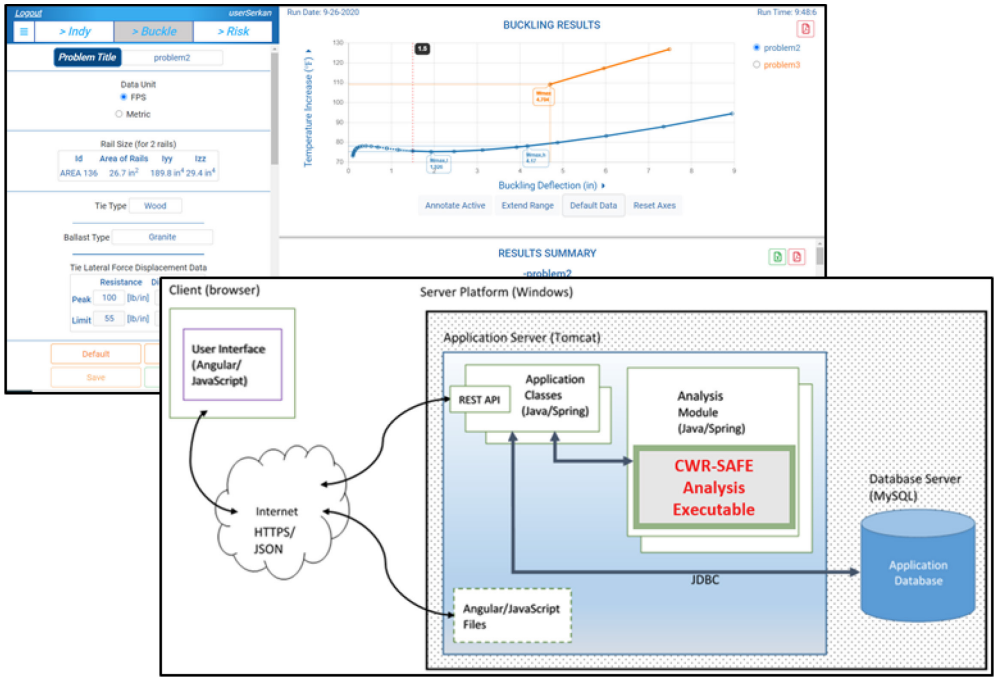
- Funding: $349,830
- Project Duration: September 2018 – December 2021

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

Upgrade of CWR-SAFE Software

PROJECT DESCRIPTION

- Upgrade CWR-SAFE, a computational model for track buckling safety analyses, to run on modern computer operating systems and mobile platforms.
- Implement improvements to user interface with focus on data visualization.
- Promote FRA and industry use of the CWR-SAFE application through provision of the utility via secure website.



RAILROAD IMPACT

- Provide industry with a tool for a deterministic evaluation of buckling strength and safety.
- Prevent or minimize consequences of track buckling-related derailments.
- Allow for sensitivity analysis to better understand impact of different variables on the track buckling safety
- Establish better awareness of track buckling for track personnel.

PROJECT PARTNER

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $344,975
- Project Duration: September 2018 – December 2021

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

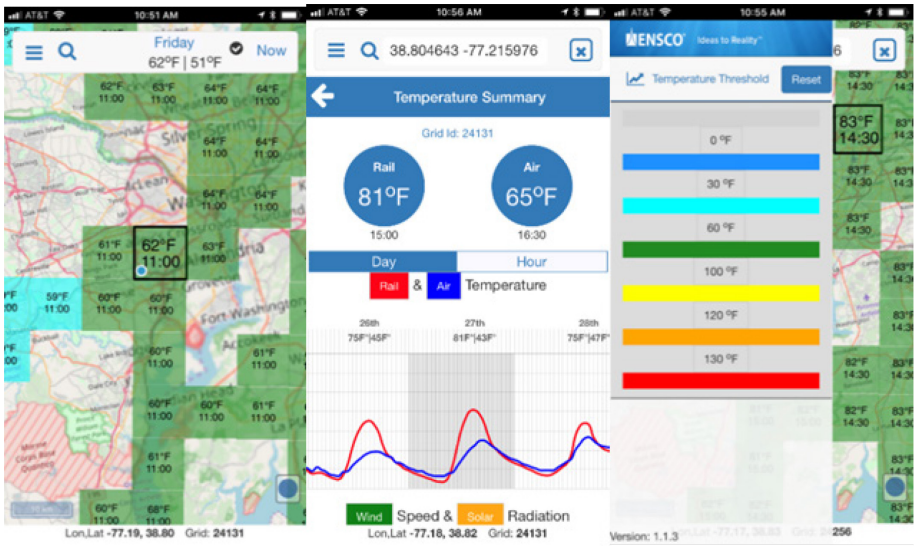
Rail Temperature and Buckling Risk Prediction

PROJECT DESCRIPTION

- Expand the functionality of FRA's existing Rail Temperature and Buckling Risk Prediction web-mobile application.
- Implement continuously welded rail readjustment methodology for standard cases into the application.
- Support training for use of the application, including user documentation and training webinars.

RAILROAD IMPACT

- Provide industry with a tool to issue heat slow orders in a more effective and targeted way.
- Prevent or minimize consequences of track buckling-related derailments by improved heat slow order management process and rail stress adjustment guidance.
- Establish better awareness of rail temperature for track personnel through use of a utility that provides information in near-real time.



PROJECT PARTNERS

- ENSCO, Inc.
- Amtrak

COST & SCHEDULE

- Funding: $144,941
- Project Duration: September 2018 – February 2021

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

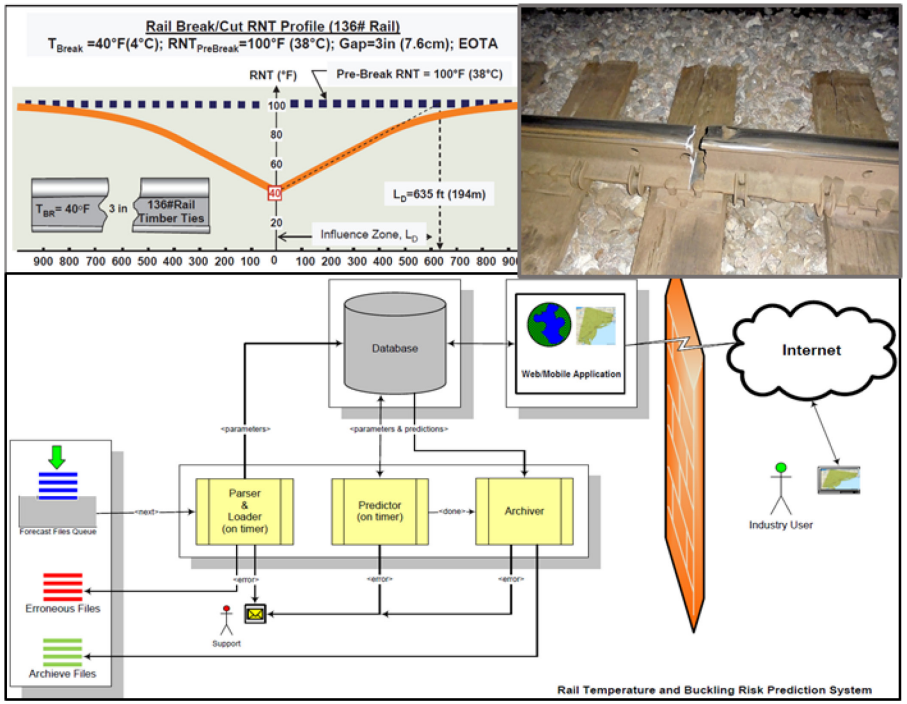
Rail Force Management Technology Implementation and Transfer

PROJECT DESCRIPTION

- Continue research, development, and hosting of important rail force management software tools.
- Develop rail stress adjustment methodology for special cases and implement it into RNT RESTORE application.
- Investigate, select, and validate suitable publicly available weather forecast data that can serve as inputs for the rail temperature prediction model.
- Develop a roadmap for the technology transfer and implementation under FRA Office of Railroad Safety.
- Convert CWR-SAFE core modules from FORTRAN into a more modern programming language.
- User support for the applications, including user documentation and training webinars.

RAILROAD IMPACT

- Provide industry and academia with simple user-friendly access to consolidated suite of software tools that can assist with CWR management, guidance development, and future research.
- Establish better awareness and tools of proper rail stress management methodologies for field personnel.
- Create a platform to disseminate the results of FRA research in the area of longitudinal rail stress and CWR management to industry, academia, and regulators.



PROJECT PARTNERS

- ENSCO, Inc.
- Kandrew Consulting, Inc.

COST & SCHEDULE

- Funding: $99,996 (to date)
- Project Duration: October 2020 – January 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:

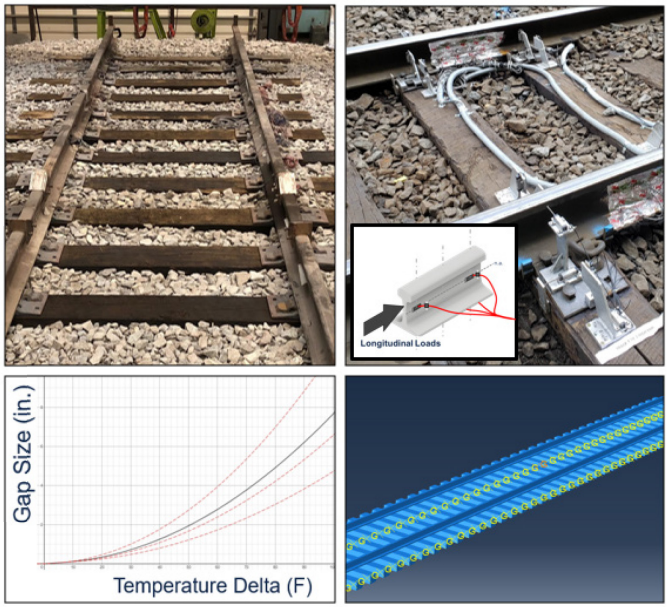
- Provide quantitative assessment of variables influencing axial stress influence zones and guide future rail stress adjustment practices

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 in 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 (RNT) as a function of time/tonnage.
- Improved quantification of how rail gap size and influence zone are influenced by:
  - Fastening system characteristics.
  - Rail tension/compression.
  - Ballast (track) longitudinal stiffness.

PROJECT PARTNERS

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

COST & SCHEDULE

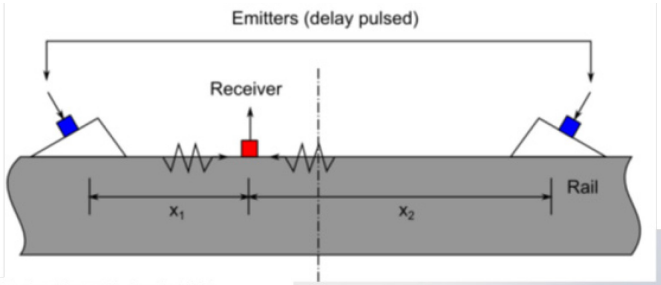
- Funding: $215,000 (to date)
- Project Duration: September 2020 – September 2024
  - Phase 1: September 2020 – November 2021

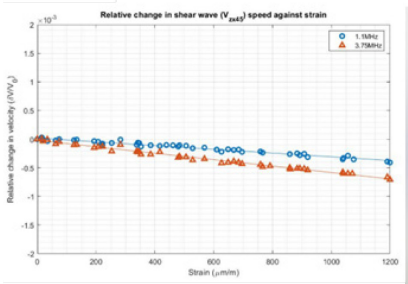
FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

Longitudinal Stress Measurement Using Ultrasound

PROJECT DESCRIPTION

- Demonstrate a measurement of the induced longitudinal stress in continuously welded rail using an ultrasonic system.
- Use sensors aligned in multiple planes to return measurements without reference to a calibration curve.
- Relate the stress value to rail neutral temperature (RNT).
- Return a measurement for rail longitudinal stress without un-pinning rail.





RAILROAD IMPACT

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

PROJECT PARTNER

- University of Sheffield, U.K.

COST & SCHEDULE

- Funding: $150,009
- Project Duration: November 2018 – June 2021

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 rail neutral temperature (RNT) within 5° F using acoustic birefringence (AB) to measure the rail stress.

- Initial test at the Transportation Technology Center (TTC) to verify linear relationship between AB and rail stress for in-situ rail. (Completed: linear relationship confirmed in field conditions. AB data correlated to the TTC strain gauge data throughout the test day within an average error of 1.9 kips, equivalent to an RNT error of 0.7° F.)
- Develop prototype portable instrumentation and sensor for extended field testing and validation.
- 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.
- University of Wyoming College of Engineering and Applied Science
- Transportation Technology Center, Inc.

COST & SCHEDULE

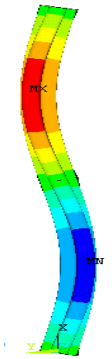
- Funding: $370,245
- Project Duration: September 2019 – September 2022

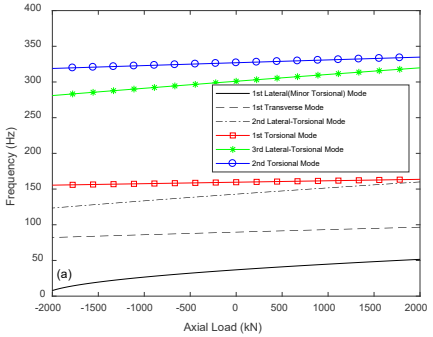
FRA PROJECT MANAGER: Robert Wilson, Ph.D. • (617) 494-2265 • robert.wilson@dot.gov

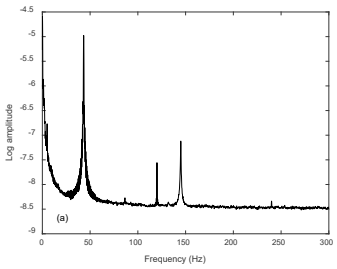
Image Processing and Machine Learning Algorithms to Measure Axial Stress in Rails

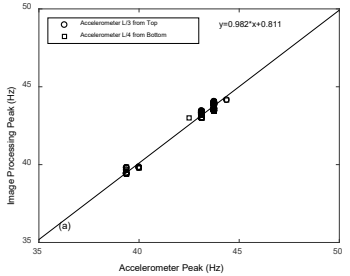
PROJECT DESCRIPTION

- Investigate a new technology able to determine the absolute stress of continuous welded rails (CWRs) without disturbing the track structure, without prior knowledge of the rail neutral temperature (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.
- Performed feasibility laboratory tests on a rail segment.
- Perform the first field test in fall 2020 at the Transportation Technology Center's High Tonnage Loop.









RAILROAD IMPACT

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

PROJECT PARTNERS

- University of Pittsburgh
- Northeastern University
- Transportation Technology Center, Inc.

COST & SCHEDULE

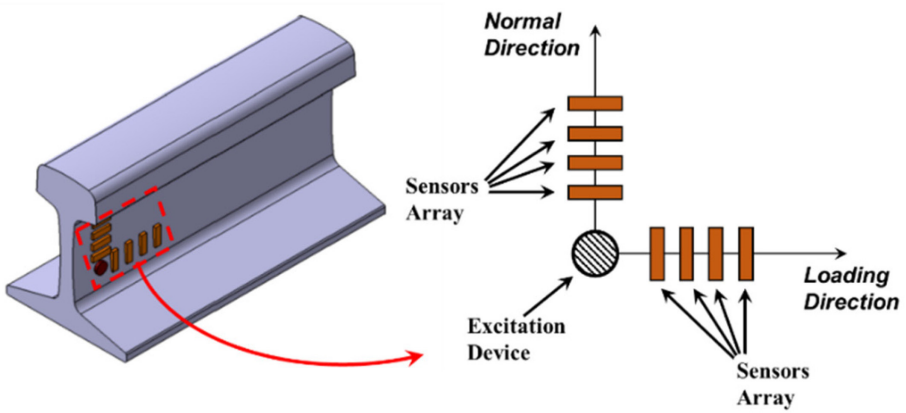
- Funding: $333,449
- Project Duration: July 2019 – July 2022

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

Rail Neutral Temperature (RNT) Measurement

PROJECT DESCRIPTION

- Develop, validate, and implement a novel acoustoelastic-based approach for longitudinal rail stress and neutral temperature measurement.
- The proposed approach has two fundamentally distinctive features compared to current ultrasonic practices:
    1. The utilization of *low-frequency* flexural waves to calculate the state-of-stress, offering enhanced sensitivity and robustness.
    2. The utilization of the vertical (normal-to-loading) direction as a reference, further enhancing the robustness of the technique and allows compensating for uncertainties in rail characteristics.



RAILROAD IMPACT

- Potential to provide reliable, *reference-free* measurements of longitudinal rail stress and neutral temperature.
- Better understanding and management of RNT through regular measurements.
- Ability to spot-check RNT on any given rail.
- Potential to reduce track buckles and pull-aparts.

PROJECT PARTNERS

- Virginia Polytechnic Institute and State University
- Norfolk Southern Railway
- Tennessee Technological University

COST & SCHEDULE

- Funding: $324,190
- Project Duration: July 2018 – September 2021

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

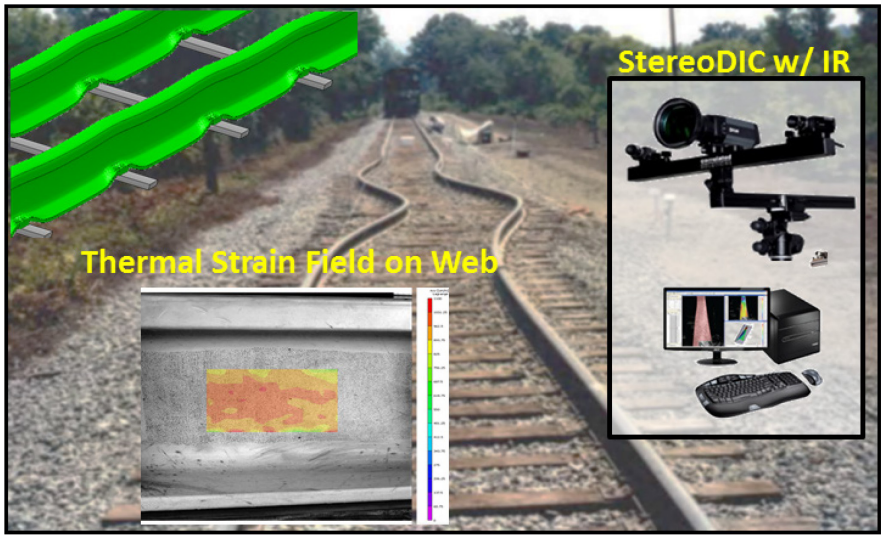
Longitudinal Stress Measurements in Rail Using a Non-Contacting, Reference-Free, Vision-Based Approach

PROJECT DESCRIPTION

A non-contacting vision-based method is proposed to estimate the rail neutral temperature and quantify the stress in the rail. This study will demonstrate the viability of the proposed technique in a laboratory environment.

Tasks

1. Design and build the prototype system.
2. Method verification.
3. Method assessment on physical track section in the laboratory.



RAILROAD IMPACT

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

PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $57,004 (Phase I); $142,544 (Phase II)
- Project Duration: May 2019 – October 2021

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 rail neutral temperature (RNT).
- Plan for Installation at the Transportation Technology Center in Pueblo, Colorado.
- 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 track and rail failures.
- Can bring new measurement technologies to full development faster.
- Can 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 (to date)
- 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

- **Establish Track Stability Technical Advisory Panel**
- **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 (TTC)**
- **Track Stability Test Facility Design Support:**
  - This task will support design (by others) of a test 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**

RAILROAD IMPACT

- Panel to advise, coordinate, and focus industry and FRA RNT research and goals.
- Measure rail movement and RNT changes simultaneously in a curve 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: $279,891 (to date)
- Project Duration: September 2020 – September 2022

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

Ballast Waiver Support

PROJECT DESCRIPTION

- Better define the performance, degradation, variability, and safety of “reduced performance” ballast through a better understanding of its long-term behavior.
- Collect and analyze pertinent information using track inspection vehicles, long-term track instrumentation, ground-penetrating radar, and other available data.
- Continue stakeholder support for the operations under the fouled ballast waiver and the activities related to concurrent, joint Association of American Railroads (AAR)-FRA research effort.

RAILROAD IMPACT

- Better understanding of reduced performance or “fouled” ballast under a range of weather conditions and its effect on track performance and safety-critical conditions.
- Development of objective criteria for both railroads and FRA inspectors to use for identifying and managing fouled ballast conditions.
- Production of information for potential data-driven recommendations related to enforcement of Track Safety Standards §213.103 .
- Improved railroad safety and maintenance operations.

PROJECT PARTNERS

- ENSCO, Inc.
- AAR
- BNSF Railway
- University of Illinois, Urbana-Champaign
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $604,433
- Project Duration: August 2018 – April 2021

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

Quantification of Track Instabilities Due to Ballast Movement at Special Locations Using Integrated Sensor Networks

PROJECT DESCRIPTION

- Develop a platform of hardware and software to: (1) quantify in the field ballast failure mechanism and criteria, and (2) offer a platform for the future real-time ballast stability evaluation and monitoring program.
- Develop advanced sensors with: (1) an onboard programmable ballast failure mechanism and criteria algorithm, and (2) advanced communication protocols such as iBeacon.
- Install field instrumentation of the advanced sensor networks at different locations under different traffic and maintenance conditions.
- Initiate the real-time ballast stability evaluation and monitoring program based on validated ballast failure mechanism and criteria.

RAILROAD IMPACT

- Real-time data collection and integrated analysis systems allow railroads to more accurately identify the instantaneous condition of ballast and track bed and proactively assign maintenance windows to ensure safe and efficient train operation with the least amount of train delay.
- Allow railroads to identify an objective threshold by which they can establish a window or opportunity for ideal track maintenance.
- Technology is “moving platform ready” with iBeacon technology because sensor data can not only be sent to the engineers in real time but can also be stored and “picked up” by geometry cars passing by, with which track engineers will have significant higher-resolution and real-time images of their track in terms of safety and serviceability.

PROJECT PARTNERS

- Penn State University
- HyGround
- Amtrak
- Railroad Technology & Services

COST & SCHEDULE

- FRA Funding: $322,842
- Granted In-kind support from:
  - RTS – 50 “SmartRocks” free of charge and other technical support (equivalent cash value of $48,600)
  - Amtrak – site access and protection, technical support, etc.
- Project Duration: September 2018 – August 2021

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Hugh Thompson • (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 a 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 a gage restraint measurement system, ground-penetrating radar, VTDMS, and similar track evaluation technologies.
- Support field activities for FRA track research.

RAILROAD IMPACT

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

PROJECT PARTNER

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $242,453
- Project Duration: August 2018 – June 2021

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

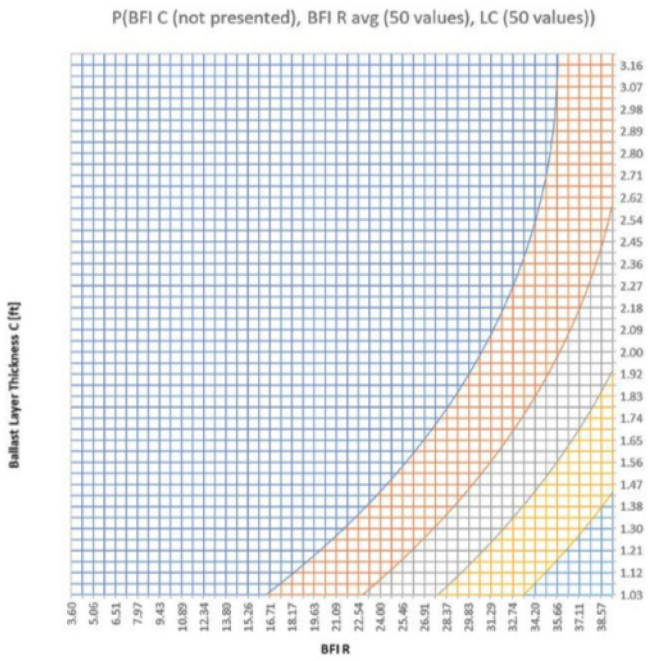
Relationship between Track Geometry Defects and Measured Track Subsurface Conditions

PROJECT DESCRIPTION

- Develop improved and expanded data analytics-based relationships between track substructure inspection parameters and track geometry defect occurrence.
- Focus on GPR data but can include M-rail data as available from FRA DOTX 218/220 consist.
- Provide for identification of track locations with potential for development of track geometry defects that will grow to unsafe levels, considering acceptable inspection intervals.
- Develop analysis algorithm(s) to correlate multiple inspection parameters with track geometry defects.
- Implement framework on suitable dataset with broad range of results.

RAILROAD IMPACT

- Track geometry cars are being equipped with additional inspection technologies to supplement the basic track geometry measurements.
- The ability to use these substructure inspection tools to identify potential track geometry defect initiation sites would be a valuable tool for railroads.
- Provide additional information on where high-risk track geometry defects could develop.
- Improved track safety.
- Lower maintenance costs.



PROJECT PARTNER

- University of Delaware, Railroad Engineering and Safety Program

COST & SCHEDULE

- Funding: $304,000
- Project Duration: September 2019 – September 2021

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

Trackbed Moisture Monitoring System (TMMS)

PROJECT DESCRIPTION

- The proposed Trackbed Moisture Monitoring System (TMMS) is based on a novel adaptation and implementation of existing nuclear magnetic resonance soil moisture measurement technology.
- The outcome will be a rail-mounted system to measure bound and mobile water content to depths of about 20” between the rails.
- Measurements will be obtainable in static and slow-speed transit modes.
- The TMMS will give railroad inspectors a unique tool to remotely measure trackbed water content.
- Results will be directly viewable in the field.

RAILROAD IMPACT

- Fouling materials in ballast absorb moisture and can lead to failure of the formation and pumping of mud from the subgrade. At an advanced stage, this requires expensive rehabilitation of the track.
- Saturated, fouled material decreases the resistance to shear deformation, decreases track support, and affects geometry.
- If fouled materials are allowed to dry, the ballast bed can bind, and the resulting lack of elasticity can damage sleepers and rolling stock.
- Saturated fouled ballast can significantly reduce effectiveness and productivity of ballast cleaning.
- TMMS will provide a direct means of measuring mobile and bound water content of the trackbed in areas targeted by GPR to have fouled BFIs.

PROJECT PARTNERS

- Vista Clara, Inc.
- Zetica Ltd.

COST & SCHEDULE

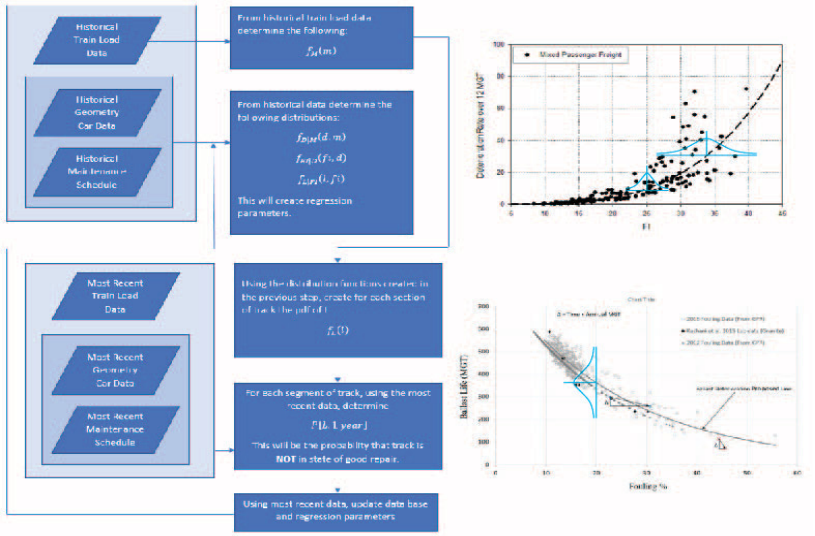
- Funding, FY19/20: $330,000
- Project Duration: September 2018 – September 2021

FRA PROJECT MANAGER: Hugh Thompson • (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 utilize 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.



RAILROAD IMPACT

- Improved 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.
- Probabilistic approach accounts for uncertainty associated with determining maintenance needs of ballasted track.
- Model will be able to predict ballast life, potentially reducing the need for remediation or catching a problematic section of track prior to an imminent need to remediate.

PROJECT PARTNERS

- University of Massachusetts (lead)
- Loram/HyGround Geotechnical Services

COST & SCHEDULE

- Funding: FY19/20 – $315,000
- Project Duration: September 2019 – September 2021

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

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

PROJECT DESCRIPTION

- Support 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, ground-penetrating radar, VTDMS, and similar track evaluation technologies.
- Support field activities for FRA track research.

RAILROAD IMPACT

- Broaden the application of innovative technologies to detect degraded track conditions.
- Improve 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

- Balfour Beatty plc
- Zetica Rail

COST & SCHEDULE

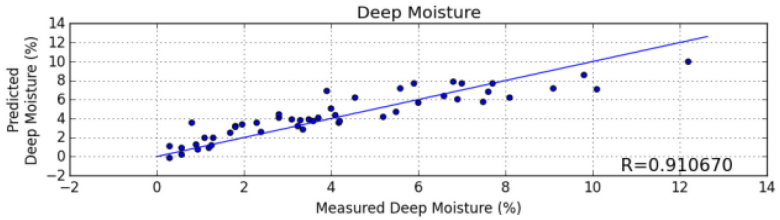
- Funding: $607,362
- Project Duration: September 2018 – September 2022

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

Advanced Development and Field Verification of the RABIT

PROJECT DESCRIPTION

- Further refine a portable, automated instrument to non-invasively determine fouling condition (i.e., "RABIT," or **RA**dar **B**allast **I**nspection **T**ool).
- Collect field data on outdoor test track and revenue service track.
- Compare ground-penetrating radar results with geotechnical laboratory analysis results to show validity of the technique.
- Investigate relationship between ballast condition and ballast performance (i.e., strength).



RAILROAD IMPACT

- Provide real-time fouling measurement; no post-processing required, eliminating the need for highly-trained personnel to interpret the results.
- Plan maintenance based on fouling measurement and relationship between ballast condition and ballast performance (i.e., strength).
- Provide railroad personnel with an automated solution that allows for track to be inspected on their schedule and to spot-check problem areas.

PROJECT PARTNERS

- Earth Science Systems, LLC
- BNSF Railway
- University of Massachusetts at Amherst
- Volpe National Transportation Systems Center
- FRA Office of Railroad Safety (Region 7)

COST & SCHEDULE

- Funding: $252,211.32
- Project Duration: September 2019 – September 2021
  - Field Evaluation with FRA Track Inspector: spring 2020
  - Final Report: 2020

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

U.S.-China Transportation Forum and Technical Exchanges in Rail

PROJECT DESCRIPTION

- Provide assistance in organizing rail-related activities for the U.S.-China Transportation Forum and technical exchanges with various rail organizations in China.
- The Transportation Forum has been postponed and other exchanges have been slowed due to the COVID-19 pandemic.

RAILROAD IMPACT

- Provide opportunities for cooperation and knowledge exchange between U.S. and China rail transportation systems.
- Enhance and promote rail safety programs informed by a broad, international experience and context.

PROJECT PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

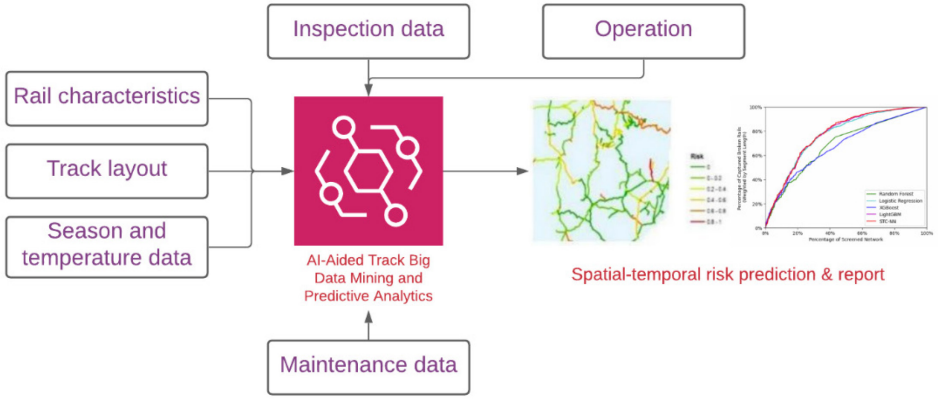
- Funding: $30,000
- Project Duration: July 2019 – June 2021

FRA PROJECT MANAGER: Luis Maal • (719) 584-7155 • luis.maal@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 the optimal track inspection and maintenance decisions.
- The project consists of Phase I (proof of concept and initial development) and Phase II (further development, validation and implementation).



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, The State University of New Jersey
  - Civil & Environmental Engineering Department
  - Computer Science Department
- CSX Transportation
- Port Authority Trans-Hudson

COST & SCHEDULE

- FRA Funding: $675,609
- Project Duration: August 2018 – 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.
- First-of-its-kind cross-agency collaboration between FRA and Federal Highway Administration (FHWA) for the advancement of highway-rail grade crossing safety.

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 our nation’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

- FHWA
- VisioStack, Inc.
- Wi-Tronix, LLC
- Volpe National Transportation Systems Center

COST & SCHEDULE

- FRA Funding: $150,000 · FHWA Funding: $150,000
- Phase I Duration: June 2020 – December 2020

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

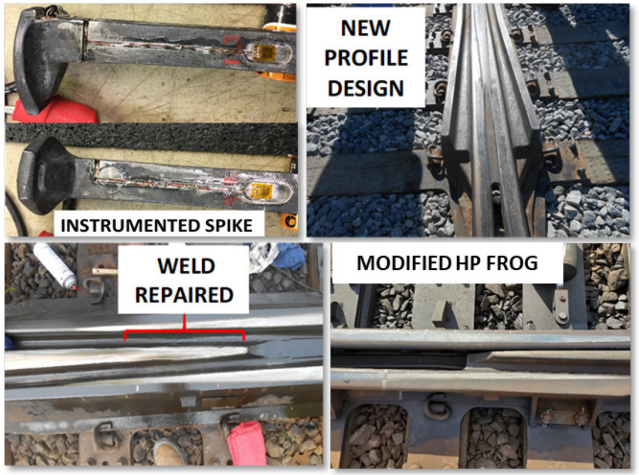
Heavy-Axle-Load (HAL) Research & In-Track Testing

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:
  - **Effects and Characterization of Moisture on Fouled Ballast:**
    - Effects of Light/Heavy Rain Events on Track Settlement using TTC's "Rainy Section"
  - **Improved Tie Performance and Ballast Section for Track Stability:**
    - Engineered-Polymer Composite Grade Crossing Tie Study
  - **Improved Fastening Systems for Various Tie Types:**
    - Investigation of Spike-Fastener Breakage under HAL
  - **New and Untried Special Trackwork Designs:**
    - Prototype Frog, New Profile Design & Weld Repair Performance Evaluations

COST & SCHEDULE

- FRA Funding: $653,538
- Project Duration: July 2020 – September 2022



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

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

Field Testing Support at Transportation Technology Center

PROJECT DESCRIPTION

- Provide multiple university- and third-party-led research initiatives with on-site 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:
  - Support of the Edison Welding Institute's in-track testing of a portable friction welding system for attaching signal wire to 136RE rail.
  - Support the initial field evaluation of seismic ballast inspection tool developed by Earth Sciences Systems, LLC, for the measurement of seismic properties of the ballast, sub-ballast, and subgrade for determining elastic moduli and stiffness.
  - Support of track geometry precision testing of the FRA's Automated Track Inspection Program (ATIP) fleet on the High-Speed Perturbation Slab Track.

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

Data Products for FRA's ATIP Imaging Systems

PROJECT DESCRIPTION

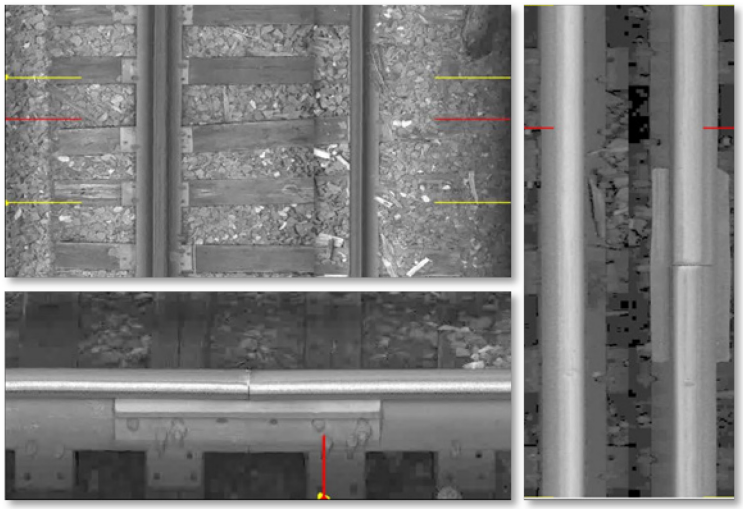
- Identify, develop, and integrate new information products from the data collected by the DOTX-220's Track Component Imaging System (TCIS) and Joint Bar Inspection System (JBIS) in support the FRA Automated Track Inspection Program's (ATIP) safety mission and the Office of Research, Development, and Technology's research objectives.
- Analyze outputs from the TCIS and JBIS system and relate to common safety issues faced by FRA. Initial efforts focused on the capture of images around switches, frogs, and areas containing track defects identified by complimentary inspection systems.
- Develop new reporting methods which produce high-resolution images of the rails and track bed surrounding defects and other points of interest.

PROJECT PARTNERS

- ENSCO, Inc.
- FRA Office of Railroad Safety (ATIP)

COST & SCHEDULE

- FRA Funding: $150,000
- Project Duration: July 2019 – November 2020



RAILROAD IMPACT

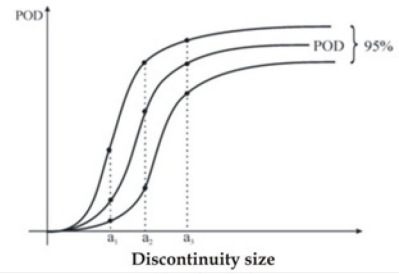
- Further development of automated vision-based inspection technologies that can isolate areas of the track structure with potentially unsafe conditions.
- Improve track inspection quality and efficiency, allowing for safety-critical maintenance to be conducted in a more timely manner.
- Introduction of high-resolution imagery to traditional tools used to identify defect conditions by FRA's ATIP vehicles and expansion of the off-track inspection toolset for safer inspections.
    - Higher level of understanding of track conditions that result in a geometry or other defect condition by adding context with two-dimensional data products.

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 technology.
- 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.



		Predicted class: P	Predicted class: N
Actual Class	P	True Positives (TP)	False Negatives (FN)
	N	False Positives (FP)	True Negatives (TN)

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

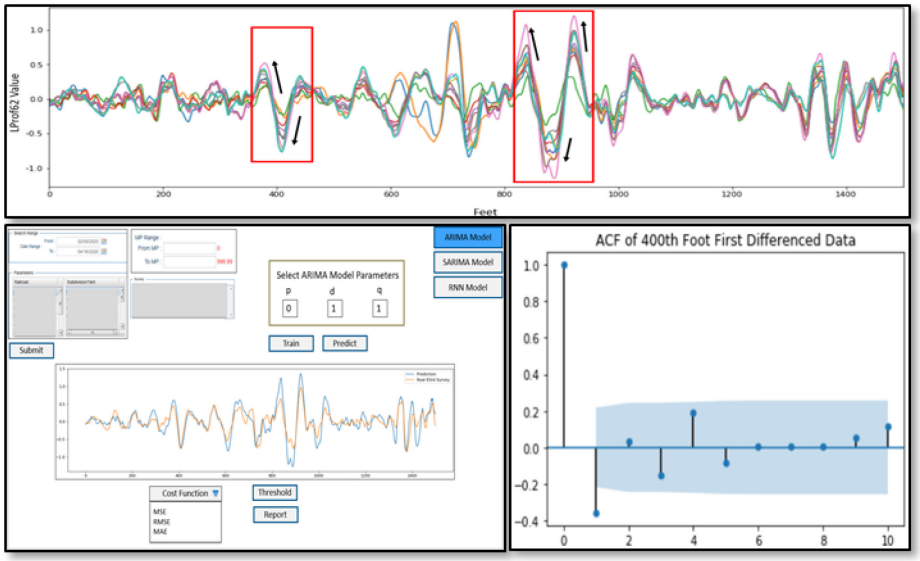
- FRA Funding: $499,800
- Project Duration:
  - Phase I: September 2019 – July 2020
  - Phase II: July 2020 – March 2021
  - Phase III: March 2021 – September 2022

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

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 effectively planning preventive maintenance activities.
- Improved data cleaning, filtering, and generating missing data points.
- Further advance application of autonomous track geometry systems through integration with advanced predictive analytics.

PROJECT PARTNERS

- ENSCO, Inc.
- Metro-North Railroad

COST & SCHEDULE

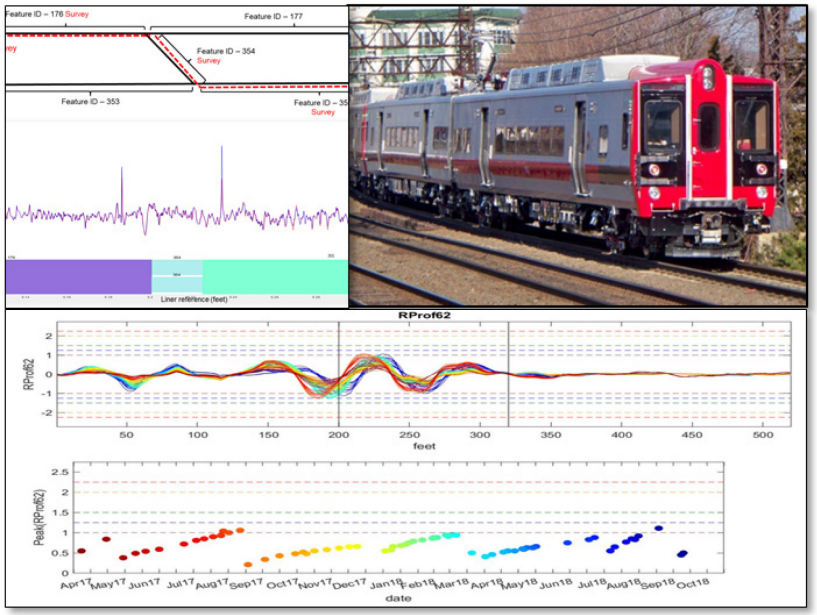
- FRA Funding: $199,982
- Project Duration:
  - Phase I: October 2020 – January 2021
  - Phase II: February 2021 – September 2021

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 for routine, frequent, track-related data to allow railroads to better monitor track conditions and facilitate predictive approaches to preventive maintenance.
- This project leverages 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.
- This project will also focus on the identification of root causes of excessive degradation rates to guide corrective actions and extend maintenance cycles.



RAILROAD IMPACT

- This project is intended to serve as a demonstration to the entire railroad industry of 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

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

U.S. Department of Transportation
Federal Railroad Administration

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

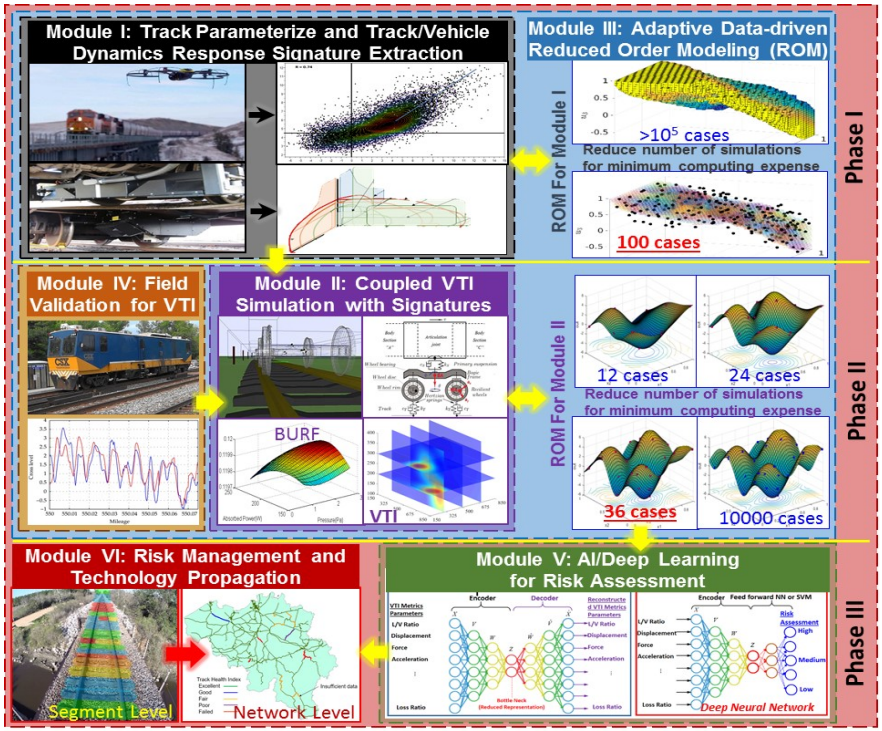
Intelligent Risk Assessment and Prediction System (i-RAPS)

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.
- Effectively utilize 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

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

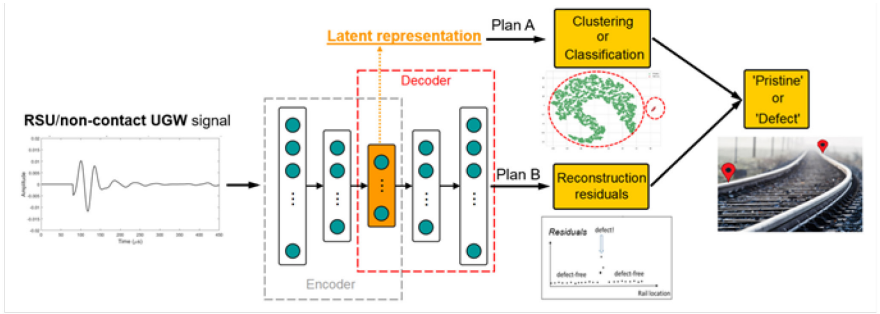
U.S. Department of Transportation
Federal Railroad Administration

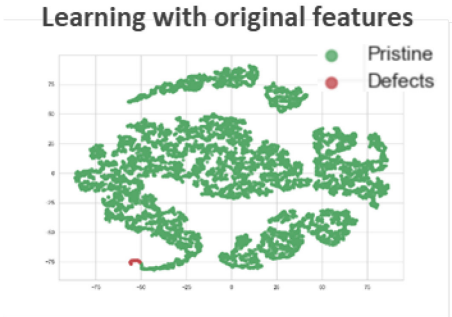
FRA PROJECT MANAGER: Jay Baillargeon • (719) 584-7155 • jay.baillargeon@dot.gov

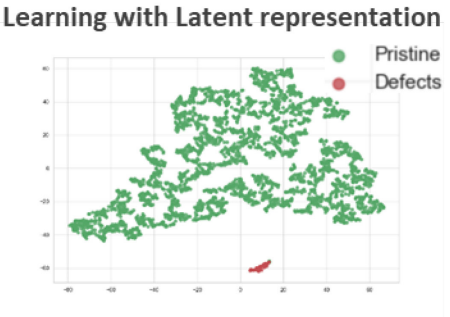
High-Speed Rail Inspection Using Anomaly Detection

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 leveraging:
  - Ultrasonic rolling search unit data.
  - Field test data from a prototype non-contact ultrasonic guided wave inspection system.
  - Recent advancements in machine learning to provide 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 Tech, LLC

COST & SCHEDULE

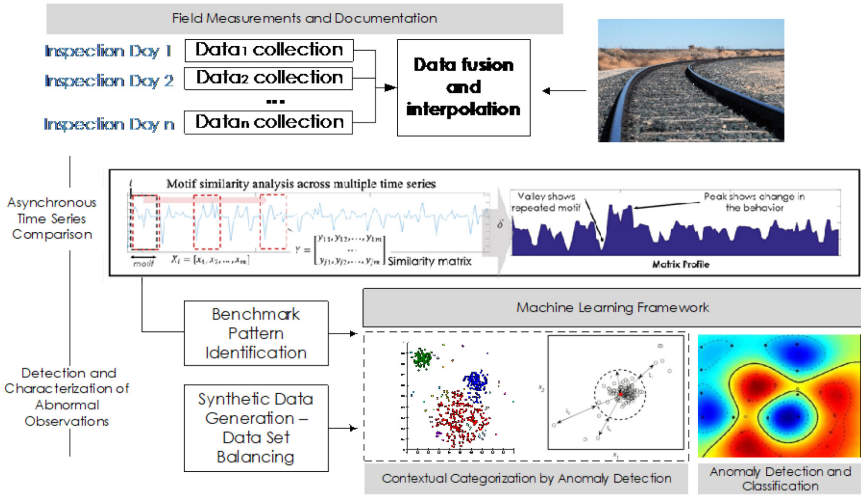
- FRA Funding: $180,000
- Project Duration: June 2020 – December 2021

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.
- Leverage 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 for the Nation's railways.

PROJECT PARTNERS

- Virginia Polytechnic Institute and State University
- Amtrak

COST & SCHEDULE

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

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

Influence of Track Irregularities on Derailment Safety

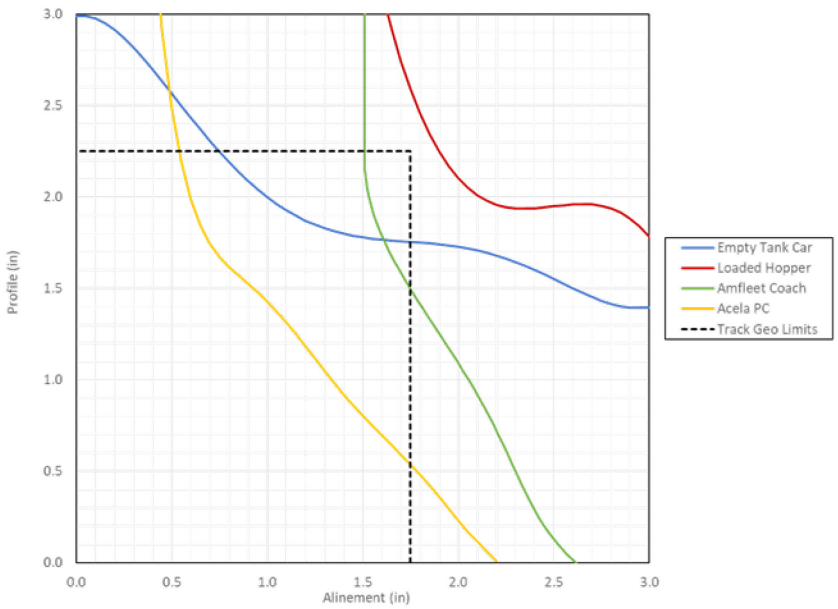
PROJECT DESCRIPTION

- Develop validated computer models of freight and passenger rail vehicles to study dynamic response for speeds up to 220 mph.
- Collaborate with Transportation Technology Center, Inc., 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 needs in terms of identifying safe track geometry limits and procedures used for assessing the performance of new rail vehicles from a derailment safety standpoint.
- 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

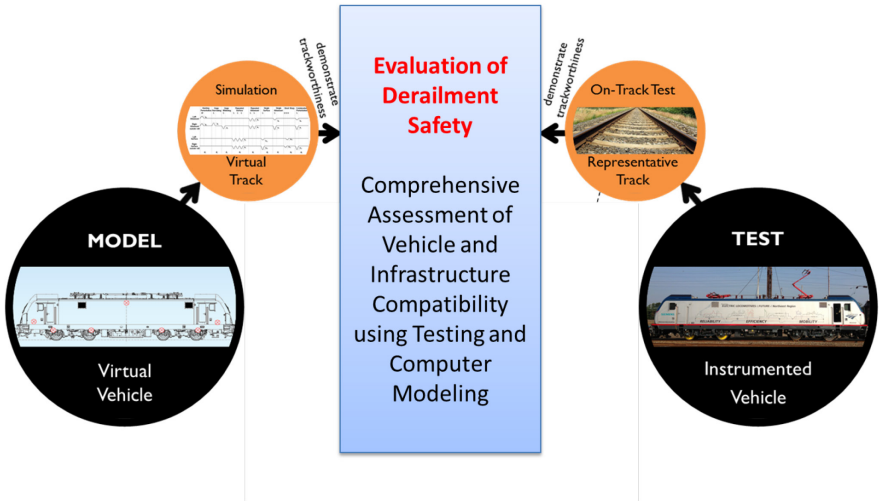
- Funding: $400,000
- Project Duration: May 2021 – June 2022

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

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 usage 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

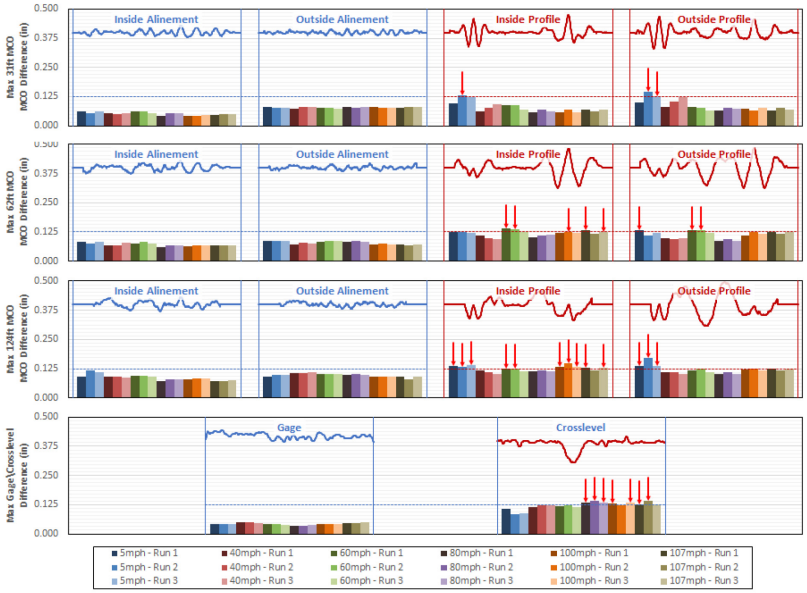
- Funding: $400,000
- Project Duration: May 2020 – June 2022

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

Procedure for Assessing Accuracy of ATGMS

PROJECT DESCRIPTION

- Develop a test procedure that could be used 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

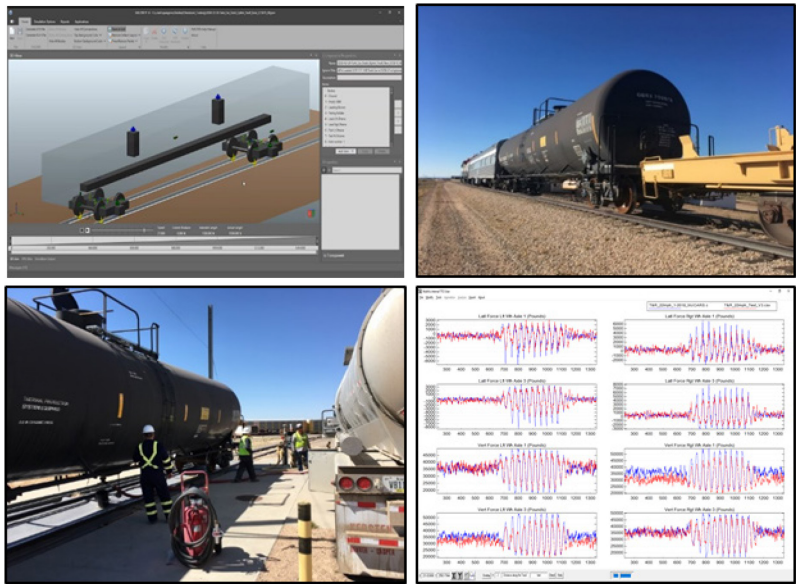
- Funding: $400,000
- Project Duration: May 2020 – June 2022

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

Track Geometry and Vehicle Performance

PROJECT DESCRIPTION

- Phases II and III consists of evaluating tank car dynamic performance and improving the tank car model developed under Phase I of the project. To that end, FRA procured a tank car DOT-117A100W1 for vehicle characterization and on-track tests.
- Conduct full-scale tank car tests on Transportation Technology Center test tracks, including the High Tonnage Loop, Precision Test Track, Wheel/Rail Mechanism loop, and Railroad Test Track. For the loaded condition, crude oil and water are to be used as lading. Data acquired from the various tests will be utilized for developing and optimizing tank car pendulum and fixed-mass model designed to account for lateral sloshing effects of fluid.



RAILROAD IMPACT

- Conducting on-track testing for empty and loaded conditions of a DOT-117 tank allows for the assessment of the vehicle dynamic behavior and provides critical data for developing the pendulum and fixed-mass NUCARS® tank car model designed to account for lateral fluid sloshing.
- The use of crude oil and water as the lading for the loaded condition duplicates the typical revenue service condition.
- The tank car model can be reliably deployed to enhance applicable track geometry limits for safer DOT-117 tank car performance.

PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $1,309,736
- Project Duration: September 2016 – September 2021

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

Steering Traction on Wheel and Rail Damage – Full-Scale Testing with RCF Simulator (RCFS)

PROJECT DESCRIPTION

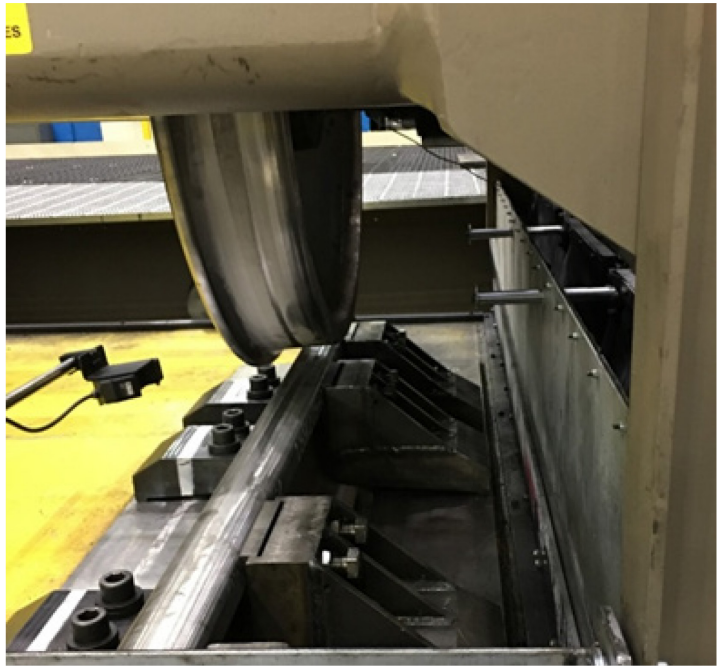
- The RCFS developed and installed in the Rail Dynamics Laboratory at FRA's Transportation Technology Center in Pueblo, Colorado.
- RCFS is capable of testing full-scale freight and passenger wheelsets and rails under current and anticipated load conditions with precisely controlled variables.
- Testing at various traction forces under 36-ton axle load shows plastic flow, combination of plastic flow and wear, and wear.
- RCF and wear performance of different class wheels and rails are investigated: wheel/rail contact forces, creep force, creepage characteristic measurement, lubrication and rail grinding effect on RCF, and tribology study.

RAILROAD IMPACT

- RCF may mask deeper-seated cracks in rail from ultrasonic detection.
- Reduction of RCF through optimization of wheel and rail materials, profiles, and maintenance procedures.
- Measured wheel/rail contact creep characteristics provide valuable information for developing maintenance strategy and safety limits.

PROJECT PARTNERS

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



COST & SCHEDULE

- Funding: $298,169
- Project Duration: September 2019 – June 2021
- Load cell modification conducted in late 2019 for improved accuracy.
- Influence of water and solid lubricant on rail RCF was conducted through multiple tests in 2019–2020. Wear, RCF crack length and deformation depth measurements were collected and are currently undergoing analysis.

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

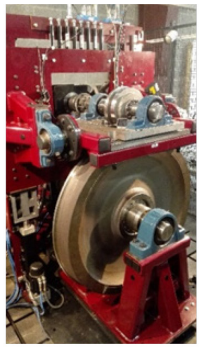
Experimental Evaluation of Wheel/Rail Contact, Third-Body Layer, and Surface Finish on Risk of Derailment

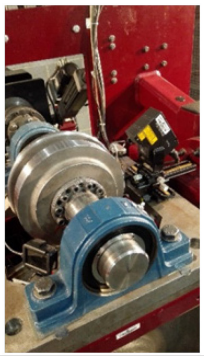
PROJECT DESCRIPTION

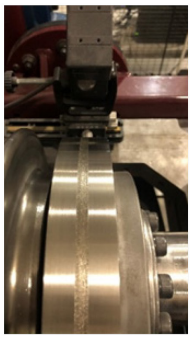
- Provide an experimental evaluation of numerical models that are widely used by the rail industry, such as CONTACT, for predicting derailment.
- Evaluate the effect of rolling stock operating conditions such as large angle of attack (AoA) and rail cant angle on contact dynamics and lateral-to-vertical force ratio (L/V) as a derailment indicator.
- Determine the effect of wheel surface finish and third-body layers occurring naturally or added to the track on longitudinal and lateral traction at the wheel-rail interface (WRI).
- Provide guidelines for corrective actions regarding wheel re-surfacing, operating newly-machined wheels, and possibly the condemning of hollow-worn wheels, to assist FRA and the U.S. rail industry with rolling stock safety.

RAILROAD IMPACT

- Understanding the complex mechanics and dynamics that occur at the WRI is critical for improving railway operational safety and efficiency.
- Introducing a new level of accuracy for measuring a multitude of contact parameters critical in WRI modeling and technology advancement for both passenger and freight trains, far beyond the means currently available to FRA and the rail industry.
- Scientifically evaluating parameters and conditions that affect wheel-rail wear but cannot be evaluated accurately in the field due to the naturally-varied conditions.
- Providing design considerations that can assist FRA in further improving the safety of U.S. railroads.

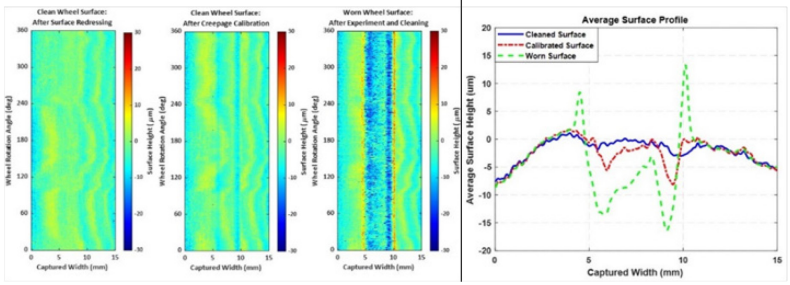






Wheel Surface Images Before and After an Experiment with Friction Modifier

Wheel Surface Profile Changes Caused by Wear



PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $564,852.00
- Project Duration: September 2019 – September 2021

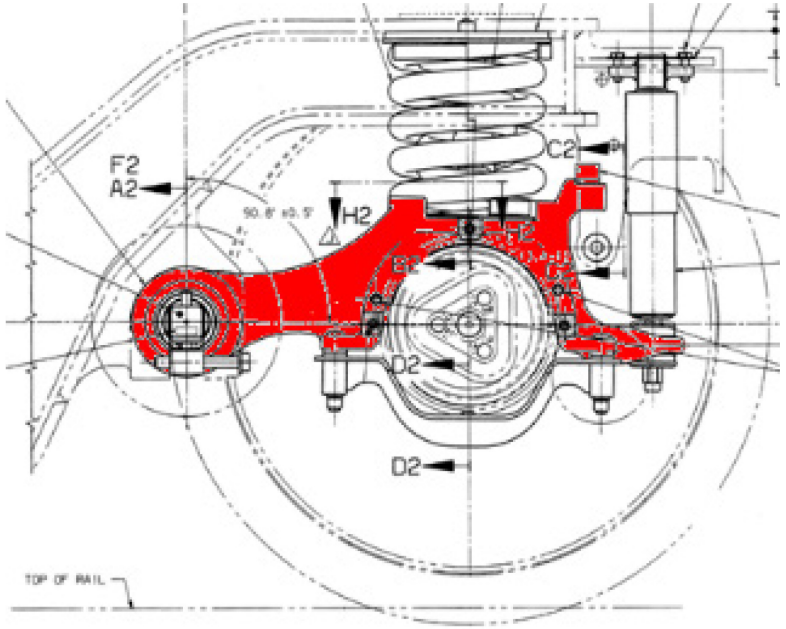
U.S. Department of Transportation
Federal Railroad Administration

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 the trucks.
- Investigate the need for modifications in the methods that 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

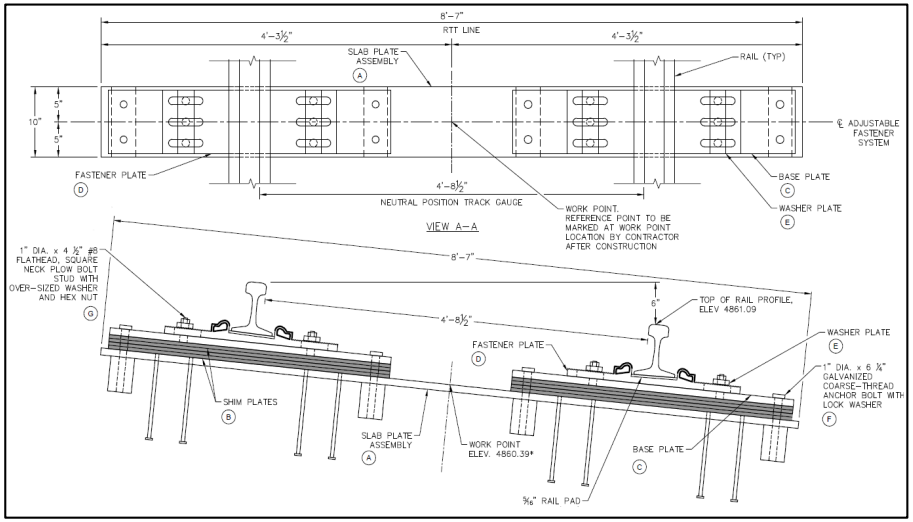
- Funding – testing to characterize springs: $200,000
- Project Duration: 2020 – 2022

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

Adjustable Precision Curved Track Anomaly Test Section

PROJECT DESCRIPTION

- Track geometry measurement validation and vehicle-track interaction testing are critical functions for safety and operations of railroads, especially for high-speed passenger trains.
- This project covers the development of designs for 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.
- This track section can be used to validate a track geometry measurement system, especially for high-speed track inspection.
- For high-speed passenger rail, the track anomaly test section will 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.

COST & SCHEDULE

- Funding: $1,340,914
- Project Duration: September 2018 – December 2020
  - Construction scheduled for 2021

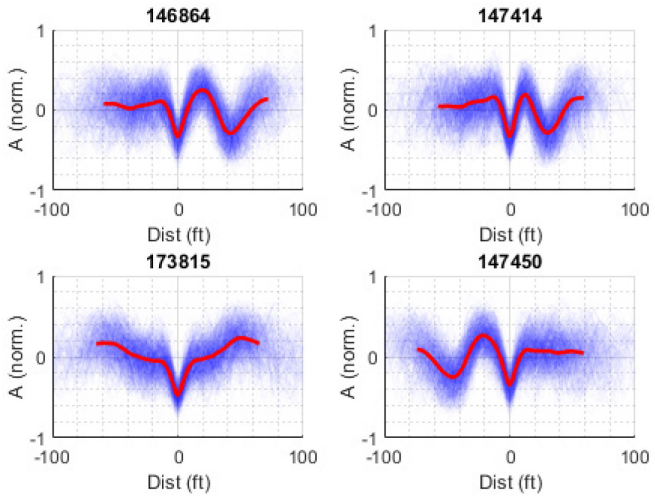
U.S. Department of Transportation
Federal Railroad Administration

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

Characterization of Track Geometry for Various Operational Conditions

PROJECT DESCRIPTION

- Conduct a review of modern literature covering measurement and characterization of track geometry:
  - Measurement methods
  - Processing procedures and settings
  - Characterization and analysis methods
- Using state-of-the-art methodology, analyze track geometry data collected on FRA and Amtrak track geometry cars.
- Investigate state of the art numerical characterization methods.
- Characterize the amplitude and wavelength content of the current track geometry environment of the U.S. rail system under various operational conditions, including:
  - Track Classes 1–8
  - Tangent vs. curved track
  - Traffic type (freight vs. passenger)
  - Crosstie type
- Examine the correlations between track geometry variables (gage, crosslevel, alignment, profile).



PROJECT PARTNERS

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

RAILROAD IMPACT

- Recommendations on best practices for track geometry measurement will be provided.
- Characterization results can be used to develop new analytical and empirical track geometry inputs for use in rail vehicle simulations and tests.

COST & SCHEDULE

- Funding: $314,512
- Project Duration: September 2018 – December 2021
  - Literature review and interim report: March 2019
  - Final Report: 2021
  - Conference paper and presentation: 2021

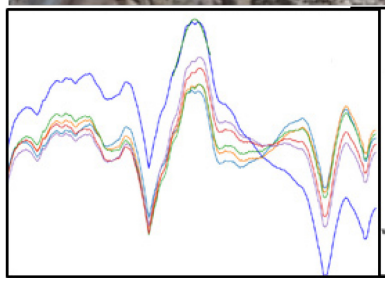
U.S. Department of Transportation
Federal Railroad Administration

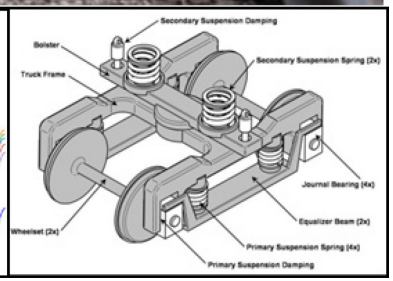
FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Vehicle-Track Interaction Testing, Modeling, and Analyses

PROJECT DESCRIPTION

- Assist FRA Office of Research, Development, and Technology in modeling, simulation, test, data collection, and analyses of vehicle-track-interaction-related issues.
- Efforts include evaluating current track geometry standards and exploring influence of track geometry characteristics and speeds on vehicle dynamic forces.
- Current activities focused on characterizing current track conditions across the nation's rail network for use in assessing derailment risks.





RAILROAD IMPACT

- Studies in this area lead directly to reduced derailment risk, track degradation, vehicle wear or damage, lading damage, and passenger discomfort.
- Research here considers performance-based track geometry tolerances and vehicle design parameters that ensure safety and maximize effective and efficient use of maintenance resources.

PROJECT PARTNER

- ENSCO Inc.

COST & SCHEDULE

- Funding: $468,000
- Project Duration: September 2018 – June 2021

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6438 • 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 TGMS systems 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 that will verify the accuracy of track geometry measurement systems.
- Once the condition of the test track is precisely determined using this system, the track can be a benchmark for use in validating a wide range of measurement systems and dynamic modeling exercises.

PROJECT PARTNERS

- ENSCO, Inc.
- Volpe National Transportation Center

COST & SCHEDULE

- Funding: $572,248
- Project Duration: September 2018 – March 2021

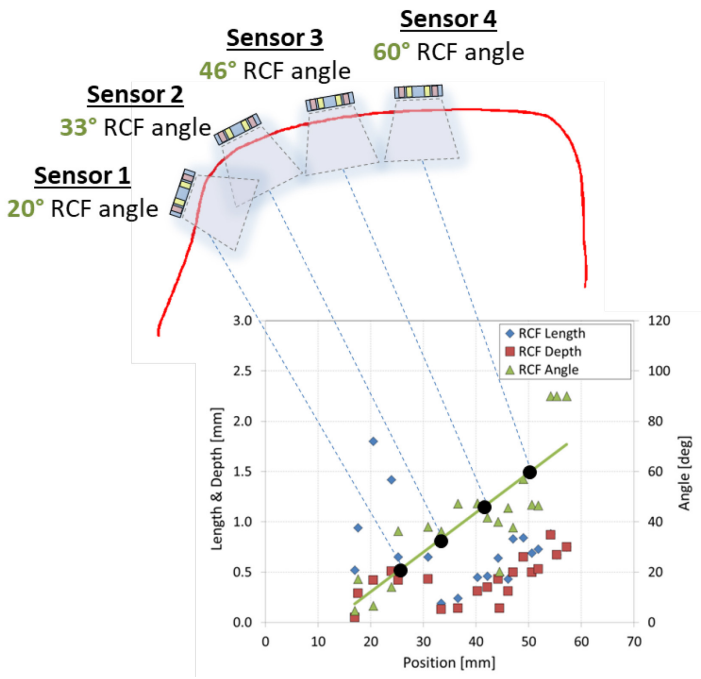
FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6438 • ali.tajaddini@dot.gov

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 rolling contact fatigue (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 at the 2019 ICRI workshop. An additional 4 sections of TTCI Nippon HEX premium rails have been examined, and the metallography work is underway for another four sections of ISG, EVRAZ RMSM, and Mittal premium rail from CSX Transportation. All outputs will be added to the existing RCF matrix and published in a final Technical Report in March 2021.



RAILROAD IMPACT

- **Safety:** Understanding rail subsurface RCF damage as a function of track curvature and million gross ton 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 modelling experts for predicting rail life under variable conditions.

PROJECT PARTNER

- National Research Council Canada

COST & SCHEDULE

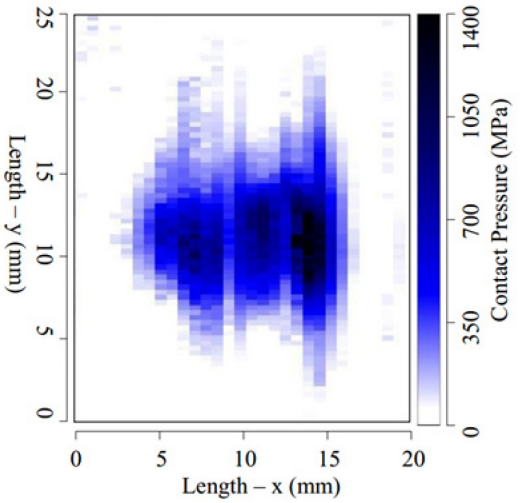
- Funding, 2017 – 2018: $95,000; 2019 – 2020 (18 months): $175,000
- Project Duration: 2017 – 2021

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

- The 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.
- The 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, funding supports management of the 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 6 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

U.S. Department of Transportation
Federal Railroad Administration

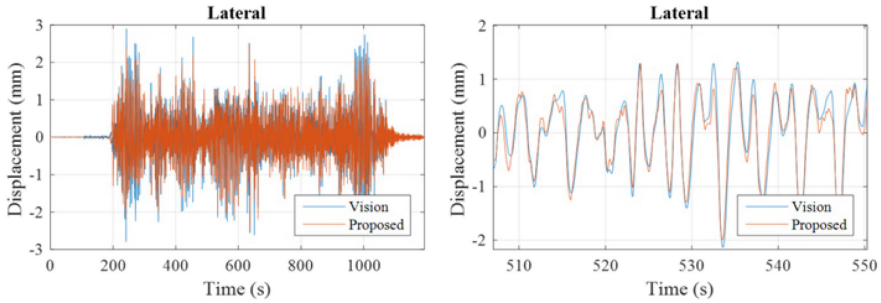
FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Bridge Condition Assessment Using Smart Sensors

PROJECT DESCRIPTION

Phase 2 Development Effort:

- 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 – August 2021

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 Test 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, Canadian National Railway
- Suppliers: Pandrol, Vossloh North America, Evertrack

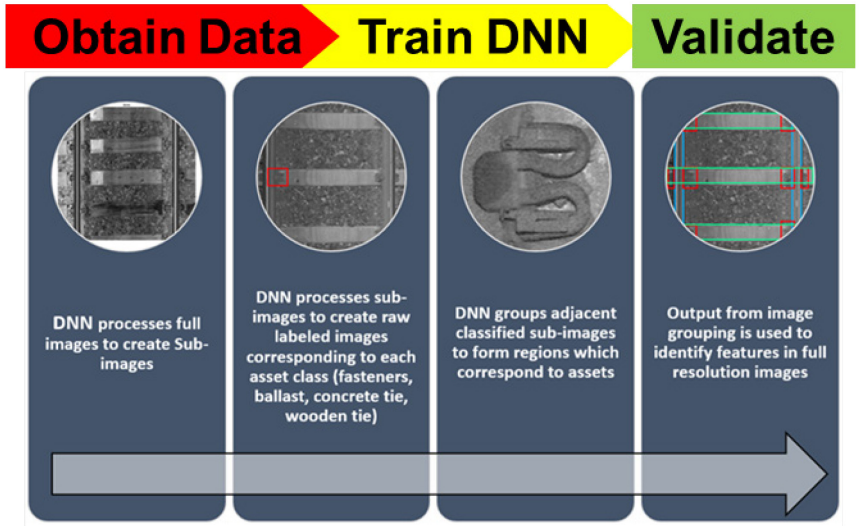
U.S. Department of Transportation
Federal Railroad Administration

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

Laser Triangulation and Deep Neural Networks for Railway Safety Inspections

PROJECT DESCRIPTION

- Evaluate the potential for use of laser triangulation and deep neural networks (DNNs) technology to improve railway inspections
- Mount sensors on FAST train at the Transportation Technology Center.
- Capture repeat scans using laser triangulation.
- Identify defects and build defect database.
- Train a DeepCNet-based neural network in the automated identification of defects.
- Evaluate performance of DNN through separate validation dataset.



RAILROAD IMPACT

- Automation of manual track inspection activities.
- Improve railway network safety through improved reliability and robustness of track inspections.
- 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.

COST & SCHEDULE

- Funding: $300,000
- Project Duration: April 2019 – October 2020

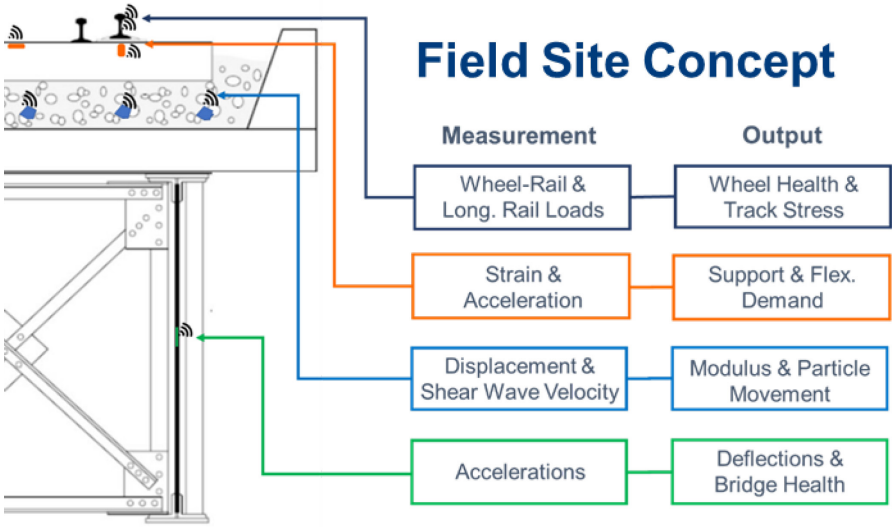
U.S. Department of Transportation
Federal Railroad Administration

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

Smart Track – Wireless Continuous Monitoring of Track Condition and Stress State Reporting

PROJECT DESCRIPTION

- Conceptual design (Phase 1) of system aimed at improving the ability to monitor and predict track health through the development and implementation of smart infrastructure capable of transmitting state-of-repair exception reports.
- 100% wireless deployment of existing, proven, forms of track instrumentation.
- Develop coordinated instrumentation communication protocol for revenue service use.
- Install field locations on Class I railroads.



RAILROAD IMPACT

- Improve railway network safety through improved reliability and robustness of track health state.
- Improve track safety through better infrastructure asset management and utilization.
- Provide value-added inspection data to existing track health data (e.g., geometry cars, vision systems).
- Project team will serve as a sounding board for future candidate forms of instrumentation or communication hardware and software.

PROJECT PARTNERS

- University of Illinois at Urbana-Champaign
- Amtrak
- BNSF Railway
- Union Pacific Railroad
- Vossloh North America
- voestalpine Nortrak
- Penn State – Altoona
- OnTrak, LLC

COST & SCHEDULE

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

U.S. Department of Transportation
Federal Railroad Administration

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

Track Structure Modification to Reduce Track Pressure and Settlement at Transition Areas

PROJECT DESCRIPTION

- Instrument track sections at the middle and portal of the Virginia Avenue Tunnel (CSX) in Washington, DC.
- Monitor track sections to determine benefits of under tie pads and under ballast mats.
- Optimize under tie pads and ballast mat design.

RAILROAD IMPACT

- Determine pressure distributions present at track transition sections with time.
- Determine benefits of under tie pads and under ballast mats especially at track transition areas.
- Determine optimal track structural system at transition areas for track durability and safety.

PROJECT PARTNERS

- University of Florida
- CSX Transportation

COST & SCHEDULE

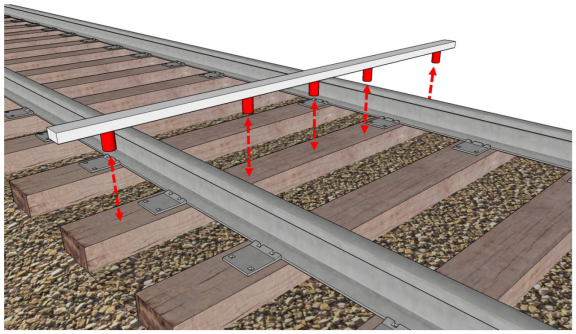
- Funding: $170,000
- Project Duration: January 2018 – January 2021

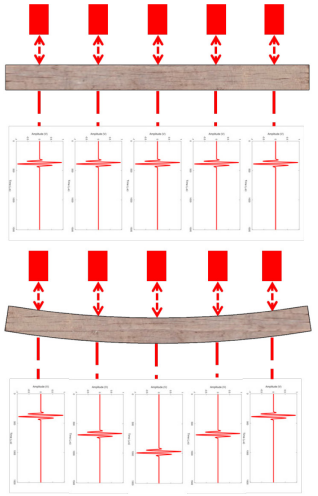
FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Airborne “Sonar” for High-Speed Tie Vertical Deflection Measurement

PROJECT DESCRIPTION

- Feasibility study to determine the efficacy of a sonar-type system to measure tie deflection under freight loads from a moving platform.
- Sensors will track the spatial position of selected points along the top surface of the tie.
- Project includes extensive testing in the lab, at a controlled field test site, and on revenue or yard tracks with a rail partner.





RAILROAD IMPACT

- Deflected tie shape is an indicator of poor ballast support and can lead to tie failure
- Center-bound tie condition can lead to bending load failures and derailments.
- Accurate measurement of the tie vertical deflection, magnitude, and shape can potentially provide qualitative evidence of a deteriorated support condition. Such data will guide remedial actions and ultimately prevent derailments.

PROJECT PARTNERS

- University of California, San Diego
- BNSF Railway

COST & SCHEDULE

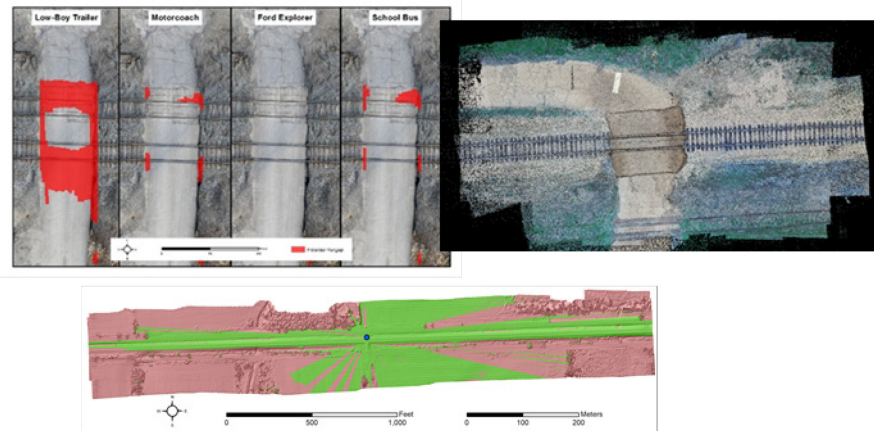
- Funding: $130,000
- Project Duration: September 2019 – December 2020

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

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

PROJECT DESCRIPTION

- Phase 1 and Phase 2 SBIR program (two projects) to develop an automated method to inspection 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 leverage 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
- VisioStack, Inc.

COST & SCHEDULE

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

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@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 Locomotive Waste Heat Recovery System (L-WHRS).
- Quantify the L-WHRS ability to generate pollution-free electric power from locomotive exhaust gases.
- Develop and test an Energy Storage System (ESS) 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 be used to augment locomotive electric power availability.
- Available power can eliminate the need to idle the locomotive engine or require shore power connection for maintaining climate controlled cab.

PROJECT PARTNERS

- ThermaDynamics Rail LLC
- Norfolk Southern Railway

COST & SCHEDULE

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

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

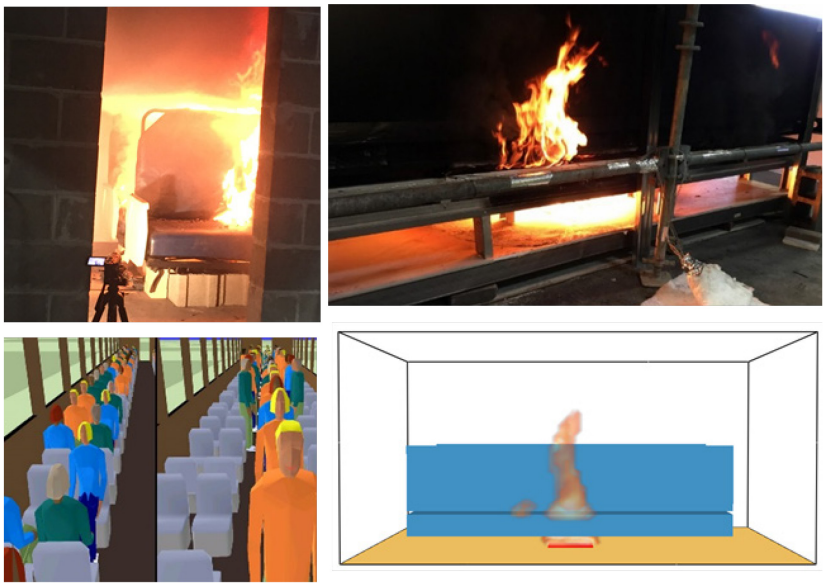
Fire Safety and Emergency Egress Research

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 rail cars 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 rail car.

RAILROAD IMPACT

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



PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

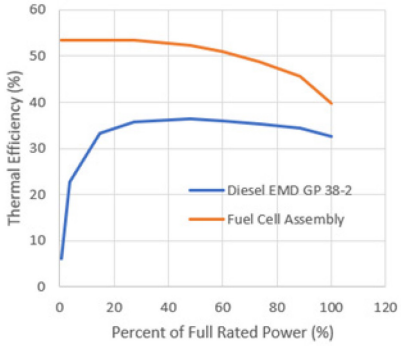
- Funding: $255,000
- Project Duration: October 2019 – September 2021

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

Alternative Fuels Research – Hydrogen and Fuel Cell for Rail Applications

PROJECT DESCRIPTION

- Evaluate the merit of utilizing a hydrogen fuel cell in railroad application.
- 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 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.



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 GREET model provides a tool for the assessment of efficiency and emissions of alternative fuels in rail.

PROJECT PARTNER

- Sandia National Laboratories

COST & SCHEDULE

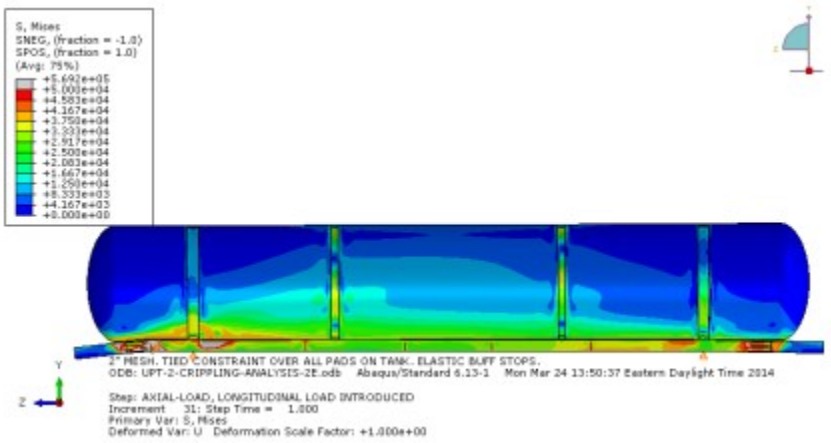
- Funding: $550,000
- Project Duration: August 2020 – December 2025

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

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 (CNG), 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: $1,350,000
- Project Duration: May 2013 – April 2020

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

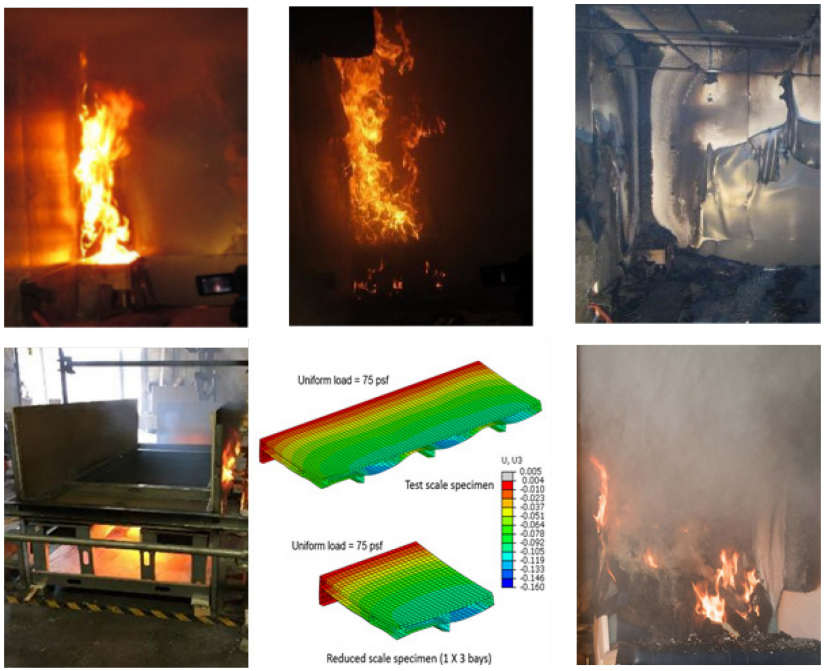
Fire Engineering Research

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 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.
- Recommendations on 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

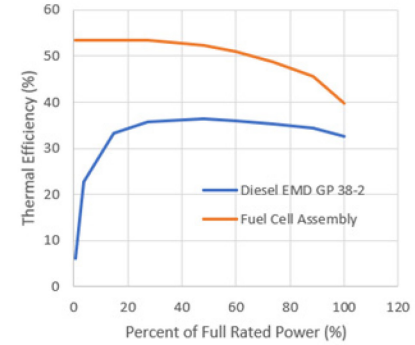
- Funding: $152,000.00
- Project Duration: April 2020 – April 2021

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

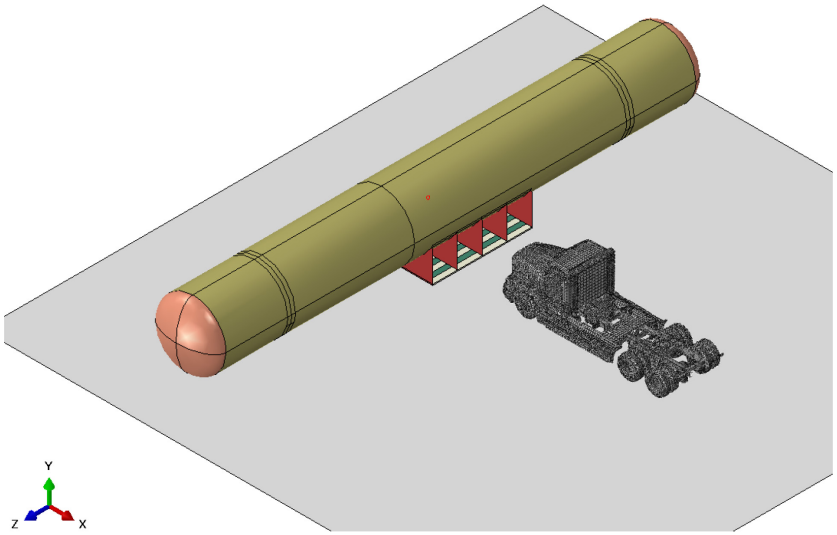
- Funding: $250,000
- Project Duration: August 2020 – December 2022

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 (CNG), 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 by nations railroad.
- 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

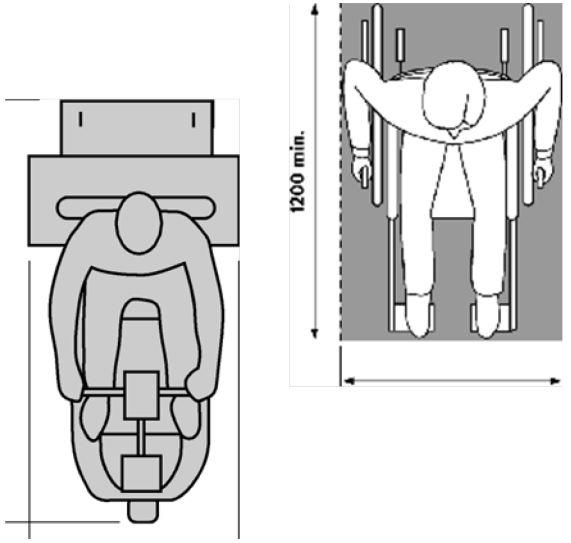
- Funding: FY 2020 – $200,000
- Project Duration: May 2020 – May 2021

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 restroom.
  - 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 rail car.
- Quantify the relative motion of wheeled mobility devices during 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 rail cars.

PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $280,000
- Project Duration: April 2017 – April 2020

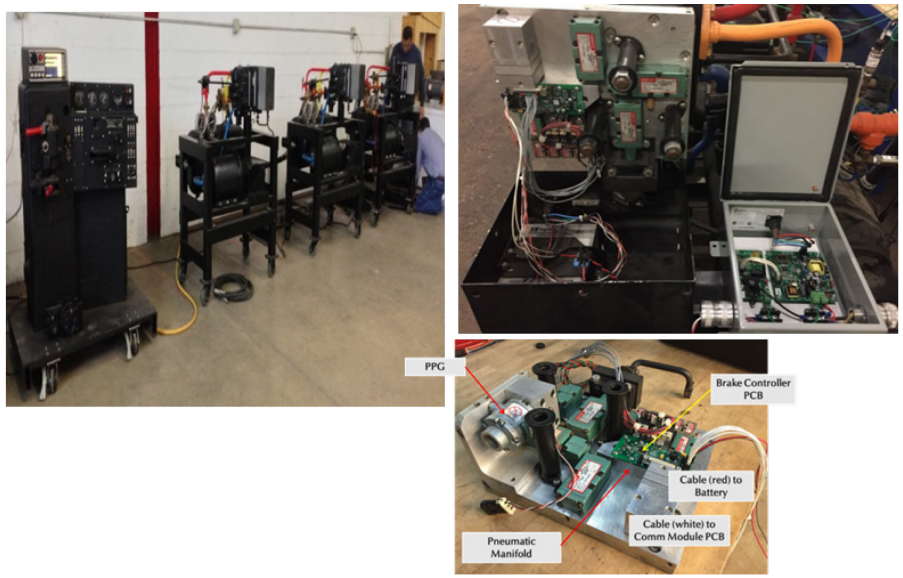
U.S. Department of Transportation
Federal Railroad Administration

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 has been engaged in the development of Emulator technology. Laboratory and field demonstrations of the technology have been successful.
- This project will further advance the emulation technology to ensure performance under harsh railroad conditions.
- Current focus:
  - Upgrading 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

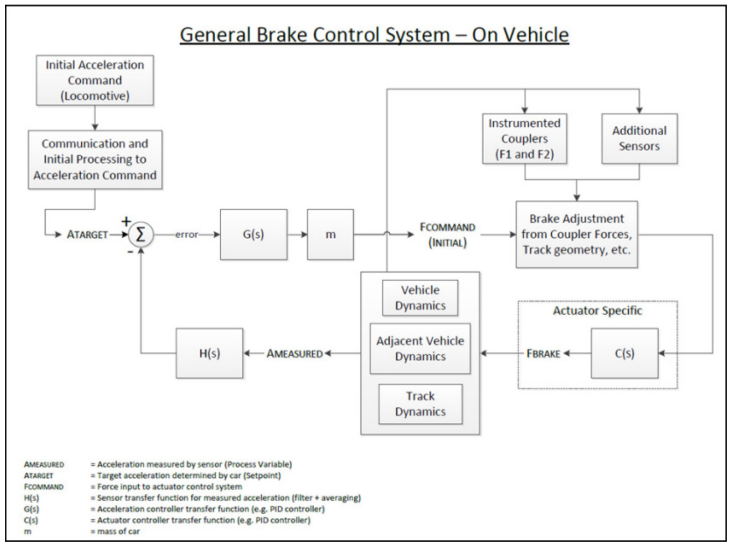
U.S. Department of Transportation
Federal Railroad Administration

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

Next Generation Brake Technology for Rolling Stock – 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 – December 2020

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 (no. of cars) and weight of trains operated over North American rail network, with many trains being over 200 cars long. While preliminary evaluations have not indicated any serious concerns about VLT operations, 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 effort is being conducted in collaboration with industry stakeholders, including the Association of American Railroads (AAR) representing the railroads, and air brake system vendors. A Test Review Committee (TRC) with representation from the various parties guides the technical effort.
- The test effort is planned in a phased manner, covering brake rack tests in laboratory settings, moving up to train level tests, first on a static train and then on a moving train.

Train Length (Number of Cars)	BP Leakage	Minimum, release and recharge	15 psi reduction, release and recharge	Full service, release and recharge	Graduated application, 8 to 10 psi	Graduated application, 16 to 17 psi	Emergency from fully charged state	Emergency from partial service application	Emergency after service release	False Gradient Braking
100	minimum	x	x	x	x	x	x	x	x	x
	60 cfm	x	x	x	x	x	x	x	x	x
	15 psi gradient	x	x	x	x	x	x	x	x	x
150	minimum	x	x	x	x	x	x	x	x	x
	60 cfm	x	x	x	x	x	x	x	x	x
	15 psi gradient	x	x	x	x	x	x	x	x	x
200	minimum	x	x	x	x	x	x	x	x	x
	60 cfm	x	x	x	x	x	x	x	x	x
	15 psi gradient	x	x	x	x	x	x	x	x	x

RAILROAD IMPACT

- Improved and demonstrated operational safety through better understanding of brake system performance.
- Potential to document safety benefits of using technologies like 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
- New York Air Brake
- Sharma & Associates, Inc.

COST & SCHEDULE

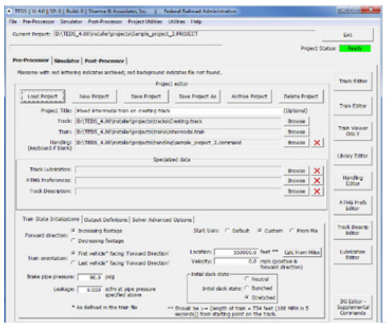
- Funding: FY20 – $192,000
- Project Duration: July 2017 – June 2021

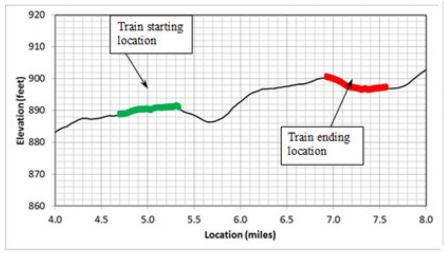
FRA PROJECT MANAGER: Monique Stewart • (202) 493-6358 • monique.stewart@dot.gov

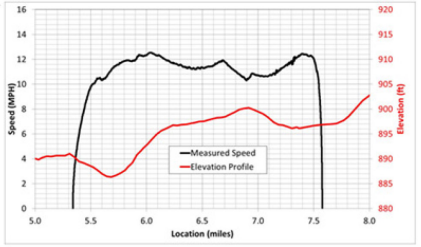
Train Energy & Dynamics Simulator (TEDS)

PROJECT DESCRIPTION

- TEDS is a computer program developed by FRA for conducting longitudinal train dynamics simulations.
- May be used to assist development of guidelines and recommendations to improve train operating safety.
- Capable of simulating train handling, train makeup, head-end and distributed power, ECP and automatic brake applications for speed control, stopping distances, and emergency stops.
- Published validation details can be found in FRA reports: DOT/FRA/ORD-15/01), DOT/FRA/ORD-20/24, and DOT/FRA/ORD-20/26.
- Used successfully for several simulations to assist FRA's Office of Railroad Safety in various investigations and policy studies.
- 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

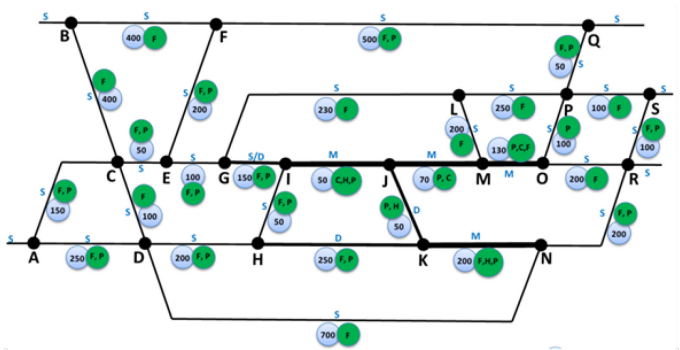
- Funding: FY20 – $150,000
- Project Duration: September 2015 – September 2025

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

Effects of Technology Implementations on Network Operations

PROJECT DESCRIPTION

- Develop a methodology to quantify network level benefits for train operations resulting from the implementation of new technologies.
- Use network simulations software OpenTrack® for various network operational characteristics:
  - Different types of corridors: Single track, double track, and multiple track corridors
  - Types of traffic: Dedicated vs. shared-use corridors
  - New technology implementation
  - 1,800 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.



Network Topology

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

Type of Train	Avg. weight (ton)	Avg. length (ft.)	No. of configurations	No. of trains
Passenger	477	645	3	66
HSR	432	571	1	32
Commuter	248	486	2	56
Freight	7982	6994	17	78

RAILROAD IMPACT

- Improve traffic congestion analysis.
- Perform 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: FY19 – $149,000
- Project Duration: September 2018 – September 2021

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 railroad rolling stock.
- Document new installation at MNR, LIRR, and NYA.
- Detection threshold analysis to help the railroads establish detection thresholds for Inspection-, Alarm-, and Emergency-level actions balanced against the shop capacity and commuter service demands for coaches.
- Identify Best Practices for Implementation and revise the Implementation Guide ***(FRA Report – An Implementation Guide for Wayside Detector Systems, May 2019).***

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: FY20 – $89,850
- Project Duration: September 2018 – September 2021

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

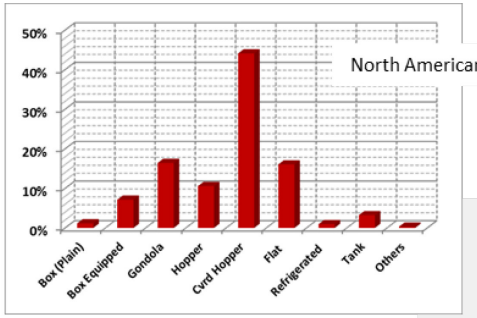
Vehicle Dynamics Infrastructure

PROJECT DESCRIPTION

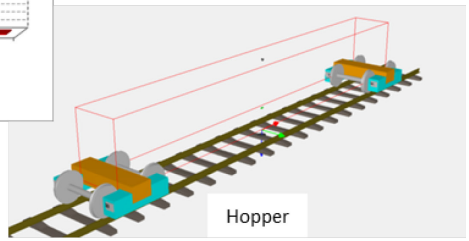
This effort covers preparation of an extended set of vehicle simulation data and results that can guide derailment investigations, especially where individual vehicle dynamics and wheel/rail forces may have a played a key role in derailment initiation.

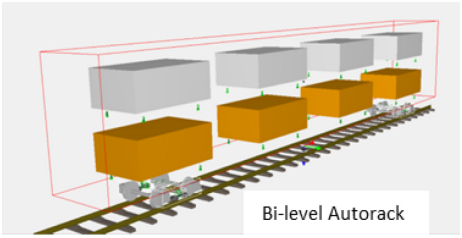
The scope that encompasses the following operating parameters:

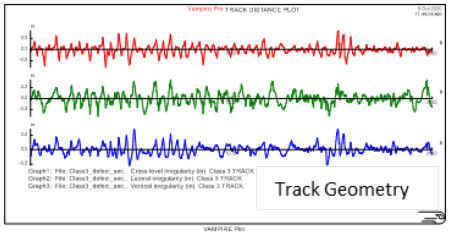
- Track curvature including the entry and exit spiral conditions
- Operating speed
- Wheel/rail friction
- Wheel and rail profile
- Short, medium, and long truck center freight cars
- Empty and loaded conditions
- Train braking
- Longitudinal coupler force effect
- Track Class
- Centerplate lubrication conditions



North American Fleet


Hopper


Bi-level Autorack


Track Geometry

RAILROAD IMPACT

- Improved understanding of train derailments
- Quickened analysis of derailment investigations
- Efficient support for the Office of Railroad Safety in railroad operation safety compliance and enforcement

PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: FY20 – $118,000
- Project Duration: September 2018 – March 2021

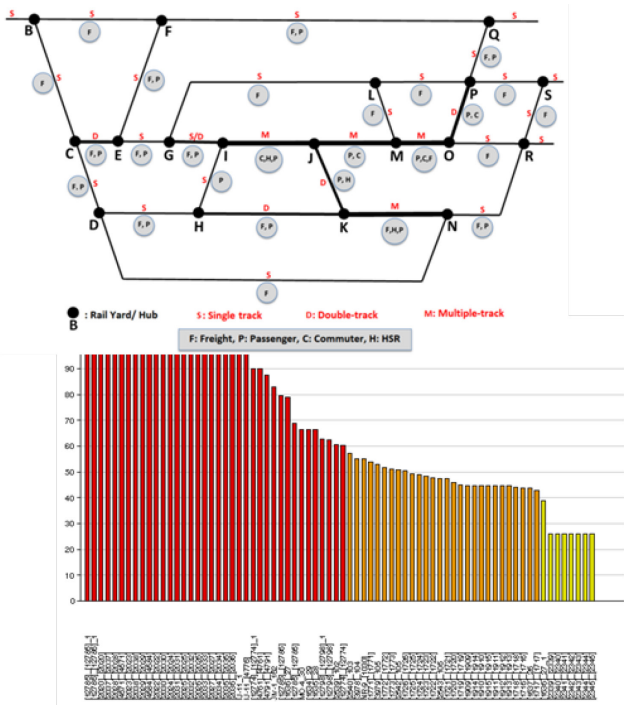
FRA PROJECT MANAGER: Monique Stewart • (202) 493-6358 • monique.stewart@dot.gov

Electronically Controlled Pneumatic (ECP) Brakes Implementation and Pilot Demo

PROJECT DESCRIPTION

Recently issued regulations on tank cars have required the implementation of ECP brakes on tank cars carrying hazardous, flammable materials. This project focuses on a roadmap for ECP implementation.

- Develop a "mini-network" with representative characteristics of the North American rail system including various types of traffic, tracks, signaling systems, and train configurations similar to the real practices in the North America's network.
- Develop network simulation scenarios based on adjusting train braking algorithms with certain daily traffic volume out of the entire network.
- Conduct a comprehensive analysis of the simulated results in terms of network capacity parameters such as train delay, dwell time, train conflicts, train speed, network velocity, track occupancy level, number of meet-pass and stops, safety, and accident mitigation.



RAILROAD IMPACT

- Improved train control and operational strategy analysis methods
- Evaluate effects of shorter stopping distance to reduce over-speed and collision incidents
- Improved network capacity through increased train speeds and train performance

PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

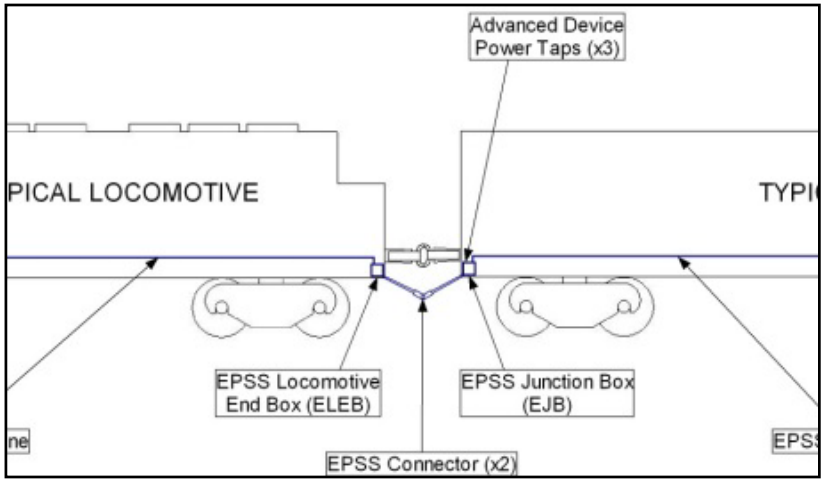
- Funding: FY20 – $98,900
- Project Duration: September 2015 – September 2020

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

Test Rack Hardening of Electrical Power Supply System (EPSS) for Freight Cars

PROJECT DESCRIPTION

- EPSS takes electrical power from locomotives and distributes it along adjoining freight cars in a train.
- Successful initial test of the prototype EPSS system at TTC in Pueblo, Colorado, included one locomotive and two freight cars that utilized advanced devices, including Electrically Driven Handbrakes (EDHBs).
- Designed, prototyped, and tested an EPSS DC access/battery charger. The interface/charger is powered by the EPSS AC power line and provides a standard 24 VDC interface to safety and security devices where desired.
- Completed a full-scale field test of the EPSS on a one-locomotive and eight-freight-car train. The system worked flawlessly and the power line losses were so small that none could be detected.
- Built and used a 50-car simulator in-lab EPSS test rack for test hardening of the EPSS design for continuity and vibration resistance and collection of performance data for EPSS model calibration to extrapolate for much longer trains.



PROJECT PARTNER

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: $299,000 – Phase II – Completed
- Project Duration: September 2016 – September 2020

RAILROAD IMPACT

- Electrical power available on freight cars would open up a completely new world of increased safety, security, and efficiency in freight railroad operations. It would allow for the implementation of an abundance of safety and efficiency improvement devices including remote controlled actuators and passive sensors for car switching mechanisms and intrusion detection, as two examples, and many other opportunities.
- The EPSS DC access/battery charger development allows future developers of safety, security, and efficiency improvement devices a 24 VDC interface with which to connect.

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

Advanced Technology Integration – Ecosystem Platform

PROJECT DESCRIPTION

- Develop and integrate a modern, powered, communications and control eco-system 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 eco-system platform; will utilize the EPSS test rack shown here as much as possible to minimize build costs
  - Utilize the test rack for in-lab testing/development.
  - With FRA, initiate the development and acceptance of AAR interchange specifications/standards for an electrical power supply system (EPSS), an electrical hand brake (EDHB), and the subject ecosystem platform.

RAILROAD IMPACT

- Improve freight railroad operations safety and security.
- 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: FY20 – approx. $99,000; total $370,000
- Project Duration: September 2019 – June 2023

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

Diagnosis and Detection of Bearing Grease Degradation and Defects

PROJECT DESCRIPTION

- The bearing grease research will investigate the properties of grease degradation related to bearing performance 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 grease degradation from 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 – October 2021

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

Technologies and Testing to Prevent Water Ingress to Railroad Bearings

PROJECT DESCRIPTION

- The water tightness of railway bearings research will test the ability of the current baseline bearing rubbing lip seals versus frictionless seals to prevent water ingress over the life of the bearing.
- This project will also determine if water ingress will occur in 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, to be conducted in two parts:
  - Research methods of water ingress causing bearing degradation
  - Recommend solutions to prevent water ingress

PROJECT PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

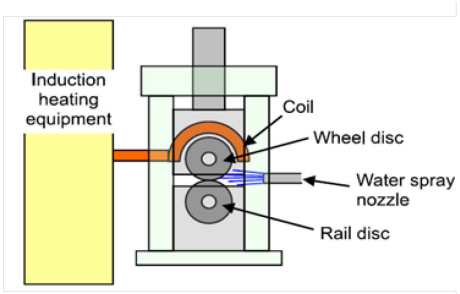
- Funding: $400,000
- Project Duration: September 2018 – October 2021

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

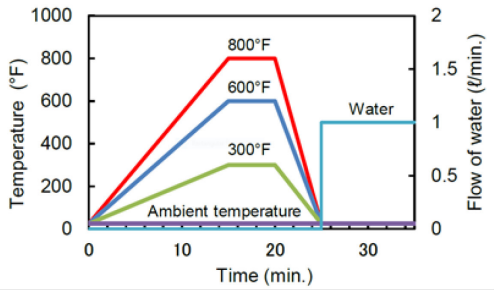
Effects of Temperature on Wheel Spalling

PROJECT DESCRIPTION

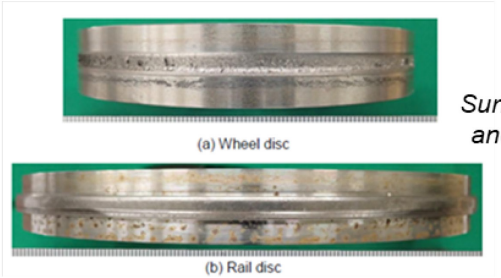
- A high-impact wheel is often characterized by the spalling (rolling contact fatigue) that occurs due to sliding of the wheels, causing high temperature and martensite formation, which in turn leads to wheel tread discontinuities.
- Investigate how temperature at the wheel-rail interface can affect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



Testing Machine Used to Study Thermal Effects on Wheel Spalling



Thermal Cycles for Twin Disc Testing



Surface Conditions of Wheel and Rail Discs After a Test

RAILROAD IMPACT

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

PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $279,350
- Project Duration: August 2017 – October 2021

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

Advanced Devices Train & Test Bed (ADT&TB)

PROJECT DESCRIPTION

- Facilitate the development of an ADT&TB to test advanced devices, either developed or under development for functionality and ergonomics.
- Advanced devices include remote-controlled Electrically Driven Hand Brake (EDHB), tri-couplers (air, electrical, and mechanical coupling systems), remote-controlled angle cocks, and remote-controlled cut levers.
- Conduct evaluations and demonstrations of advanced devices and the advanced device wireless network.
- Advanced devices can be operated either on the side of the car or remotely from within the locomotive via a wireless connection.

RAILROAD IMPACT

- Improve safety of train operations by minimizing human interaction with cars and car devices.
- Improve reliability of newly developed devices through testing in revenue service environment.
- Increase train capacity and reduce costs by decreasing the time needed during stops due to functionality of devices.

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: $381,755
- Project Duration: July 2014 – December 2021

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

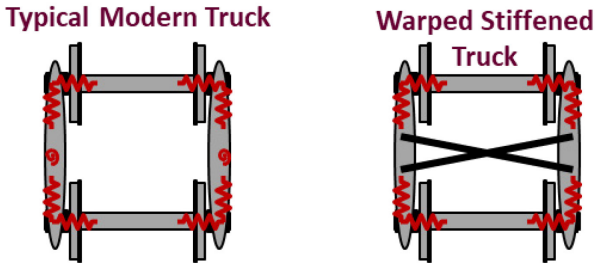
Improved Freight Car Truck Performance and Safety

PROJECT DESCRIPTION

- Phase I
  - Task 1: Perform a literature search to identify relevant 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

- 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.
- Improved freight car truck using methods, such as warp restraint, will improve high-speed stability (hunting stability) and curving performance.
- Improved freight car truck 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 wear.



PROJECT PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: FY20 – $240,360 – Phase I
- Project Duration: September 2020 – September 2021

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

Wheel Failure Research Program

PROJECT DESCRIPTION

- The objective of the effort is the reduction of wheel failures, including vertical split rims and shattered rims through collaboration with industry.
- 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 will focus on 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.
- AAR, wheel suppliers
- SimuTech Group

COST & SCHEDULE

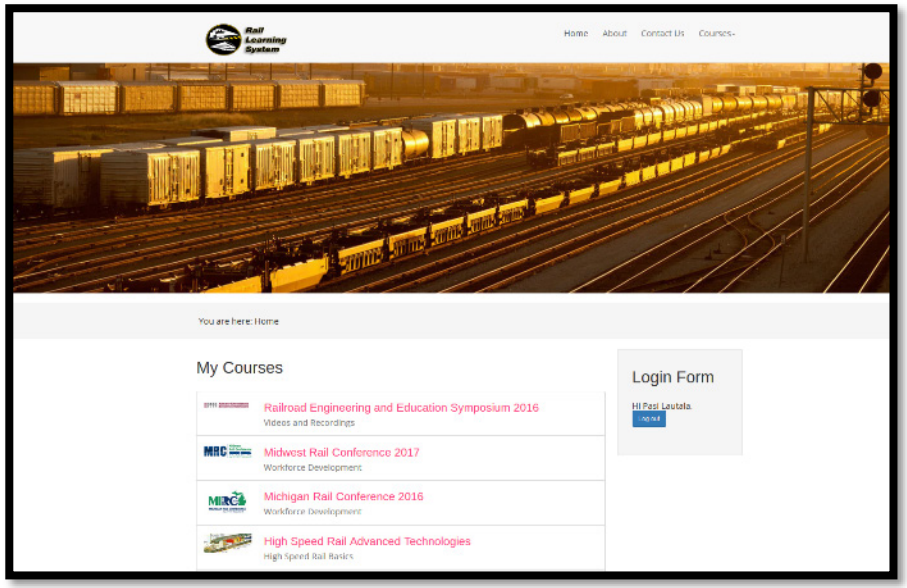
- Funding: $520,000 – Phase III
- Project Duration: September 2020 – January 2022

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

Implementation of Training Modules for Online Rail Learning System

PROJECT DESCRIPTION

- Perform site and system updates (Moodle and Joomla) to the proof-of-concept online Rail Learning System (RLS).
- Host educational and training modules from the Railway Engineering Education Symposium (REES) and distribute to stakeholders.
- Establish “FRA employees only” section within the system.
- Work with FRA Office of Railroad Safety (RRS) in developing and hosting Railroading 101 pilot modules.



RAILROAD IMPACT

- Expand the reach of railway engineering education.
- Increase the flexibility for learners by creating 24/7 access to materials.
- Improve accessibility of FRA employees to training provided by RRS.
- Retain knowledge possessed by seasoned employees.
- Reduce resources needed for delivery of education and training.

PROJECT PARTNER

- Michigan Technological University

COST & SCHEDULE

- Funding: FY19 – $32,910
- Project Duration: September 2017 – September 2020

FRA PROJECT MANAGER: Monique 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.
- This project is intended to set test procedures for 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 is 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 to update locomotive headlight standards and recommended practices.

PROJECT PARTNERS

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

COST & SCHEDULE

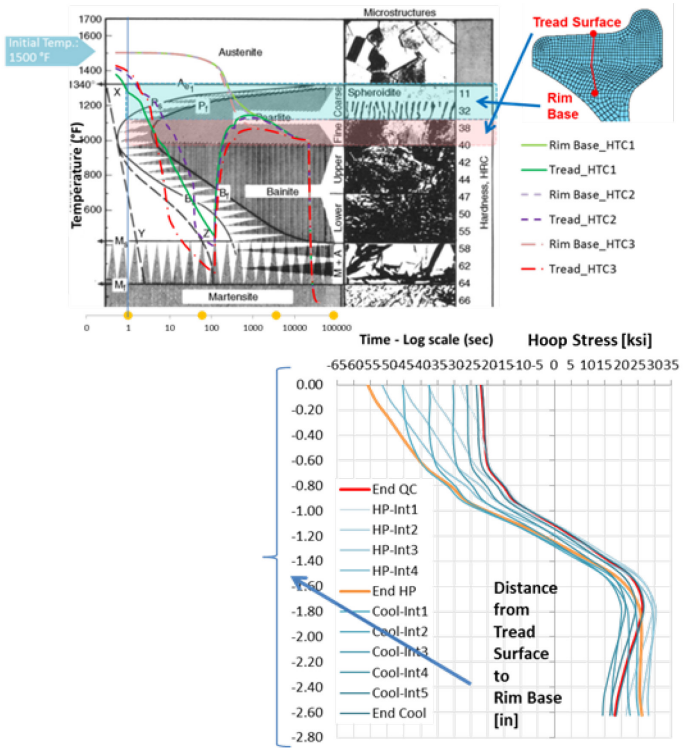
- Funding: $265,000
- Project Duration: July 2019 – July 2020

FRA PROJECT MANAGER: Tarek Omar, PhD • (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, the tonnage carried per wheel has progressively increased thus subjecting the wheel-rail contact area to much higher stresses. These higher stresses have accelerated the problem of rolling contact fatigue (RCF).
  - 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 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

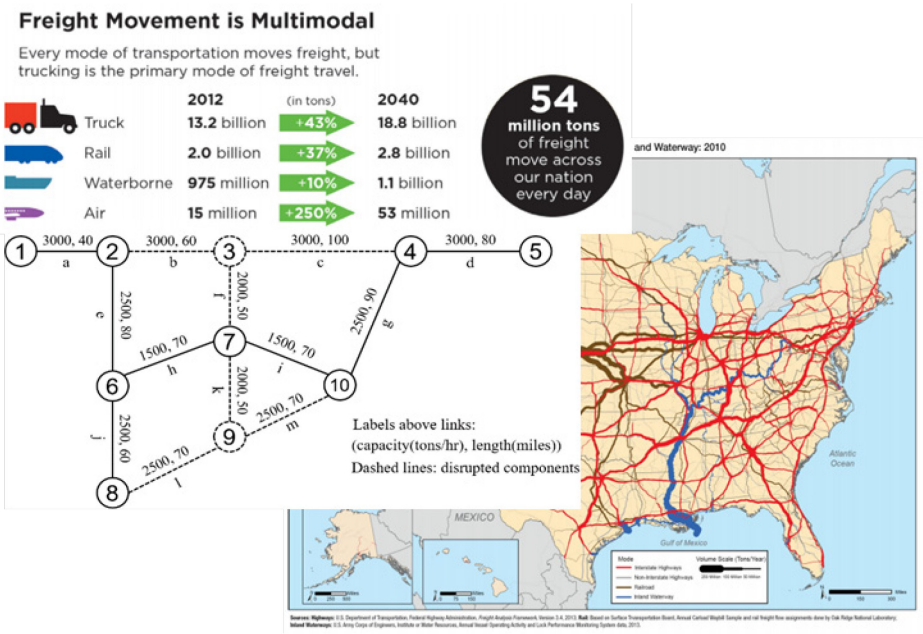
- Funding: 224,804
- Project Duration: September 2018 – March 2020

FRA PROJECT MANAGER: Tarek Omar, PhD • (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 2020 – June 2021

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Tarek Omar, PhD • (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 the 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 the FRA has successfully provided vital safety information in a central location.
- The FRA received feedback requesting information on the ENS signs.
- The ENS signs display information necessary for the public to report an unsafe condition at the grade crossings when dispatching information to the railroads.
- These ENS signs are mandatory at all grade crossings which include public, private, and pathway crossings. Phone numbers and USDOT National Crossing inventory number are displayed to relay the appropriate information to the railroads.
- After the release of the safety videos, it was evident that there is a gap in knowledge in regard to 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, PhD • (202) 493-6189 • tarek.omar@dot.gov

Emergency Responders: Extrication Video

PROJECT DESCRIPTION

- There is a gap in trainings pertaining to rescue operations centered 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 via the internet.

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, PhD • (202) 493-6189 • tarek.omar@dot.gov

Wireless Digital Train Line for Passenger Trains, Phase II

PROJECT DESCRIPTION

- Current analog train line system is outdated, error-prone, and at the limit of its capabilities.
- Wireless technologies can augment a digital train line (DTL) in providing high performance communications in support of passenger services, and the control and communications of train management elements.
- This project 1) investigated current train line systems; 2) assisted stakeholders with development of DTL; and 3) researched a wireless extension to DTL.
- Advanced network architectures and computer simulation models were designed and implemented to explore wireless DTL performance scenarios.
- Worked closely with Next Generation Equipment Committee, Association of American Railroads, American Association of State Highway and Transportation Officials, Amtrak, etc.

PROJECT PARTNER

- University of Nebraska-Lincoln

COST & SCHEDULE

- Funding: $150,000
- Project Duration: April 2019 – March 2020

RAILROAD IMPACT

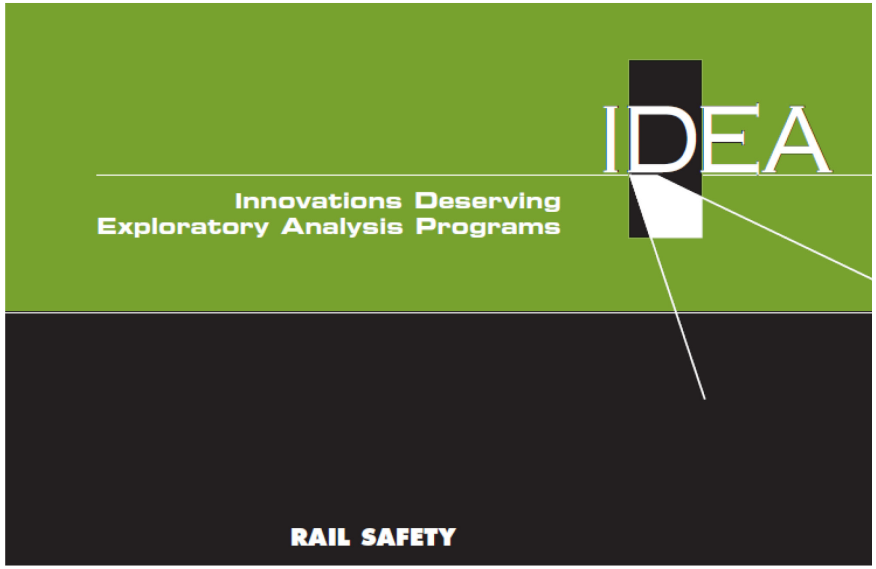
- This project conducted in-depth research into utilizing wireless technology for DTL (WiDTL).
- WiDTL can provide a flexible, high-performance, highly expandable, low-maintenance system for control & comm.
- WiDTL can provide rail operators tightly integrated train control functionality, fault alerting, system operations, etc.
- WiDTL can provide passenger services such as interactive infotainment systems, onboard WiFi, and on-demand services.
- Developed computer simulation models and framework are available to the rail industry for custom scenario evaluations.

FRA PROJECT MANAGER: Tarek Omar, PhD • (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 (TRB).
- Rail Safety IDEA 43, “Augmenting Reality for Safer Inspections of Railroad Infrastructure and Operations.”
- Rail Safety IDEA 44, “Laser-based Non-destructive Spike Defect Inspection System.”
- Rail Safety IDEA 45, “Development of a Fatigue Load for Railway Bridges.”



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, FY20: $400,000
- Project Duration: August 2019 – March 2023

FRA PROJECT MANAGER: Tarek Omar, PhD • (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 operations 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, FY20: 540,000
- Project Duration: October 2018 – September 2021

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

Tank Car Impact Tests

PROJECT DESCRIPTION

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

RAILROAD IMPACT

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

PROJECT PARTNERS

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

COST & SCHEDULE

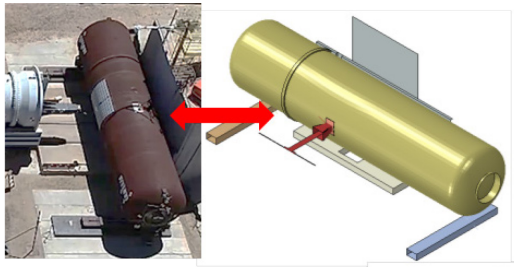
- Funding, FY20: $2.4M
- Project Duration: July 2015 – July 2022

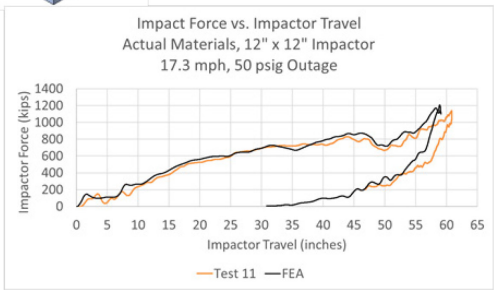
FRA PROJECT MANAGER: Francisco González, III • (202) 493-6076 • francisco.gonzalez@dot.gov

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

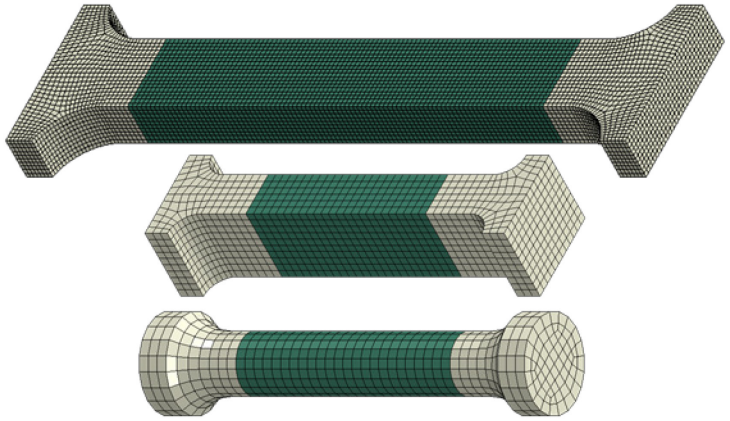
- Funding, FY20: $300,000
- Project Duration: May 2020 – May 2021

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

Behaviors of Tank Car Materials of Construction

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 DOT113 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

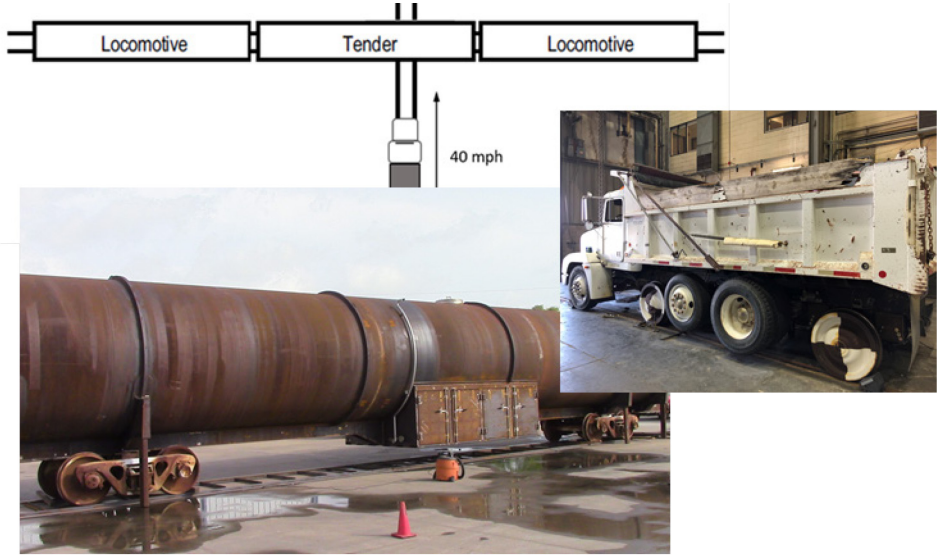
- Funding, FY20: $175,000
- Project Duration: May 2020 – May 2021

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

COST & SCHEDULE

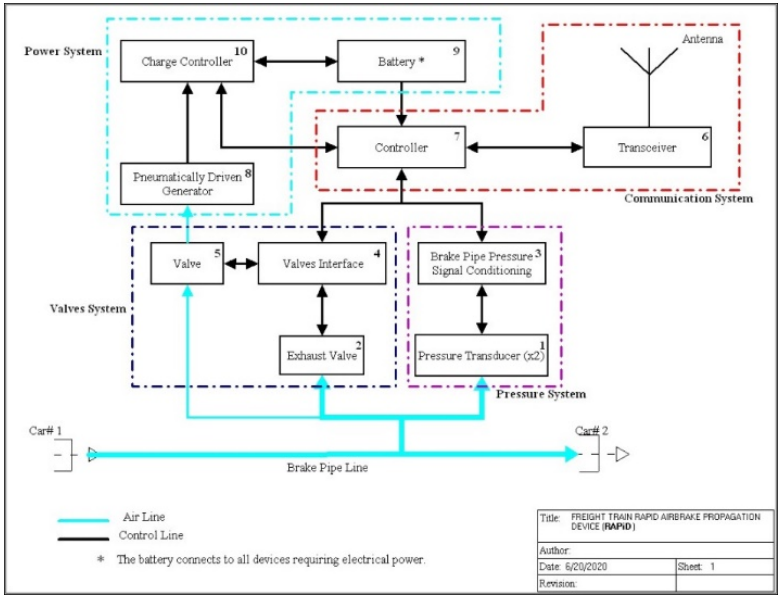
- Funding: $875,000
- Project Duration: August 2018 – September 2021

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

Development of Freight Train Rapid Airbrake Propagation Device (RAPiD)

PROJECT DESCRIPTION

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



RAILROAD IMPACT

- RAPiD is envisioned to improve the safety of freight train operations by readily making available 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

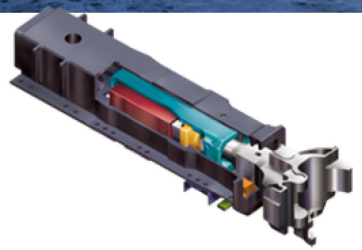
Tank Car Research

PROJECT DESCRIPTION

- FRA has shown that high-magnitude coupling forces that occur in yard operations have the potential to exceed yield limits of mild steel.
- FRA, Union Tank Car, and Amsted Rail recently completed a comprehensive test program to characterize tank car load 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 being faced by the industry.



PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $310,000
- Project Duration: September 2018 – September 2021

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

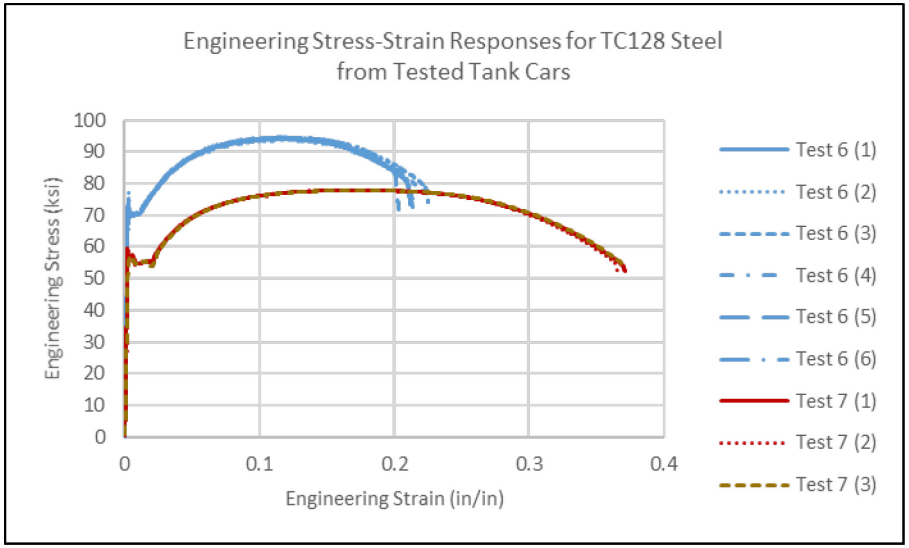
Structural Behavior under Operating Conditions

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 previous 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

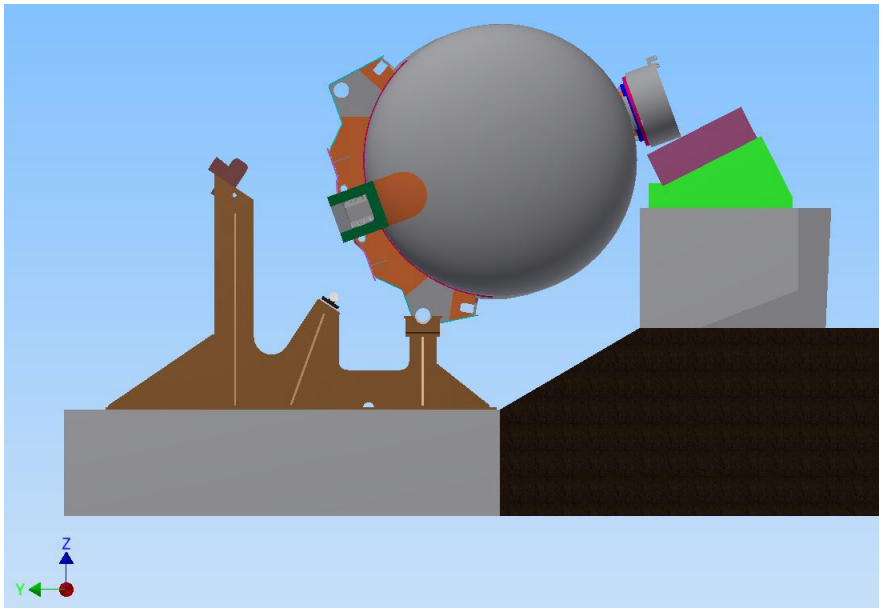
- Funding, FY20: $150,000
- Project Duration: August 2018 – May 2021

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 2021

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 has not previously been evaluated/confirmed.
- The intent of this project is to document, by scale testing under nominal fire conditions, PRV performance with respect to opening pressure, reclosing, and evacuating the tank.
- Initial tests planned with water as lading; subsequent tests to be conducted with flammable lading.
- Results will be used to validate detailed analytical models being developed by agencies such as Transport Canada.

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 appropriate for flammable liquid service.

PROJECT PARTNERS

- Sharma & Associates, Inc.
- Transport Canada
- UL LLC
- BAM Technologies, LLC
- TransQuip USA, Inc.
- Fort Vale Engineering, Ltd.

COST & SCHEDULE

- Funding, FY20: TBD
- Project Duration: 2018 – 2020

U.S. Department of Transportation
Federal Railroad Administration

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

Fire Performance of a UN-T75 Portable Tank

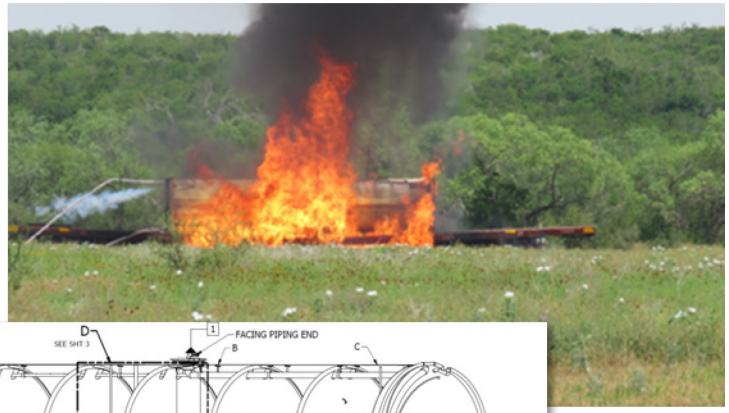
PROJECT DESCRIPTION

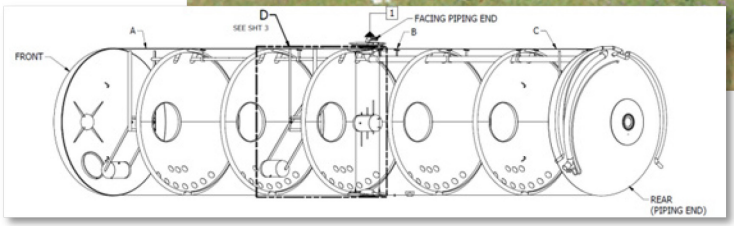
PHASE I:

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

PHASE II:

- Repeat Phase I test with LNG in test tank, instead of liquid nitrogen.
- Make improvements to internal instrumentation, including several floating temperature measurements (see schematic), which will be used for future computer model validation.
- Phase II test scheduled for fall 2020.





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 (formerly CVA)

COST & SCHEDULE

- Funding, FY20: $230,000
- Project Duration: September 2017 – September 2021

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

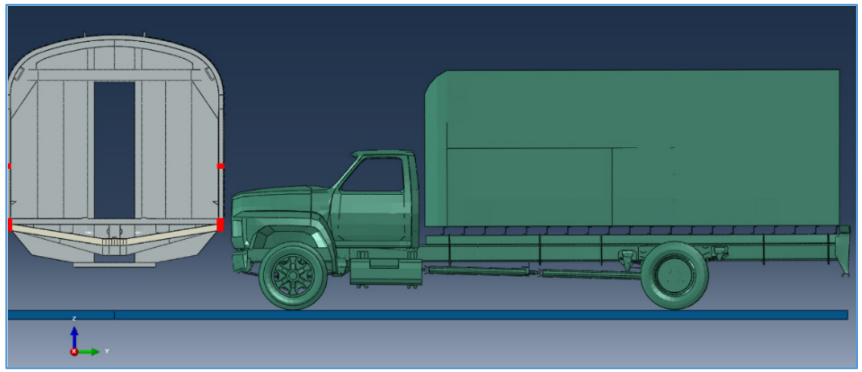
Passenger Equipment Structural Crashworthiness

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 that 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

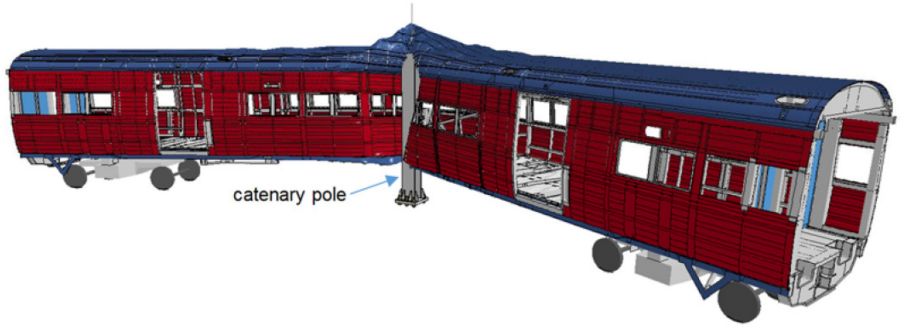
Resilient Wayside Structures and Passenger Car Survivability

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: $259,828
- Project Duration: April 2020 – April 2021
  - 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, ongoing
  - Additional slip tests and dynamic impact tests, TBD 2021
  - Numerical analysis of OLE support structure, April 2021
  - Commercialization planning, throughout project
  - Final report to be issued in 2021



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
- Arup
- Southwest Research Institute

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.
- Plan for full-scale vehicle-to-vehicle (V2V) impact tests in January 2019 and beyond 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, FY19: $1,000,000
- Project Duration: August 2018 – July 2021
  - FRA report on conventional coupling tests, September 2019
  - Presentation on V2V test #1 results, February 2019
  - Joint Rail Conference paper on coupling tests evaluation and V2V test #1 plans, 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 2020
  - Presentation on V2V test #2 results, Summer 2021

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
- TIAX LLC
- Transportation Technology Center, Inc.
- CANARAIL Consultants Inc.

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

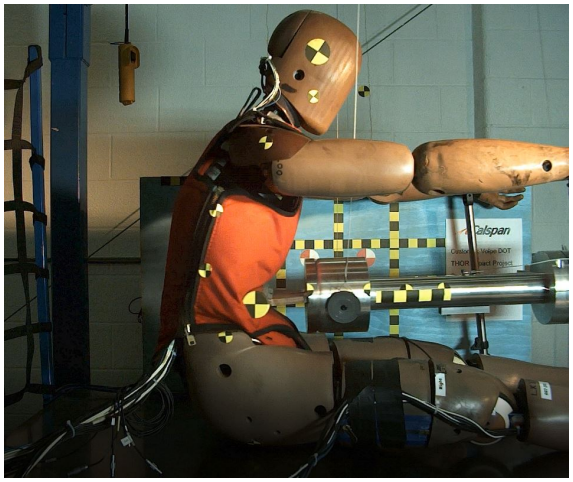
Interior Occupant Protection

PROJECT DESCRIPTION

- Volpe contracted with Calspan to conduct abdomen impact testing on the THOR-50M ATD to evaluate the biofidelity, repeatability, and sensitivity to multiple impact conditions.
- Volpe is providing technical support on FRA contracts with MGA 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 CEM locomotive train-to-train test.
- 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: $220,000
- Funding from Standards Support and Equipment Evaluation: ~$65,000
- Project Duration: May 2020 – May 2021
  - Volpe/Calpsan 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, Mar 2021
  - Final APTA Seat Standard, Dec 2020
  - Draft APTA Cab Seat Standard, Dec 2020



RAILROAD IMPACT

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

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- 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: $10,000
- Project Duration: May 2020 – May, 2021
- 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

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 to begin late 2020.

COST & SCHEDULE

- Funding, FY19: $176,966
- Project Duration: September 2018 – March 2021
  - Present research findings to APTA or RSAC, March 2021
  - Issue report describing project and results March 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 re-iterated 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

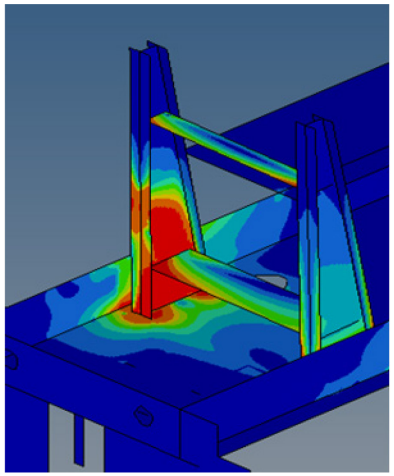
PROJECT DESCRIPTION

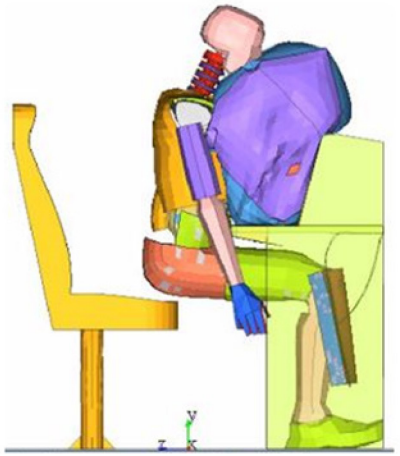
- Modern locomotives are built to crashworthiness standards defined in Title 49 of the Code of Federal Regulations, Part 229, and Association of American Railroads S-580 standards.
- Locomotives manufactured before 1990, specifically the narrow-nose locomotives, were not designed to crashworthiness standards 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 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, FY19: $378,000
- Project Duration: August 2013 – December 2020*
  - Issue report on collision post-tests, early 2021
  - Issue report on SIPS tests with improved airbag, mid-2021

* *Likely to be extended due to supplier delays*





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.

PROJECT PARTNERS

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

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.

COST & SCHEDULE

- Funding: $125,000
- Project Duration: May 2020 – May 2021
  - 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.

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: $349,345
- Project Duration: September 2019 – March 2021
  - Intermediate reports to be delivered on accident investigations, finite element analysis and preliminary test plan, end 2020.
  - Publish final report documenting all activities, March 2021.

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

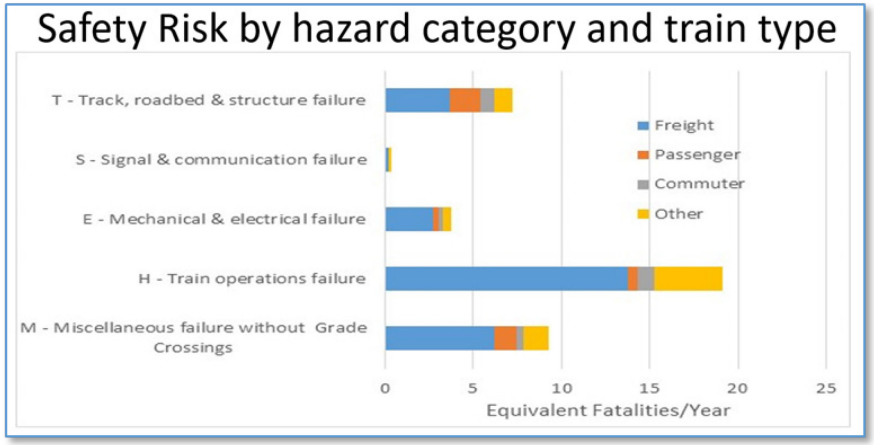
- Sharma & Associates, Inc.

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.
- FRA 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 U.K.
- The SRM provides a means for quantitative risk-ranking to facilitate project selection. Knowledge of the characteristics of the distribution of risk will allow FRA to make strategic project investments for maximum safety benefit and allow for future assessments of risk reduction resulting from implementation of the products of RD&T efforts.
- Future updates to the model will include 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.



RAILROAD IMPACT

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

COST & SCHEDULE

- Funding, FY20: $75,356
- Project Duration: September 2020 – September 2021

PROJECT PARTNER

- Sharma & Associates, Inc.

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

SECTION THREE

TRAIN CONTROL & COMMUNICATION

PTC Monitoring and Analysis of the Integrated Network (MAIN)

PROJECT DESCRIPTION

This research area explores methods for supporting the industry with improved monitoring, analysis, and troubleshooting of interoperable PTC scenarios.

Project Overview*:*

- MAIN Core Data Exchange (MAIN-CDX) is a web application, designed in this project, that railroads utilize to create and respond to requests for PTC interoperable troubleshooting data.
  - Currently used by 47 railroads.
  - ~1,000–1,500 request/responses per month.
- Collaborated with industry to define and create new ITC System Management (ITCSM) messages to support automation of requests and responses utilizing MAIN-CDX.
  - Railroads can choose to implement new ITCSM messages within their back offices to automate requests for data and responses to requests for data.
  - Integrates ITCSM messages with MAIN-CDX application to support ITCSM to MAIN-CDX data transfers.
- Researching industry needs for improved monitoring and troubleshooting of foreign, PTC-equipped locomotives.

RAILROAD IMPACT

- The primary goal is to ensure railroads have efficient access to interoperable PTC data, allowing them to monitor and maintain their PTC operations safely with minimal delays.

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Railinc Corp.
- Interoperable PTC Railroads
- MeteorComm LLC

COST & SCHEDULE

- Funding: Phase II – $766,830
- Project Duration: August 2018 – May 2021

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

PTC Reliability, Availability, and Maintainability (RAM)

PROJECT DESCRIPTION

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

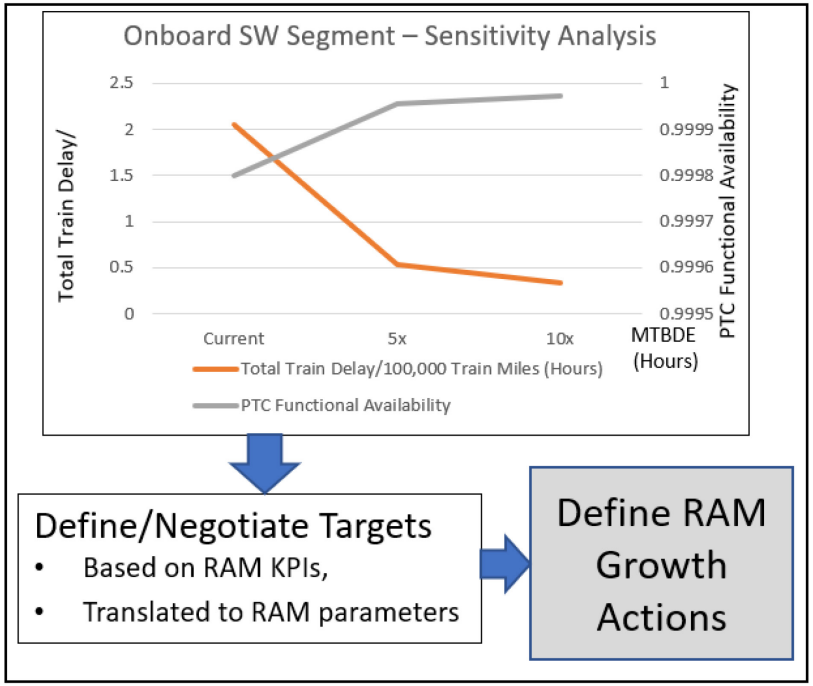
- Quantify the impact of PTC on operations.
- Identify main contributors to reduced operational availability.
- Develop PTC system and operational impact targets.
- Develop PTC RAM targets allocated to RAM segments.
- Prepare RAM growth recommendations.
- Prepare a high-level RAM program plan.

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.

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.



PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Class I railroads

COST & SCHEDULE

Funding: $1,747,451

- Project Duration: September 2018 – December 2021

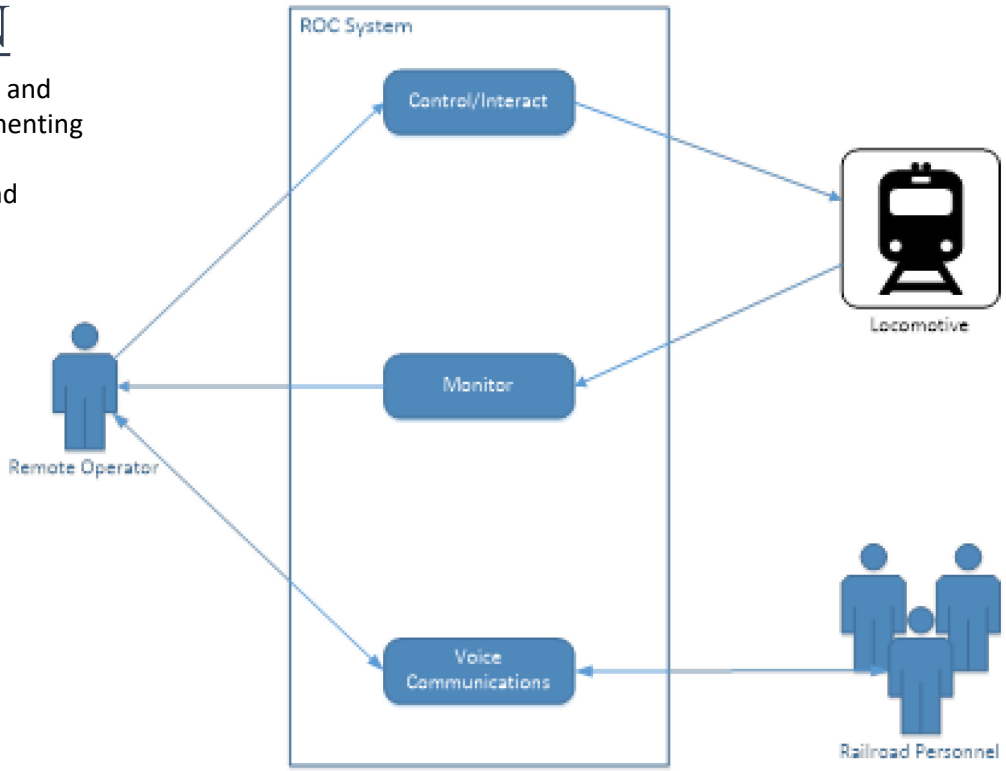
U.S. Department of Transportation
Federal Railroad Administration

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

Automated Train Operation

PROJECT DESCRIPTION

- Develop a concept of operations, with industry input and review, describing the technical approach for implementing automated train operations (ATO).
- Research, develop, and evaluate sensor platforms and technologies for support of ATO.
- Develop and analyze safety cases for ATO.



RAILROAD IMPACT

- Improve operational efficiencies and network capacity.
- Improve safety by reducing human error.
- Test and evaluate remote sensing suite that will influence the feasibility of automated train operation in the future.

PROJECT PARTNER

- Transportation Technology Center, Inc.

COST & SCHEDULE

- Funding: $1,105,414
- Project Duration: September 2015 – December 2020

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 (LCS).
2. Definition of interface and messaging requirements between ATO back office subsystems.
3. Definition of ATO back office subsystem functional and performance requirements.
4. Definition of an ATO safety program to progress safety analysis tasks in conjunction with system definition activities.

RAILROAD IMPACT

- The primary goal is to ensure that an interoperable ATO system is defined to meet industry safety and automation objectives.
- ATO requirements and safety documents will be submitted to the AAR for use at its discretion.

PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $2,304,683
- Project Duration: September 2019 – December 2021

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Jared Withers • (202) 483-6362 • 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, as well as to support 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 Automated Train Operations (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 (BNSF)
- Canadian Nation 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

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Jared Withers • (202) 483-6362 • jared.withers@dot.gov

Automated Train Operations (ATO) Sensor Test Bed Spec Development

PROJECT DESCRIPTION

The Automated Train Operations (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 Nation 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) 483-6362 • jared.withers@dot.gov

Next Generation Track Circuit (NGTC)

PROJECT DESCRIPTION

This project evaluates the feasibility of a previously developed concept to support future methods of train control, such as Quasi-Moving Block (QMB) or variants thereof, intended to be a simple, reliable, and cost-effective modification to existing track circuit technology, providing substantive benefits.

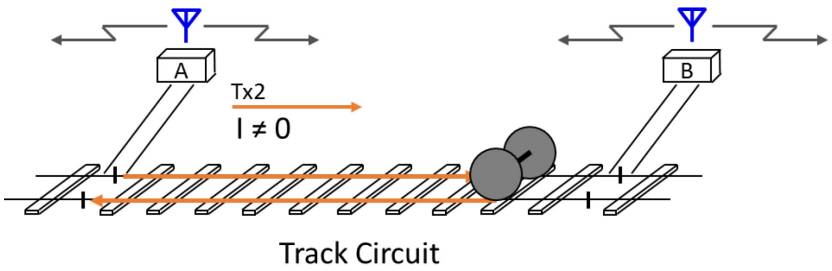
In this concept, broken rails are detected by monitoring the transmission current in addition to conventional methods. If the current is substantial, then there are no broken rails within that current loop. If the current is near-zero, then there is a broken rail. This detection mechanism can be integrated with QMB and potentially allow maximum authorized speed into a block that has an occupancy.

Key objectives:

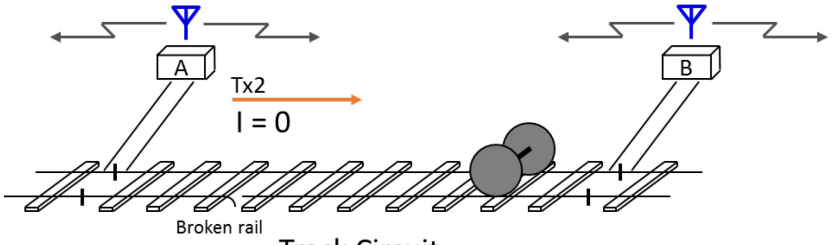
- Determine the extent to which electrical current can be used to reliably detect a broken rail (i.e., electrical open) with a shunting axle in the same track circuit under nominal circumstances.
- Identify technical challenges associated with fail-safe implementation of the concept.
- Develop additional analyses and requirements documentation to advance the NGTC concept to support a future product development and evaluation phase.

RAILROAD IMPACT

- The primary goal is to improve capacity with the QMB method of train control while evaluating any safety concerns.



Track Circuit



Track Circuit

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Class I railroads

COST & SCHEDULE

- Funding: $636,903
- Project Duration: September 2019 – January 2021

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

Onboard Broken Rail Detection Research and Development

PROJECT DESCRIPTION

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

The major tasks for this project include:

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

RAILROAD IMPACT

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

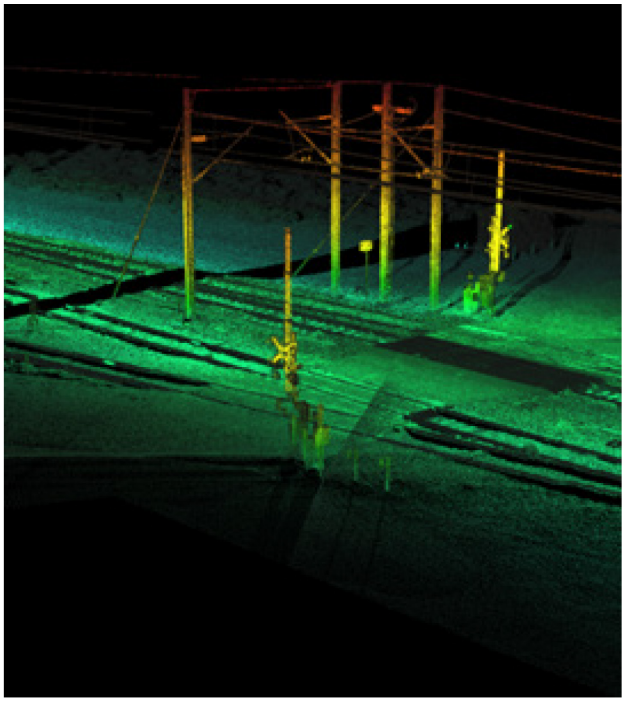
The Track Data Auditing System (TDAS) program focuses on the documentation and development of standards and best practices for the auditing of track data for PTC critical assets, including advancing the level of automation of the auditing process.

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.

- Evaluate COTS data collection systems to verify they meet core requirements, and validate the requirements previously established, through field testing.
- Select vendors from this phase to develop a full data collection subsystem prototype for evaluation in a follow-on phase.

RAILROAD IMPACT

- The TDAS program aims to establish requirements and standards for the auditing of Positive Train Control (PTC) critical assets from the perspective of audit process management, data collection, and verification of PTC critical assets. The TDAS 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 – June 2021

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

Next Generation Head-of-Train / End-of-Train (NGHE) System

PROJECT DESCRIPTION

The Next Generation Head-of-Train/End-of-Train (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.
- Association of American Railroads (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

U.S. Department of Transportation
Federal Railroad Administration

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

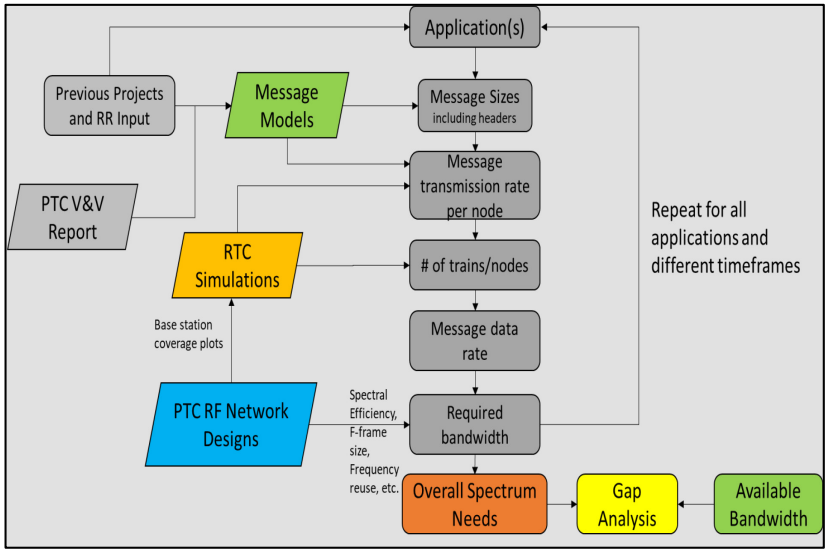
Railroad Wireless Communications Roadmap

PROJECT DESCRIPTION

Wireless communication is increasingly becoming more important to railroad operations. Applications relying on wireless communications for safety, operations, and/or business purposes are becoming more numerous, complex, and critical. At the same time, global demand and competition for radio frequency (RF) spectrum continues to increase rapidly. Lack of RF spectrum could cause a negative impact on certain applications or limit the ability to deploy wireless applications altogether.

Project Objectives:

- Generate an updated list of current and future railroad applications that need wireless spectrum.
- Quantify the wireless needs of the railroads in terms of bandwidth over the next 20 years.
- Identify the gaps between RF spectrum currently owned or licensed by the railroads and their projected needs over time.
- Perform a study of 5G services to identify challenges and opportunities that they may offer to the railroad industry.
- Develop a high-level, time-phased roadmap to address these gaps.



RAILROAD IMPACT

- The results of this project will help the railroad industry develop a strategy for meeting its spectrum needs in the near term and in the future.
- The project is identifying spectrum needs as they evolve for existing and future applications. Recommendations are being developed for addressing spectrum gaps in various dedicated RR bands as well as commercial resources.
- This work supports a proactive approach to avoid having the industry experience a future wireless spectrum shortfall.

PROJECT PARTNERS

- Transportation Technology Center, Inc.
- Class I railroads

COST & SCHEDULE

- Funding: $575,754
- Project Duration: September 2019 – September 2021

U.S. Department of Transportation
Federal Railroad Administration

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

Quasi-Moving Block (QMB) Train Control

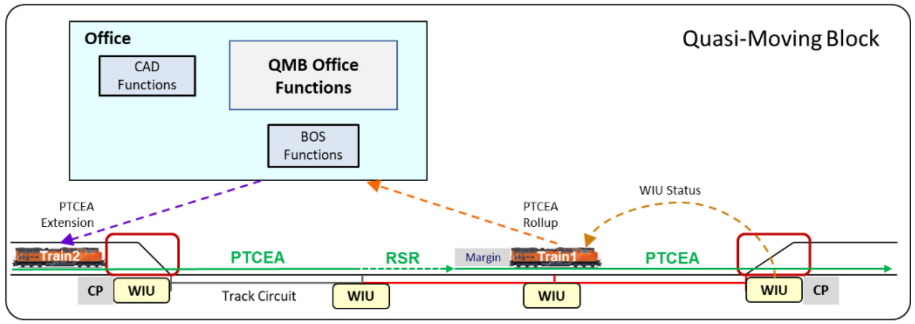
PROJECT DESCRIPTION

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. **Quasi-Moving Block (QMB)** consists of governing any train operation in PTC territory by the issuance of non-overlapping movement authorities, known as PTC Exclusive Authorities (PTCEA). This offers more consistency in train control as well as safety improvements over current Overlay PTC, including the ability to provide rear-end collision protection and collision protection within a joint authority. QMB offers improved capacity and reliability beyond Overlay PTC and is a logical step in the migration to a full moving block train control method.

2. **Centralized Interlocking (CIXL)** introduces an office-based interlocking system that leverages the QMB design and PTCEA concept. CIXL has the potential to improve overall system availability when compared to current field interlocking systems.

3. **Office Safety Checker (OSC)** is the primary office safety function required for QMB, full moving block, and CIXL.



PROJECT PARTNERS

- 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

RAILROAD IMPACT

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

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

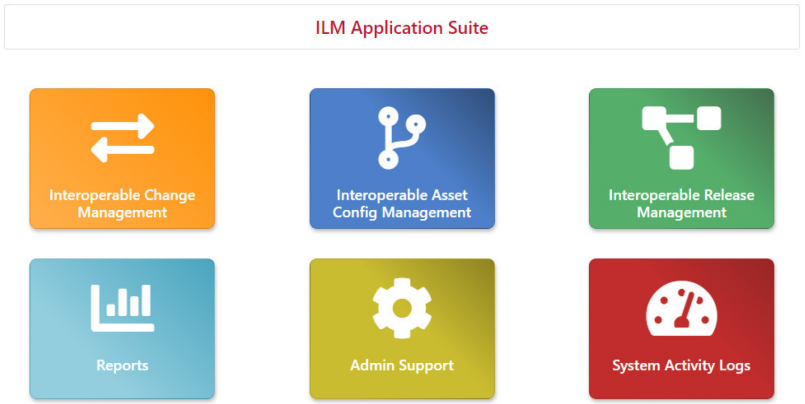
Positive Train Control (PTC) Interoperability Support

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.



PROJECT PARTNERS

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

COST & SCHEDULE

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

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.

U.S. Department of Transportation
Federal Railroad Administration

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 Remote Control Locomotive (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 for use at its discretion.

PROJECT PARTNERS

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

COST & SCHEDULE

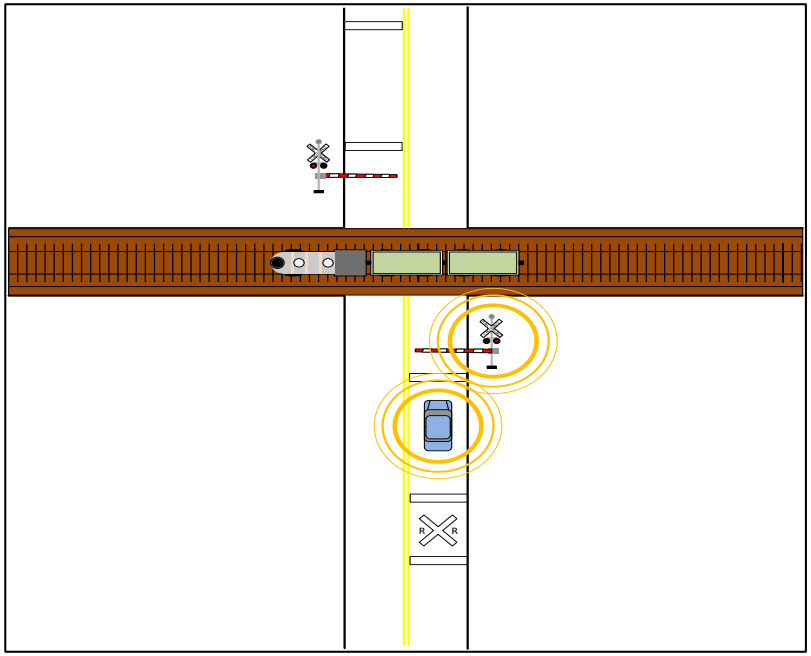
- Funding: $971,685.00
- Project Duration: August 2020 – September 2022

FRA PROJECT MANAGER: Jared Withers • (202) 483-6362 • jared.withers@dot.gov

Rail Crossing Violation Warning

PROJECT DESCRIPTION

- Develop a connected vehicles reference application for in-vehicle driver warning of an imminent violation of a grade crossing protection system.
- Suitable for retrofitting existing infrastructure.
- Evaluate the technical feasibility of implementing the proposed system.
- Provide recommendations and data for future analyses.



RAILROAD IMPACT

- Mitigation of many grade crossing accidents.
- Railside integration with connected and automated vehicle systems being deployed by the automotive industry.
- Test platform for evaluating the effectiveness of connected vehicle safety systems for grade crossing scenarios.

PROJECT PARTNERS

- Battelle Memorial Institute
- Honda R&D Americas
- CTC, Inc.
- Transportation Technology Center, Inc.

COST & SCHEDULE

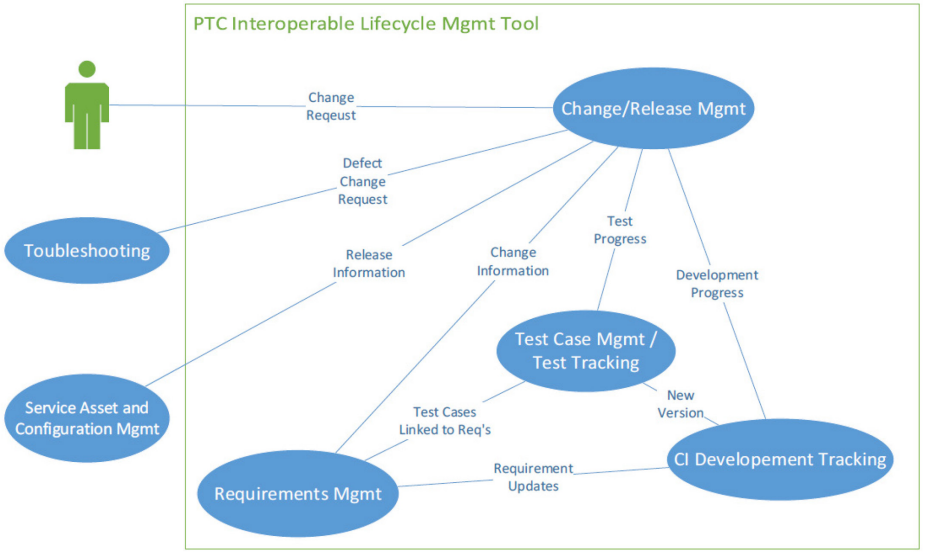
- Funding: $853,156
- Project Duration: September 2015 – March 2020

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

Positive Train Control (PTC) Interoperability

PROJECT DESCRIPTION

- Organize industry stakeholder advisory group.
- Develop operational concepts/system description documentation.
- Develop requirements for the PTC Interoperable Lifecycle Management System.
- Research existing commercially available tool options.
- Support the Interoperable Train Control (ITC) Change and Configuration Management Team.



RAILROAD IMPACT

- Support implementation of PTC systems that depend on accurate configuration information between railroads.
- Support automation of PTC Compatibility Database.
- Improve operational safety and network capacity by reducing the manpower and time to verify inter-railroad operations.
- Migration support for new/updated software and hardware releases.
- Support multiple and unique PTC applications and installations.
- Expandable to support future upgrades/ versions of PTC.

PROJECT PARTNERS

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

COST & SCHEDULE

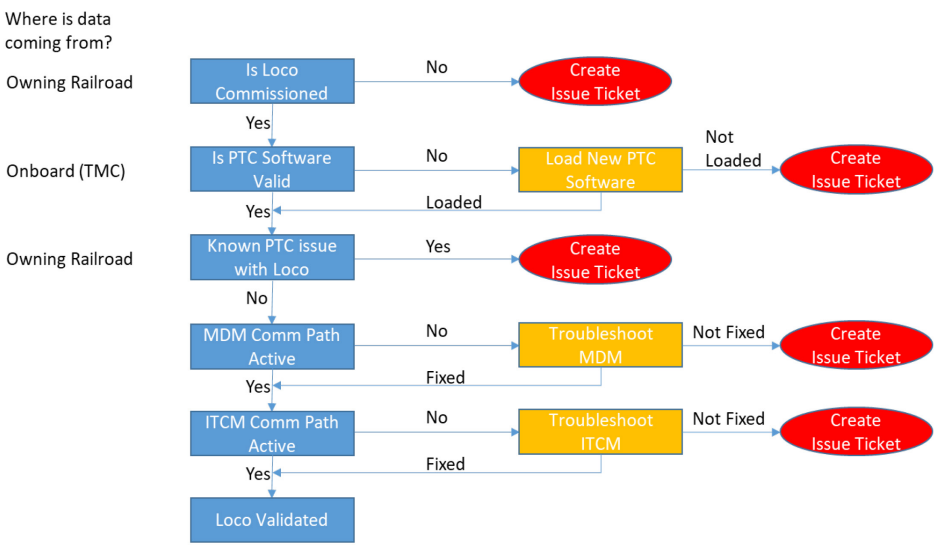
- Funding: $886,000
- Project Duration: March 2017 – March 2020

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

Monitoring and Analysis of the Integrated Network

PROJECT DESCRIPTION

- Collaborate with Technical Advisory Group made up of members from FRA, the Association of American Railroads (AAR), and Transportation Technology Center, Inc. (TTCI).
- Determine data collection needs, analytic methods, and feasibility of monitoring and analysis of the integrated network.
- Develop analytic tools to quickly identify and alert users of problems; provide key information for diagnosing problems; and automatically diagnose problems when possible.
- Automate communications and file transfers between railroads for analysis and recovery of Positive Train Control (PTC) enforcements.



RAILROAD IMPACT

- Provide real-time alerts/alarms, health and status information, diagnostics support, and key performance indicators for PTC help desks, railroad signal and locomotive troubleshooters, network operation centers, dispatchers, urban area coordinators, PTC220 LLC, and PTC maintainers.
- Deploy an industry standard technological platform for railroads to exchange data.
- Provide ongoing message statistics and frequency of instances where locomotives are unable to obtain a communication timeslot (or are delayed in doing so).

PROJECT PARTNERS

- AAR
- TTCI
- Railinc Corp.

COST & SCHEDULE

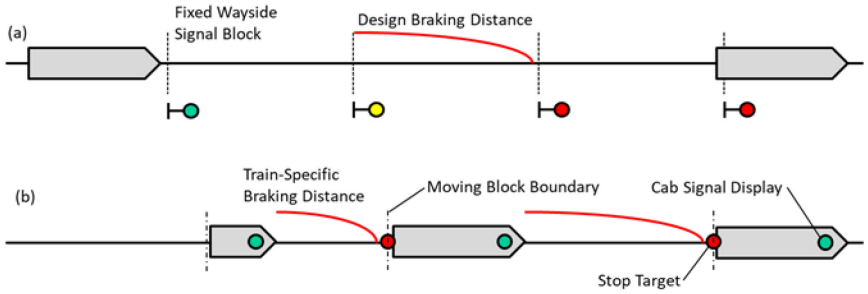
- Funding: $1,489,300
- Project Duration: August 2016 – May 2020

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

Leveraging Connected Highway Vehicle Platooning Technology to Improve the Efficiency and Effectiveness of Train Fleeting

PROJECT DESCRIPTION

- Investigate control algorithms developed to support connected highway vehicle platooning.
- Simulate fleets and understand how closely following trains respond to different throttle and brake control algorithms under moving blocks.
- Develop improved train control algorithms that allow railway operators to optimally balance fuel efficiency and train headway when fleeting trains.
- Show potential of train-to-train communication in efficiently fleeting trains with moving blocks.



RAILROAD IMPACT

- Facilitate driver advisory systems that allow for minimum train headways without repeated PTC enforcement brake applications and associated incident risks from in-train forces.
- Support fuel-efficient operations of train fleets at minimum headways to increase line capacity.
- Thorough understanding of the implications of operating train fleets under moving blocks to support investments in advanced PTC systems.

PROJECT PARTNERS

- University of Illinois at Urbana-Champaign
- Vanderbilt University
- Michigan Technological University
- New York Air Brake Corp.

COST & SCHEDULE

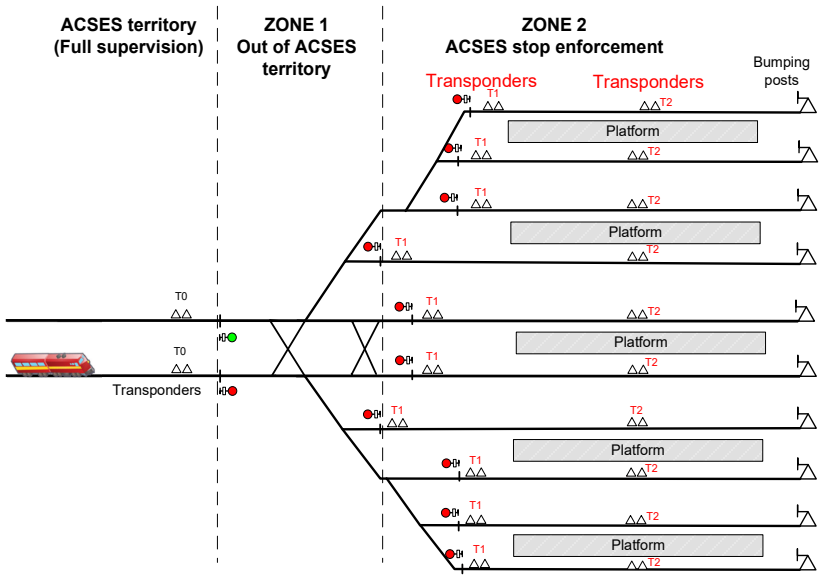
- Funding: $399,840
- Project Duration: October 2019 – January 2021

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

Restricted Speed Enforcement for Positive Train Control (PTC) Systems

PROJECT DESCRIPTION

- Evaluate safety of PTC-preventable accidents below restricted speeds, particularly end-of-track collisions in passenger terminals.
- Develop concept of operations for PTC enforcement to prevent end-of-track collisions.
- Estimate the cost-effectiveness and operational impact of PTC enforcement on terminating tracks in terminals.
- Develop field testing to verify and validate the research concept and method.



RAILROAD IMPACT

- Evaluation of the safety, cost, and operational implications of PTC enforcement to prevent end-of-track collisions in passenger terminals.
- High-level operational concept for modifying PTC systems to function below restricted speeds.
- Field testing to verify the technical feasibility of PTC enforcement under restricted speeds.

PROJECT PARTNERS

- Rutgers, The State University of New Jersey
- HNTB Corp.
- Amtrak

COST & SCHEDULE

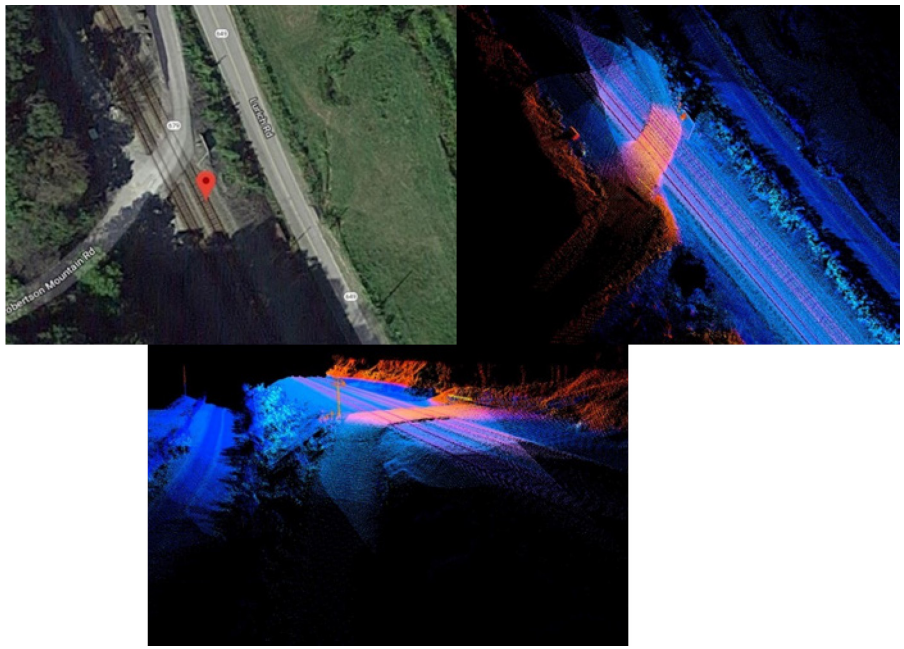
- Funding: $400,550
- Project Duration: February 2017 – May 2020

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

Enhanced Humped Crossing Database Using LiDAR

PROJECT DESCRIPTION

- Enhance FRA's National Grade Crossing Inventory database by including LiDAR point clouds of humped crossings that have a history of accidents.
- Study the feasibility of implementing a portable LiDAR system (e.g., UAV) for grade crossing scanning.
- Develop and test a quasi-real-time alerting system if a humped crossing is detected and not reported as such.



RAILROAD IMPACT

- Consistent verification to what is currently reported to the National Grade Crossing Inventory database.
- Provide a new tool for the public to further analyze and study the crossing profiles.
- Improve efficiency in documenting the state of a grade crossing profile.
- Increase public safety.

PROJECT PARTNER

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $299,804
- Project Duration: October 2018 – September 2020

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

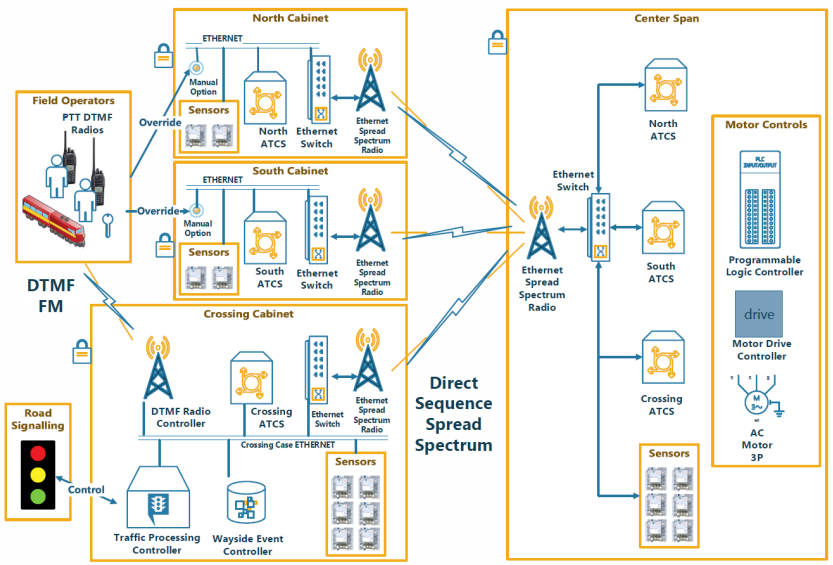
Cybersecurity Risk Management for Connected Railroads

PROJECT DESCRIPTION

- Develop a cybersecurity risk management framework specific to railroads.
- Focus on understanding communications-related cybersecurity risks for connected railroad technologies.
- Implement the risk methodology for selected use cases, such as advanced train control systems and remote control of movable bridges.
- Provide recommendations and identify future research needs for mitigating railroad cybersecurity risks.

RAILROAD IMPACT

- Description of selected connected railroad technologies and use cases.
- Assessment of cybersecurity risk profiles (scenario and hazard source, vulnerability, capability of attack, impact of an attack).
- Implementation issues of cybersecurity risk management and research needs.



PROJECT PARTNERS

- Rutgers, The State University of New Jersey
- George Mason University
- HNTB Corp.
- Industry partners (e.g., Conrail, Belt Railway of Chicago, Amtrak, PATH, CSX)

COST & SCHEDULE

- Funding: $799,713
- Project Duration: September 2017 – May 2020

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

Trespass Risk in Quiet Zones

PROJECT DESCRIPTION

- This project will analyze rail trespass incident data to determine the effects of implementation of Quiet Zones (QZs) on trespass incidents, and include pedestrian incidents at crossings as well.
- Localities desiring to establish a QZ are first required to mitigate the increased risk at grade crossings caused by the absence of a horn. This is typically done through additional safety improvements such as gates with channelization or medians, four-quadrant gates, one-way streets, and crossing closures. However, no trespass mitigation requirements are included.
- It is uncertain how well these improvements work in place of a train horn for both pedestrian safety at crossings and trespassing on a rail right-of-way (ROW).

RAILROAD IMPACT

- Identify possible trends in pedestrian safety around rail ROWs.
- Support analysis for rulemaking and legislative processes.
- Increase public safety.
- Reduce trespass deaths – there were 536 ROW trespass fatalities and 482 injuries in 2018.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

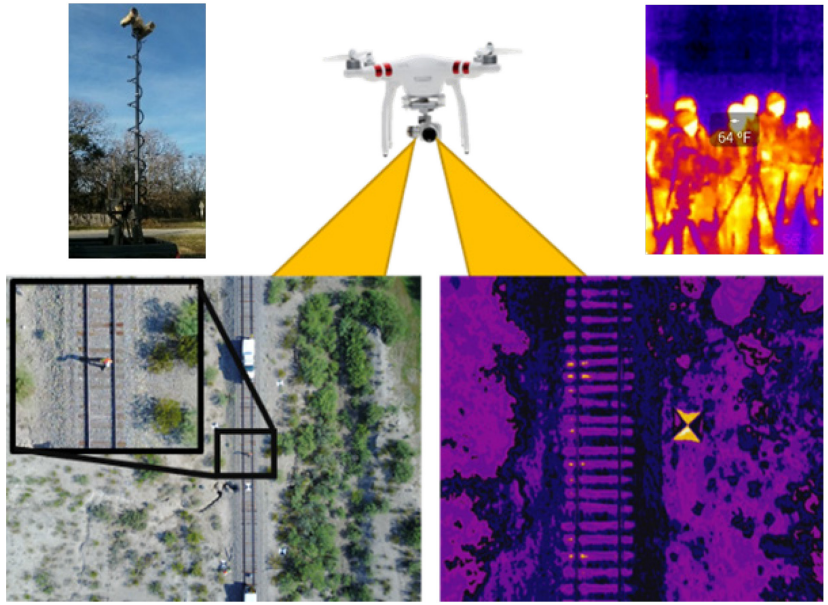
- Funding: $90,000
- Project Duration: March 2019 – December 2019

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 for the problem of intruder detection in 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 (UAV)-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 Company
- Michigan Department of Transportation

COST & SCHEDULE

- Phase 1, April 2019 – October 2019: $103,808
- Phase 2, October 2019 – December 2020: $199,857

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

Full Moving Block (FMB) Train Control

PROJECT DESCRIPTION

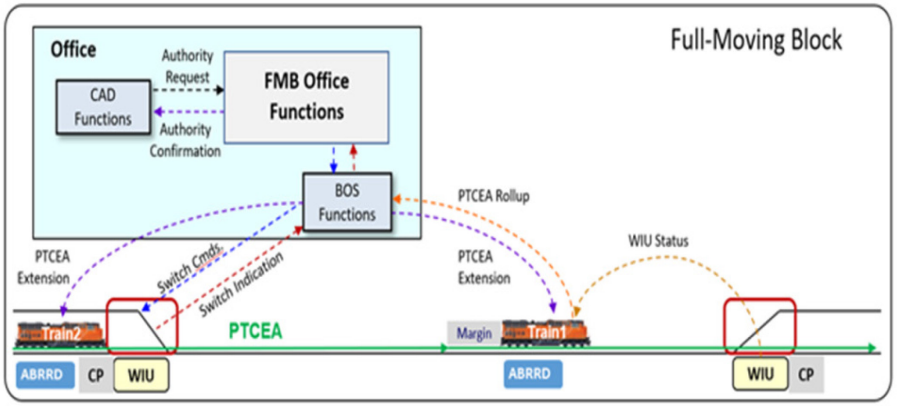
As part of the FRA-sponsored research on Higher Reliability/Capacity Train Control (HRCTC), several enhanced methods of operation, leveraging elements of current Positive Train Control (PTC) systems, were identified and predicted to provide benefits over conventional methods of train control.

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 (FMB)

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

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



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.

PROJECT PARTNERS

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

COST & SCHEDULE

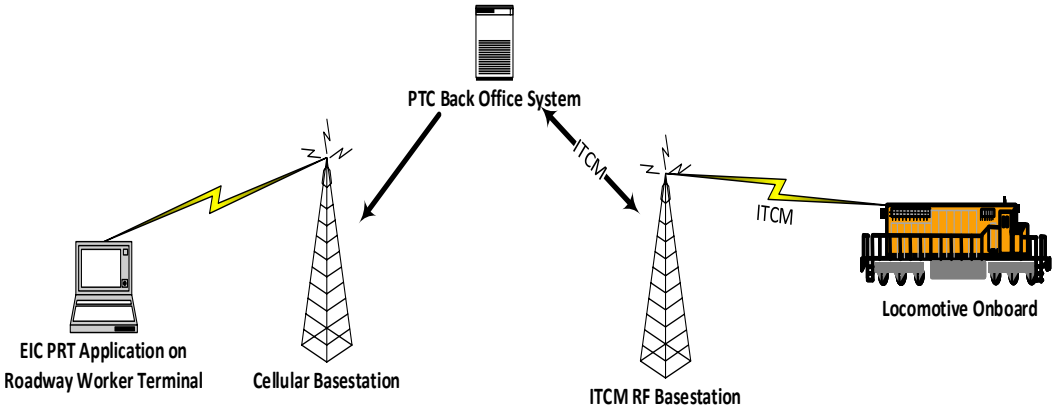
- Funding: $681,554
- Project Duration: May 2020 – September 2022

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 (i.e., 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.
- Mitigates EIC working outside of MOW protected time.
- Prevents instructions to the locomotive by third party (spoofing) through the EICPRT interface.

PROJECT PARTNERS

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

COST & SCHEDULE

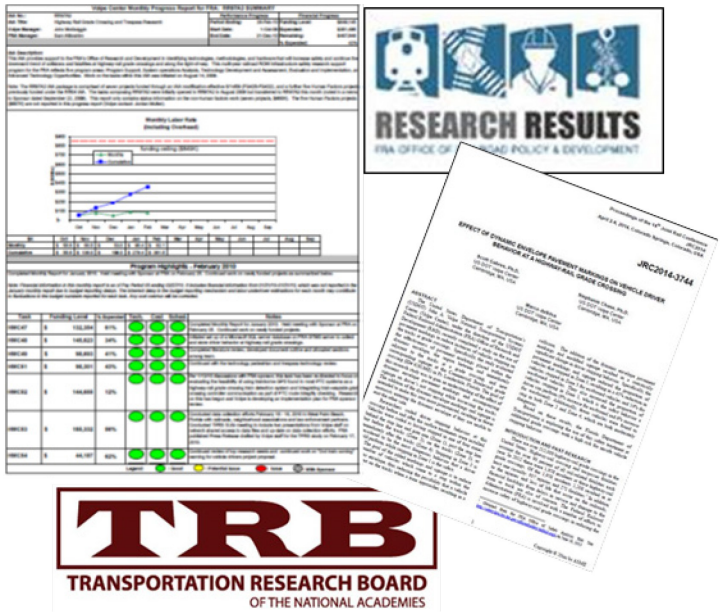
- Funding: $3,200,400
- Project Duration: September 2012 – December 2020

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, 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 which are not specifically funded under another task (e.g., TRB AHB60 Committee, 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: $460,000
- Project Duration: November 2016 – November 2021

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

Gate Skirts Research

PROJECT DESCRIPTION

- Evaluate a specific type of pedestrian gate enhancement, commonly known as gate skirts, designed to prevent pedestrians from violating the grade crossing while the grade crossing protection systems are activated.
- Research in Ramsey, NJ builds on the lessons learned from previous research on gate skirt prototypes in Matawan, NJ, and New Britain, CT.
- Gate skirts installed at Ramsey crossing in September 2017.
- Pedestrian channelization installed and evaluated in 2019.
- Before/after data collected and analyzed.

RAILROAD IMPACT

- Demonstrate and evaluate new technologies and strategies that increase pedestrian safety at grade crossings; there were 172 pedestrian incidents at grade crossings in 2017 (about 9% of the total crossing incidents).
- Partnerships with State DOTs and railroads.
- Information exchange with rail safety partners on cutting-edge technologies and/or strategies.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- New Jersey DOT
- New Jersey Transit
- Borough of Ramsey, NJ

COST & SCHEDULE

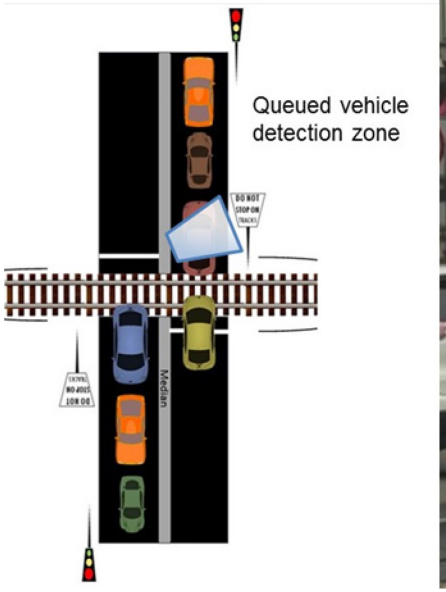
- Funding: $100,000
- Project Duration: May 2017 – December 2020

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

LED-enhanced DO NOT STOP ON TRACKS Sign Research

PROJECT DESCRIPTION

- Evaluated the effectiveness of flashing light-emitting diode (LED)-enhanced "Do Not Stop on Tracks" (R8-8) signs on reducing traffic queuing at highway-rail grade crossings. System installed in October 2018.
- Final report on continuously-flashing LED enhanced sign published in June 2019: https://rosap.ntl.bts.gov/view/dot/41694.
- Performed tradeoff analysis of applicable sensor technologies for stopped vehicle detection.
- Performed a before/after analysis of LED R8-8 sign triggered by laser-based queue detection system.
- Location: Katonah, NY, on MNCR Harlem Line.



RAILROAD IMPACT

- Develop techniques or technologies that reduce instances of vehicles queuing over and stopping on the tracks which may lead to incidents and casualties (such as the 2015 crash in Valhalla, NY, that killed 6 and injured 15).
- Facilitate implementation and evaluation of innovative safety technologies.
- Information exchange on cutting-edge technologies and/or strategies for grade crossing safety.

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Town of Bedford, NY
- MTA/MNR

COST & SCHEDULE

- Funding: $185,000
- Project Duration: June 2017 – September 2020

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

Emergency Notification System Sign Study

PROJECT DESCRIPTION

- To learn more about drivers' awareness and understanding of the Emergency Notification System (ENS) signs posted at highway-rail grade crossings.
- The study will help shed light on how drivers react when crossing infrastructure that appears to be malfunctioning or when stuck on the crossing.
- This study will pay particular attention to whether drivers look for or attempt to make use of the information on an ENS sign.
- This experiment will be conducted in the Volpe National Transportation Systems Center (Volpe Center) driving simulator.

RAILROAD IMPACT

- Identify possible trends in vehicle driver behavior at and approaching grade crossings.
- Identify potential driver education/awareness strategies on presence and use of ENS signs.
- Provide design considerations for the most effective location and orientation of ENS signs.
- Support analysis for potential legislative processes.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $180,000
- Project Duration: June 2018 – September 2020

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

UAS Technology Exploratory Study

PROJECT DESCRIPTION

- The objective of this project is to investigate the potential use of drone technology to quickly create accurate 3D profiles of humped grade crossings (using LiDAR, photogrammetry, and other methods).
- 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, 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 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
- 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

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*

RAILROAD IMPACT

- Provides FRA partners with information on the latest trespass prevention strategies.
- Fosters an exchange of information on trespassing mitigation among 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 10 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

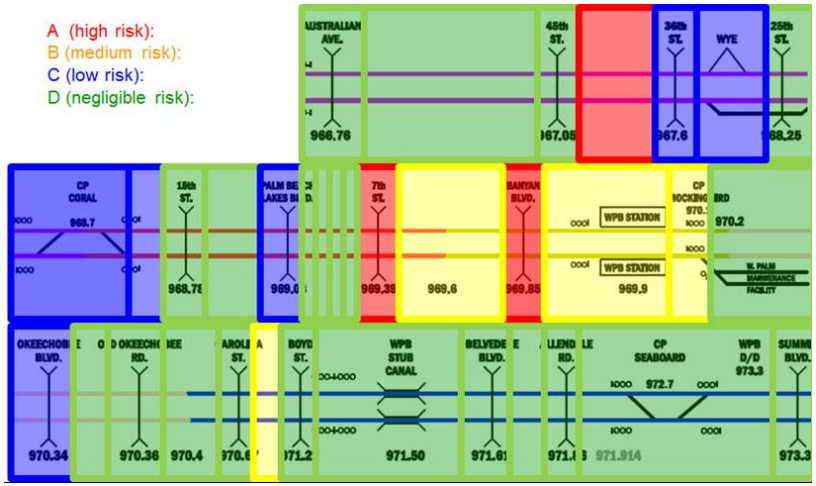
- Funding: $150,000
- Project Duration: August 2019 – September 2021
  - Schedule affected by COVID-19; original summits planned for spring 2020

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 (https://rosap.ntl.bts.gov/view/dot/12075) 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 536 ROW trespass fatalities and 482 injuries in 2018).

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $180,000
- Project Duration: March 2019 – December 2020

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

ROW Trespass CRISI Grant Evaluation

PROJECT DESCRIPTION

- The objective of this project is to 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 geographic information system 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

Artificial Intelligence for Trespassing

PROJECT DESCRIPTION

- This project continues the work on Artificial Intelligence (AI) algorithms for different trespass and crossing scenarios started under the Anti-Trespass Treatments project (subtask 2.4).
- This work also includes continued collaboration with Rutgers University on its AI detection system and supports installation and evaluation at the E. Main St crossing in Ramsey, NJ.
- Collaboration with Michigan Tech on its AI algorithms will also be explored.

RAILROAD IMPACT

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

PROJECT PARTNERS

- Volpe National Transportation Systems Center
- Rutgers, The State University of New Jersey
- Michigan Technological University

COST & SCHEDULE

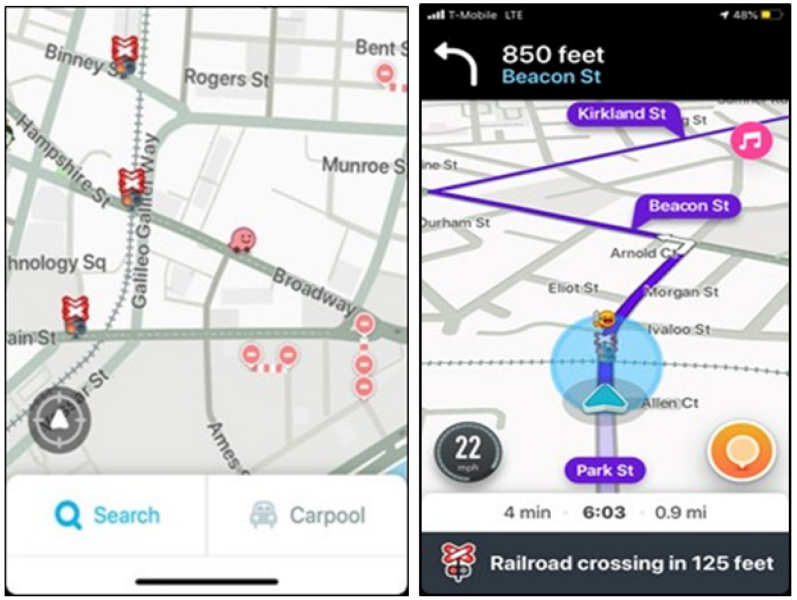
- Funding: $150,000
- Project Duration: November 2019 – December 2020

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

Waze Notifications Research

PROJECT DESCRIPTION

- 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 application 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.
- 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

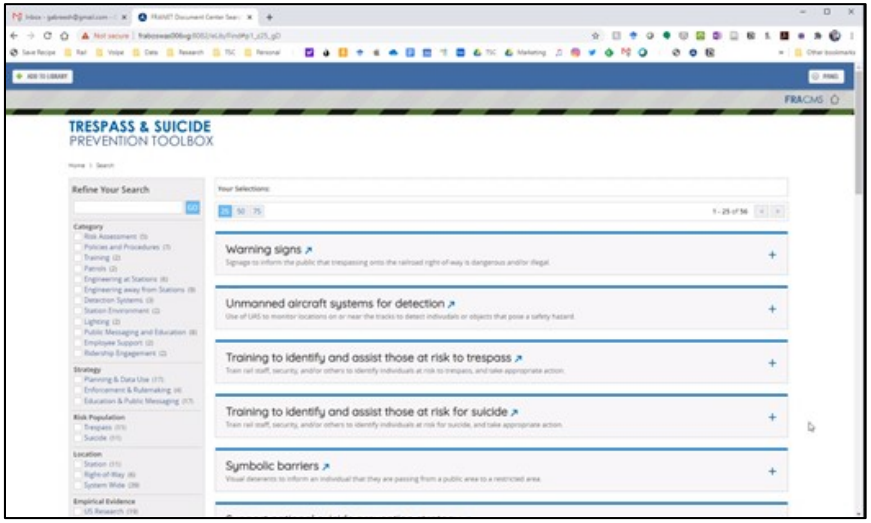
- Funding: $150,000
- Project Duration: May 2020 – February 2021

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

Trespass Toolbox

PROJECT DESCRIPTION

- The objective of this project is to support the development of a rail right-of-way web-based trespass "toolbox" currently under development by FRA RD&T.
- Rail stakeholders have long desired a central repository of results of trespass mitigation measures implemented throughout the country.
- This toolbox 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

- Provides FRA partners with information on cutting-edge technologies and/or strategies for trespass and suicide prevention.
- Fosters an exchange of information on rail trespassing and suicide mitigation among stakeholders.
- Facilitate implementation and evaluation of innovative safety technologies.
- Facilitates 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 – December 2020

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

Trespass Close Call Data

PROJECT DESCRIPTION

- This project supports FRA RD&T on 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, the data does not provide enough information on non-incident trespass activities for determination of hotspots or contributing factors along rail lines.
- Many railroads and 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's 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.
- Fosters an exchange of information on rail trespassing between all stakeholders.
- Reduce the number of pedestrians that trespass onto railroad rights-of-way.
- Increase public safety.

PROJECT PARTNER

- Volpe National Transportation Systems Center

COST & SCHEDULE

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

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:* Prototype a Head-Up Display (HUD) augmented reality 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.

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.

COST & SCHEDULE

- Funding: $3,415,628.89
- Project Duration: September 2018 – May 2025

PROJECT PARTNERS

- MIT Human Systems Lab
- 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:* Provide scientifically valid information about the importance of sleep; proven, practical tips and strategies for improving sleep health.
3. *Fatigue Research Plan:* Identify fatigue research needs for the railroad industry.
4. *Combating Performance Degradation in Railroad Operations:* Conduct pilot testing to assess whether habituation to alerts exists in locomotive engineers.

PROJECT PARTNERS

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

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.

COST & SCHEDULE

- Funding: $379,175.98
- 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

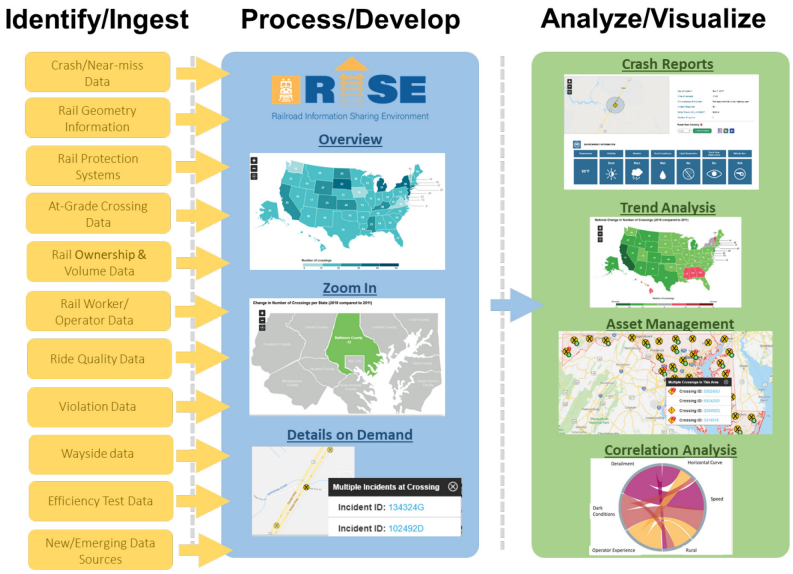
Support FRA's Office of Railroad Safety (RRS) by providing subject matter expertise, consultation, research, data, and tools to improve railroad safety. RRS works closely with RD&T to provide insight into research needs.

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. *C3RS – PTC Deep Dive:* Use near miss reports to learn about the potential risks associated with PTC technology currently being implemented on the nation's rail systems
4. *Scenario-Based Training (SBT):* Evaluation of the effectiveness of SBT implemented at passenger railroads to address close call reports; determine whether SBT can reduce human factors accidents and incidents.

RAILROAD IMPACT

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



PROJECT PARTNERS

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

COST & SCHEDULE

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

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

Motorist Behavior at Highway-Rail Grade Crossings

PROJECT DESCRIPTION

This research area examines the human factors that significantly impact motorists' behavior at grade crossings.

Sample Acquisitions*:*

1. *Intelligent Crossing Assessment and Traffic Sharing System:* Develop an affordable and field-deployable system that detects and predicts blocked crossings and provides real-time information to emergency responders.
2. *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.
3. *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.
4. *Modeling Grade Crossing Treatments in Virtual Reality:* Test novel grade crossing treatments in virtual reality; observe and measure behaviors and perceptions of motorists, pedestrians, and bicyclists

RAILROAD IMPACT

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

PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $1,135,040.87
- 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.
3. *Training of Railway Staff on Trespasser Strikes Using a High Fidelity Simulator:* Work with a partner railroad to understand how iPads may be used to reduce trespass strikes.

PROJECT PARTNERS

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

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.

COST & SCHEDULE

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

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

Railroad Suicide Prevention

PROJECT DESCRIPTION

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

Sample Acquisitions:

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

RAILROAD IMPACT

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

PROJECT PARTNERS

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

COST & SCHEDULE

- Funding: $590,000.00
- Project Duration: May 2020 – May 2025

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

Short Line Safety Institute (SLSI)

PROJECT DESCRIPTION

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

Sample Acquisitions*:*

1. *SLSI grant:* SLSI seeks to improve safety practices and provide safety training for Class II and Class III freight railroads to build a stronger, sustainable safety culture.
2. *SLSI Evaluation:* Conduct an independent evaluation of SLSI's program improvement and funding accountability.
3. *SLSI Commuter Railroad Assessment:* Determine the extent to which SLSI's safety culture assessment process can be applied to passenger operations.
4. *Pilot project for C3RS and shortline 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

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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Washington, DC 20590

For more information visit us at
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