FEDERAL RAILROAD ADMINISTRATION

RAIL
MOVING AMERICA FORWARD

FRA OFFICE OF RESEARCH, DEVELOPMENT & TECHNOLOGY

CURRENT RESEARCH PROJECTS

U.S. Department of Transportation
Federal Railroad Administration

2018 TRB Annual Conference

RESEARCH SECTIONS

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

SECTION ONE

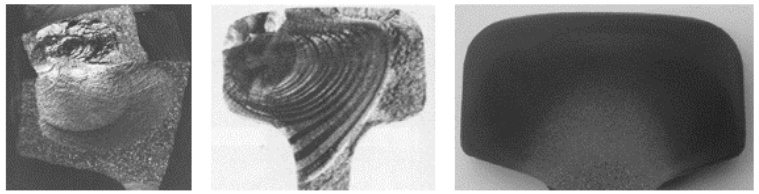
TRACK

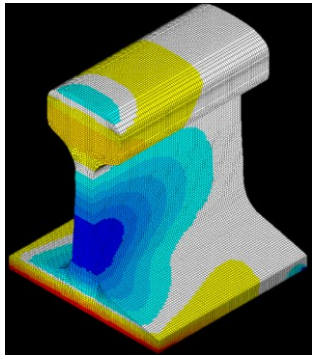
U.S. Department of Transportation
Federal Railroad Administration

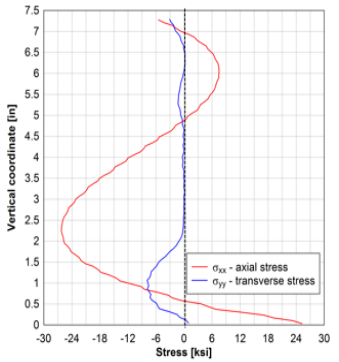
Defect Growth Characterization in Modern Rail Steel

PROJECT DESCRIPTION

- **Task 1:** Influence of microstructural gradient on crack growth rate in head-hardened rails: hardness → crystallography (LOM, SEM) → CT specimens from key locations → toughness and crack growth rate testing.
- **Task 2:** Residual stress distribution → neutron diffraction measurements and detailed analyses.
- **Task 3:** Influence of wheel-induced bending stress gradient on crack growth rate in head-hardened rail - stress ratio effects.
- **Task 4:** Data analysis and formulation of **The Framework** → material characterization and testing protocol for rails (i.e. best practices and initial decision tree for life evaluation).







RAILROAD IMPACT

- Detailed experimental characterization of microstructural gradient and residual stress effects in head-hardened rails.
- Framework for modern rail characterization with a consistent testing protocol applicable to variety of rail grades and types.
- Modular/ building block development framework that considers previously collected data and expertise and allows multiple extensions to account for advancements in material science and rail manufacturing technology – paradigm shift.
- Likely adoption by the railroad industry and FRA.

PROJECT PARTNER(S)

- Weidlinger Associates, Inc.
- Harvard University
- Lehigh University
- ArcelorMittal
- NIST

COST & SCHEDULE

- Funding: $417,016
- Project Duration: January 8, 2016 – January 7, 2018

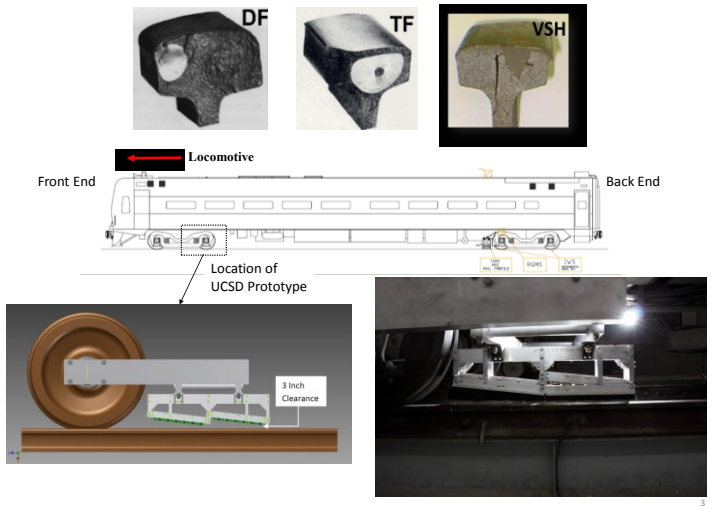
U.S. Department of Transportation
Federal Railroad Administration

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

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

PROJECT DESCRIPTION

- The project is evaluating a new technique that uses non-contact acoustic sensors and special signal processing algorithms to detect internal defects in rails by exploiting the acoustic excitations naturally induced in the rail by the wheels of a running train.
- This new inspection concept is based on the application of special signal processing algorithms aimed at extracting a “stable” acoustic Transfer Function between two points of the rail despite the “random” acoustic excitation by the rolling train wheels.
- Successful feasibility tests of the “passive” Transfer Function extraction were conducted in September 2016 at TTCI RTT by using a prototype designed by UCSD and installed under DOTX216 Test Car operated by ENSCO and tested at speeds up to 80 mph.
- Plans are in place for a second field test at TTCI in 2018.



PROJECT PARTNER(S)

- University of California San Diego (grantee)
- ENSCO, Inc. (test support)
- Transportation Technology Center, Inc. (TTCI) (test support)

COST & SCHEDULE

- Funding: $286,361
- Project Duration: May 2016 – March 2018

RAILROAD IMPACT

- Passive rail inspection technology that exploits the natural train wheel excitations 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.

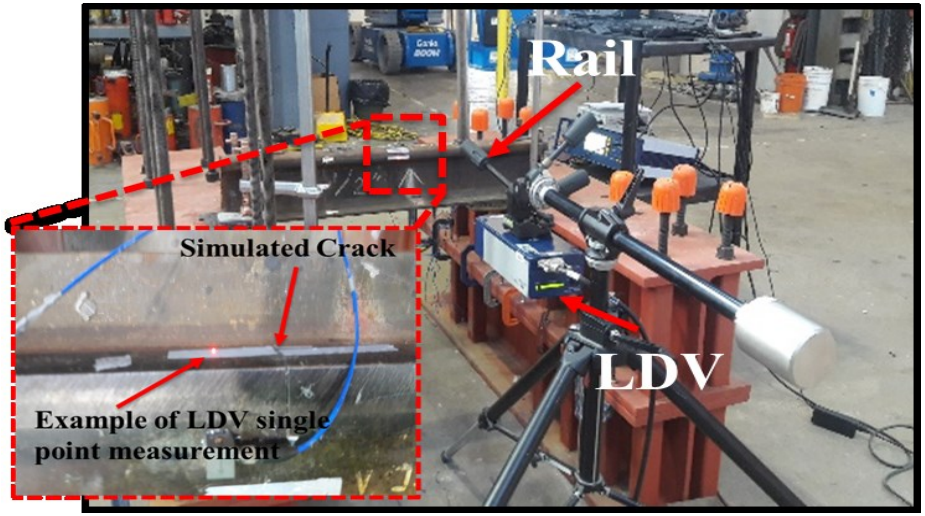
U.S. Department of Transportation
Federal Railroad Administration

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

Rail Defect Detection by Non-Contact Vibration Measurements

PROJECT DESCRIPTION

- The objective of this project is to investigate the hypothesis that natural vibrations induced in the rail by the wheel-rail contact can be used for the identification of rail defects.
- Overall it is proposed to use laser-based vibration measurements in the rail, and advanced data processing techniques to detect rail flaws.



RAILROAD IMPACT

- A non-contact rail integrity inspection system to detect rail flaws including internal flaws.

PROJECT PARTNER(S)

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

COST & SCHEDULE

- Funding: $286,361
- Project Duration: May 2016 – March 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Robust Railway Track Crack Detection System Using Thermal Signatures

PROJECT DESCRIPTION

- In Phase I, a prototype sensor with low-power microprocessor, IR camera, GPS and gyro stabilizer were integrated into one sensor platform that can be mounted at the back of train.
- This sensor platform was mounted on an MBTA train and a large amount of IR images of rails were collected as the train traveled at speed of 40 mph.
- Broken rail thermal signatures were studied in different hours of a day and under different weather conditions. It was concluded that the rail cracks of 0.5'' gap can be reliably detected.
- IR image processing algorithms have been developed and tested using the rail data collected. Image enhancement algorithm was developed to help chip out the rail segments for monitoring railroad integrity.

PROJECT PARTNER(S)

- Migma Systems, Inc.

COST & SCHEDULE

- Funding: Approx. Cost to Date: $150,000
- Project Duration: May 2017 – November 2017

RAILROAD IMPACT

- Automated railway inspection is critical for ensuring the safety of public transportation. Rails often break under trains but do not lead to immediate derailment until further damage occurs at the fracture, causing catastrophic derailment.
- Video cameras have been used to detect the rail cracks with limited success as the video image quality is highly impacted by the environment such as alignment of light source and weather conditions. The system developed under this SBIR Phase I utilizes IR camera for the detection of rail cracks through their unique thermal signatures. It can be mounted on the back of trains and detect cracks in real time as trains are in service.

U.S. Department of Transportation
Federal Railroad Administration

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

High-Speed Broken Rail Detection

PROJECT DESCRIPTION

- Demonstrate prototype detection system.
- Automated detection of broken rails.
- Real-time imaging of rail morphology allows breaks to be differentiated from rail joints.
- Novel high-speed detector enables detection of broken rails from trains at normal operational speeds (does not require dedicated metrology/inspection).
- Detection of early-stage rail defects from normal service revenue trains enables repair before catastrophic failure and derailment.

RAILROAD IMPACT

- Broken rails or welds are a common cause of Class I mainline derailments. Rails often break under trains but do not cause immediate derailment until further damage leads to catastrophic failure.
- Current inspection methods are periodic and may miss the critical period during which initial damage progresses to complete failure.

PROJECT PARTNER(S)

- Creare, LLC
- Vermont Rail System

COST & SCHEDULE

- Funding: $150,000
- Project Duration: May 2017 – November 2017

U.S. Department of Transportation
Federal Railroad Administration

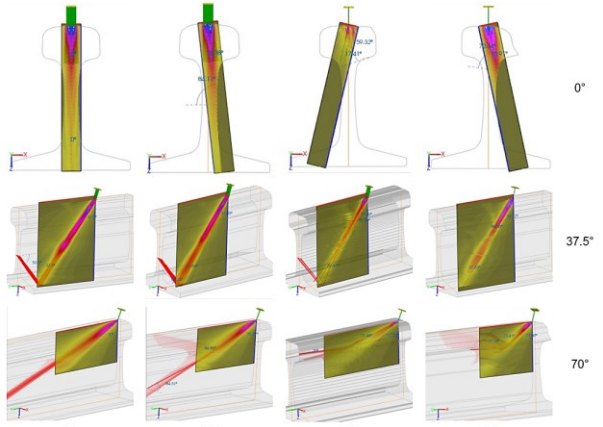
FRA PROJECT MANAGER: Robert Wilson • (617) 494-2265 • robert.wilson@dot.gov

Quantification and Evaluation of Rail Flaw Inspection Practices and Technologies

PROJECT DESCRIPTION

- **Rail Flaw Library of Associated Defects (RF-LOAD)**
- Complete Matrix of Master Gages (Artificial reflectors) and collect naturally occurring flaws. These rail flaw samples will be used for training of inspectors using hand-held NDE instruments, POD method development, and initial development of advanced inspection technologies. In addition, this library will serve other researchers to allow them direct access to the realistic rail flaw samples for validating their work on rail inspection technologies.
- **Ultrasonic Beam Modeling & Inspection Simulations**
- Conduct UT simulations to better understand ultrasonic beam and probe responses for commonly missed flaws (shape, size, orientations) in revenue service under different inspection scenarios. The outcome of this task is to come up with recommendation for ultrasonic parameters and inspection angles for improved detection of missed flaws in revenue service.

Rail Flaw Library



Ultrasonic beam field computation (transmission) of ultrasonic transducers for different 136 RE rail head profiles. (a) Virgin rail profile; (b) Normal used profile; (c) Surface damaged profile; (d) Gage wear profile.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: $149,931
- Project Duration: June 21, 2017 – May 31, 2018

RAILROAD IMPACT

- Increase safety, integrity, efficiency, and reliability of railway transportation.
- Support future research directed towards 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.
- Achieve higher reliability of Ultrasonic NDE inspection for rail flaw detection and characterization.
- Collaborate with rail flaw service providers and railroad industry stake holders.

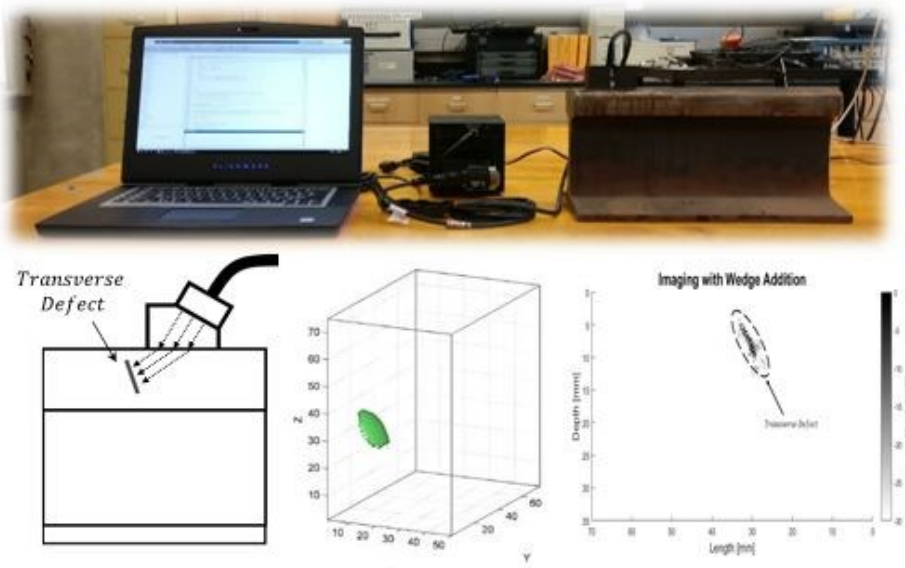
U.S. Department of Transportation
Federal Railroad Administration

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

Rail Flaw Imaging – Ultrasonic Tomography

PROJECT DESCRIPTION

- Experimental imaging prototype has been developed based on ultrasonic arrays and Synthetic Aperture Focus (SAF) techniques.
- Developed and tested several signal processing algorithms, including wave mode structure weights, point-spread function deconvolution and mode compounding, to increase contrast and reduce artifacts of the SAF images.
- Implemented imaging algorithms in Graphical Processing Unit (GPU) for increased speed – technique can potentially be extended to in-motion rail inspection.
- Evaluating prototype performance on man-made and natural internal rail flaws including five samples from the FRA Rail Defect Library managed by TTCI.



RAILROAD IMPACT

- Manual rail flaw verification is currently operator dependent. Flaw sizing is highly subjective.
- Imaging flaws by Synthetic Aperture Techniques will provide more objective quantification of flaw size and position.
- Will lead to more informed decisions on remedial actions and increased safety.
- Technique can potentially be extended to in-motion inspections.

PROJECT PARTNER(S)

- University of California, San Diego
- Transportation Technology Center, Inc. (TTCI) (test support through loan of rail sections from FRA Rail Defect Library)

COST & SCHEDULE

- Funding: $149,024
- Project Duration: September 2016 – March 2018

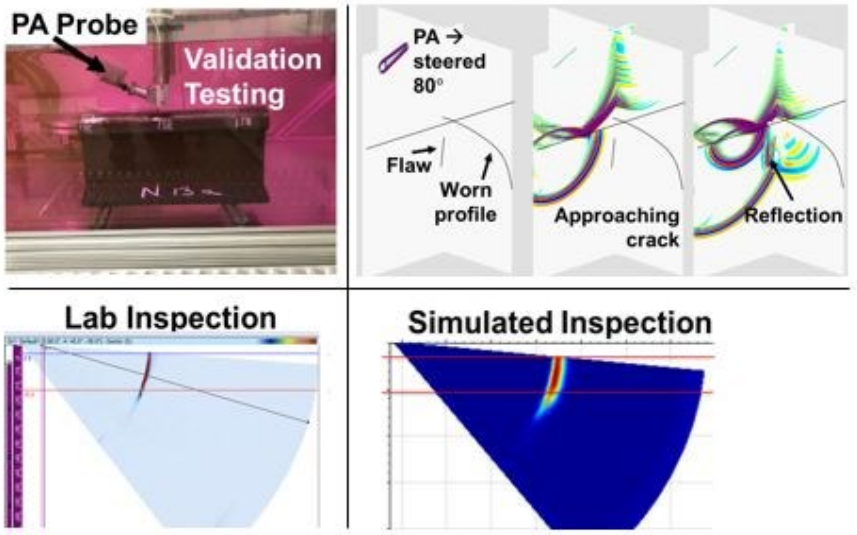
U.S. Department of Transportation
Federal Railroad Administration

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

Automated Rail Head Internal Flaw Characterization Using Phased Array Systems

PROJECT DESCRIPTION

- This project leverages artificial intelligence to size rail head flaws from PA ultrasonic inspections.
- **Task 1:** High fidelity finite element simulation of a PA inspection validation against laboratory PA inspection of 136RE rail sample.
- **Task 2:** Novel signal post-processing for flaw feature characterization and sizing.
- **Task 3:** Development of virtual Library of flaws and associated PA inspection signals.
- **Task 4:** Automated, probabilistic flaw characterization for previously unseen flaws and inspection data.



RAILROAD IMPACT

- Current technology cannot alter beam direction without physically moving the probe or replacing the lens.
- Phased array (PA) systems can be understood and optimized to reliably find flaws.
- Increased flaw sizing reliability and inspection speed enabled by pre-inspection virtual Library of flaw data.
- Shifts flaw sizing burden from inspector with limited PA experience and on to analysis and software development.
- Increased flaw sizing (e.g. % rail head area) reliability will decrease chance of derailments.

PROJECT PARTNER(S)

- Thornton Tomasetti (Weidlinger Applied Science Practice)
- EWI
- University of Pittsburgh

COST & SCHEDULE

- Funding: $149,550
- Project Duration: February 28, 2017 – August 27, 2018

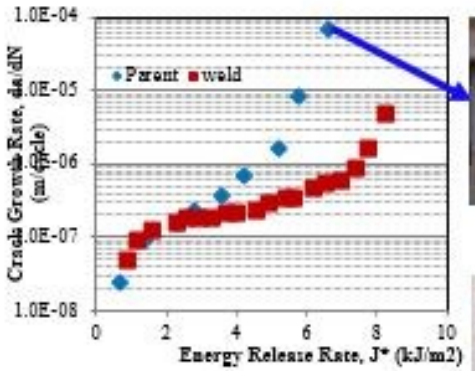
U.S. Department of Transportation
Federal Railroad Administration

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

Pre-Heating Optimization and Field Testing of Railhead Defect Repair

PROJECT DESCRIPTION

- **Task 1:** Optimization of pre-heating conditions that includes computational heat transfer analysis on a simulated railhead defect (slot) under uniform preheating applied to the web and lab experiments to assist with the computational heat transfer analysis.
- **Task 2:**Perform multiple (5) head repair welds based on the patented technology by Tuskegee University using an AREMA 136 RE rail section length.
- **Task 3:** Perform multiple metallurgical lab testing on three (3) weld samples provided by TU. These tests will be performed by TTCI. TU will also perform similar tests for comparing results with TTCI.
- **Task 4:** Perform 6 slow bend tests similar to AREMA requirement for electric-flash butt welding. This will be performed by an independent laboratory approved by both TU and TTCI.



Slot welded pearlitic railhead shows better fatigue performance than the parent rail steel.

Parent pearlitic rail head before repair

Slot welded railhead

RAILROAD IMPACT

- Improve the quality of rail head defect weld repair.
- Provide a more efficient and consistent field repair method for rail head defects.
- Enhance the fatigue damage tolerance of weld repaired rail.

PROJECT PARTNER(S)

- Tuskegee University
- Transportation Technology Center, Inc. (TTCI)
- Nucor Steel

COST & SCHEDULE

- Funding: $123,895.36
- Project Duration: October 1, 2017 – September 30, 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Rail Neutral Temperature and Longitudinal Force Management

PROJECT DESCRIPTION

RNT Loss Modeling

- Determine RNT loss from rail installation and maintenance records.
- Determine effects of track design parameters.

Monitoring RNT and Curve Movement under Heavy Axle Loads

- Determine RNT at 15 minute intervals in two 5 degree curves; this allows determination of rail longitudinal stress at the time of rail break/cut.
- Assess the effects of track maintenance on RNT.
- Provide test bed for curve monitoring technologies.

Evaluation of Potential Curve Monitoring Technologies

- Benchmark the cost and accuracy of the currently used manual measurement method.
- Scan and evaluate technology and potential technologies against the benchmark.

RAILROAD IMPACT

- Characterization of RNT changes in revenue service track.
- Characterization of rail force at the time of weld and rail failure under “real world” conditions.
- Evaluation of new methods to monitor curve movement.
- Understand how curves breathe with and without train traffic.
- Measure rail movement and RNT changes simultaneously in curves at the FAST Facility.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: Approx. $365,000
- Project Duration: July 2016 – January 2019

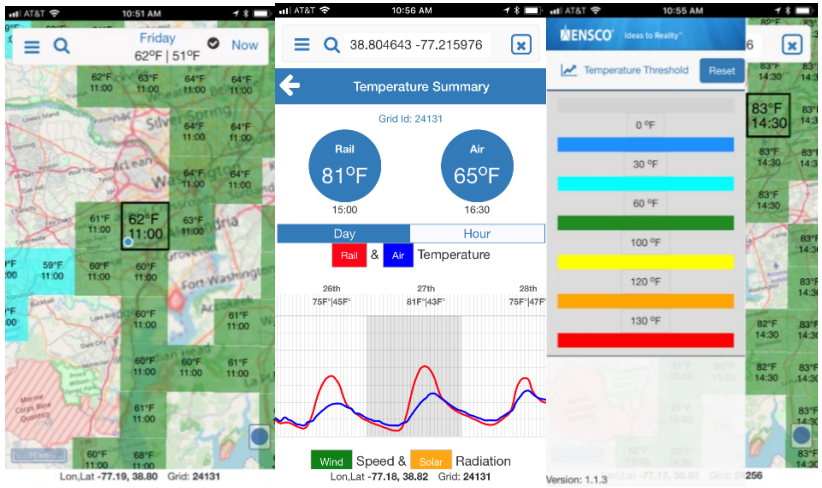
U.S. Department of Transportation
Federal Railroad Administration

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

Rail Temperature Prediction

PROJECT DESCRIPTION

- Extend weather forecast and rail temperature prediction outlook to 36 hours ahead.
- Develop a rail temperature web/mobile application.
  - Support implementation with industry partners.
  - Provide daily rail temperature reports to industry partners as part of a pilot initiative.



RAILROAD IMPACT

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

PROJECT PARTNER(S)

- ENSCO, Inc.
- Amtrak
- MBTA
- Norfolk Southern

COST & SCHEDULE

- Funding: $89,000
- Project Duration: February 2017 – February 2018

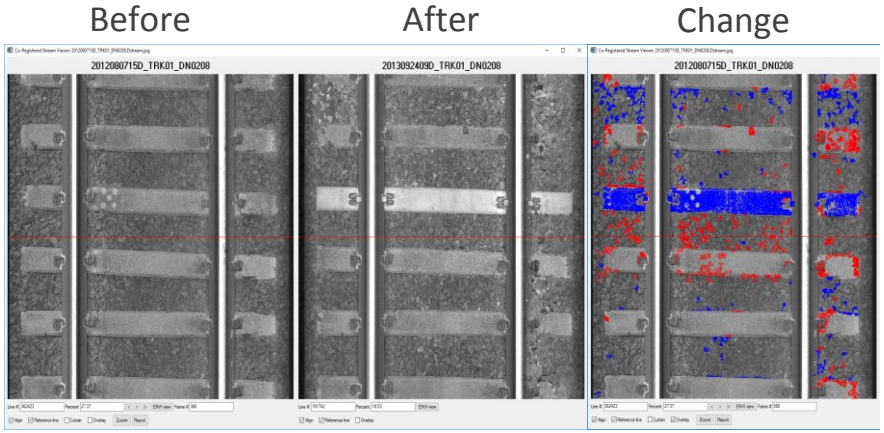
U.S. Department of Transportation
Federal Railroad Administration

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

Application of Off-the-Shelf Change Detection Software in a Rail Environment

PROJECT DESCRIPTION

- The project assesses potential merits of applying commercially available change detection software to railway images.
- ENSCO and Exelis Visual Information Systems, a subsidiary of Harris Corporation, collaborated to evaluate Harris' ENVI change detection software in rail environment.
- ENSCO provided Exelis with railway images; Exelis added workflow capabilities to the ENVI software to accommodate and process the railway images; ENSCO evaluated final results.



RAILROAD IMPACT

- Machine vision offers significant potential to isolate unsafe track conditions; however, a large number of relevant conditions need to be detected to ensure safety.
- Today's image-based change detection technology offers the potential to automatically flag a broad range of unsafe conditions using one algorithm based on generalized principals.
- Effort intends to evaluate readiness of current change detection technology for application to rail images.

PROJECT PARTNER(S)

- ENSCO, Inc.
- Harris Corporation

COST & SCHEDULE

- Funding: $128,000
- Project Duration: March 2017 – September 2017

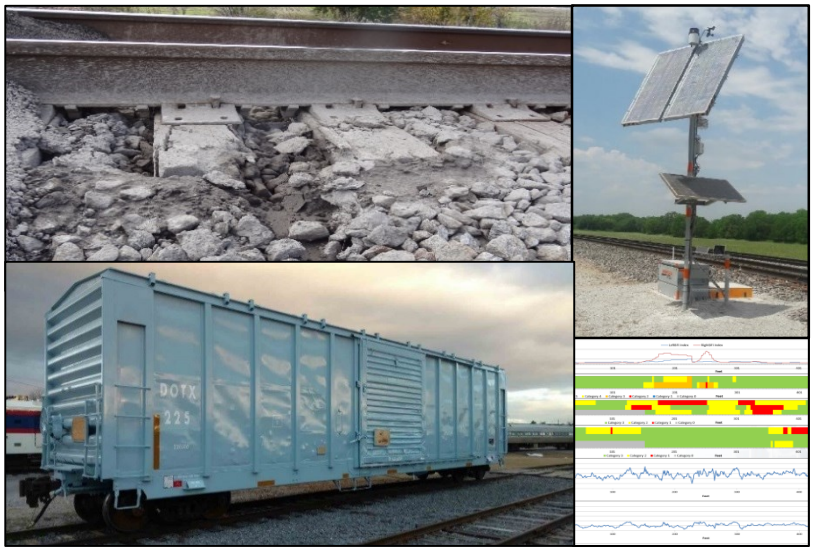
U.S. Department of Transportation
Federal Railroad Administration

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

Ballast Waiver Study Data Collection

PROJECT DESCRIPTION

- Demonstrate an alternative class-specific approach to management of fouled ballast as opposed to the current 30-day defect while subject to controlled conditions and other safety measures.
- Better define reduced performance of fouled ballast related to through observation of the full ballast deterioration cycle.
- Collect pertinent information using track geometry measurements, long-term wayside instrumentation, GPR, and other available sources.
- Weekly geometry measurements, reporting on ballast compliance, long-term instrumentation of six sites.



RAILROAD IMPACT

- Better understanding of “reduced performance” or “fouled” ballast under a range of weather conditions.
- Development of objective criteria for identifying “fouled” ballast conditions.
- Collection of information for a possible data driven revision of §213.103 of Track Safety Standards.

PROJECT PARTNER(S)

- ENSCO, Inc.
- AAR
- BNSF
- UIUC

COST & SCHEDULE

- Funding: $1,440,000
- Project Duration: June 2015 – February 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Track Strength and Innovative Inspection Technologies

PROJECT DESCRIPTION

- Support the research into innovative technologies for inspecting track.
- Continue the study of GRMS performance over concrete ties to develop and refine methods to detect track issues.
- Further testing of GRMS and other technologies over locations exhibiting signs of rail seat deterioration on concrete ties.
- Evaluation of GRMS Thresholds; Analysis of Vertical Track Deflection Measurements.

RAILROAD IMPACT

- Improve understanding of track behavior on concrete ties under load and offer methods for detecting weak restraint using GRMS.
- Assess methods to identify rail seat deterioration on concrete ties to minimize the risk of rail rollover derailments.
- Broaden the application of innovative technologies to detecting degraded track conditions.

PROJECT PARTNER(S)

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $383,000
- Project Duration: May 2015 – February 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Freight Car Autonomous Track Geometry Measurement System

PROJECT DESCRIPTION

- This task focused on the creation of a self-powered freight car-based ATGMS system for demonstration on short line and other freight railroads.
- Efforts included installation and commissioning of carbody-mounted ATGMS on an FRA-owned boxcar as well as design and implementation of a power supply system relying on solar (primary) and fuel cell (secondary) power sources.
- System deployed over short line railroads during a 10-month demonstration covering 29 railroads and ~12,800 miles.

RAILROAD IMPACT

- Autonomous track geometry measurement offers several advantages to current practices including minimal traffic interruption; increased frequency of testing; facilitates comparison of geometry for preventative maintenance.
- This deployment demonstrated the ability of self-powered freight car-based ATGMS system which is to lead the expansion of ATGMS use on short lines and other freight railroads.

PROJECT PARTNER(S)

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $801,000
- Project Duration: December 2013 – June 2017
  - Design and Implementation of System
  - Demonstration Program
  - Dissemination of Research Results

U.S. Department of Transportation
Federal Railroad Administration

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

Operations and Maintenance Support for DOTX 218

PROJECT DESCRIPTION

- DOTX 218 performs geometry testing to support the FRA Office of Railroad Safety, FRA field offices, and railroad partners.
- DOTX 218 is used to conduct research including enhancements to GRMS requirements in the Federal Track Safety Standards.
- Additional research products being demonstrated on DOTX 218 include evaluation and improvement of the FRA's Vertical Track Deflection Measurement System.

RAILROAD IMPACT

- FRA's fleet provides data for track related studies in the areas of high-speed passenger operations track evaluations.
- DOTX 218 is used as a platform to develop and demonstrate track inspection technologies as well as a tool to evaluate the nations rail network when employed by the Automated Track Inspection Program.

PROJECT PARTNER(S)

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $153,000
- Project Duration: February 2017 – February 2018
  - DOTX 218 Ballast Waiver Testing in NE
  - Heavy Axle Load Testing
  - VTDMS Hardware/Software Upgrades

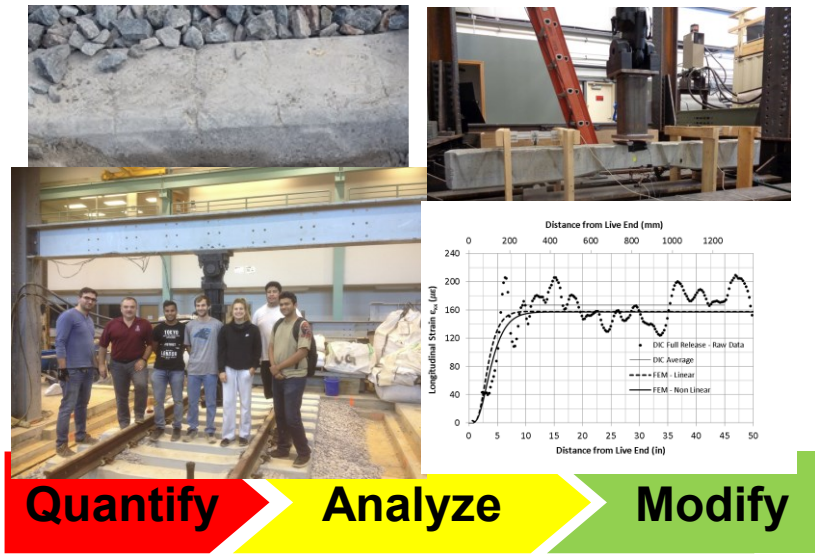
U.S. Department of Transportation
Federal Railroad Administration

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

Concrete Tie Design and Performance Research

PROJECT DESCRIPTION

- Basic research to quantify the stress state of the track superstructure.
- Review and revise FRA regulations pertaining to concrete ties.
- Advanced computer modeling of ties and track systems.
- Research new materials for improved concrete tie performance.
- Improve testing standards for concrete ties.
- Study the operating environment of concrete ties, especially areas that foster tie abrasion and poor support conditions.
- Create new technologies to asses the internal stress state of concrete ties.



RAILROAD IMPACT

- Basic and applied research to establish sound design, construction and testing practices for concrete crossties.
- Advance the state of science in the area of concrete ties for high-speed rail and freight applications.
- Develop industry recommended practices and testing standards for design and production of concrete ties.
- Create useful tools and techniques for improving concrete tie quality and performance.
- Study the operating environment and understand the effects of this environment on the performance of concrete ties.

PROJECT PARTNER(S)

- Universities
  - University of Illinois, Kansas State, University of South Carolina, WNEU, University of Florida
- Class I railroads (all)
  - Rocla, CXT, GIC and Other Suppliers

COST & SCHEDULE

- Funding: Total program LOE – Approx. $1,000,000/year
- Project Duration: June 2011 – December 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Automated Frog Repair Technology

PROJECT DESCRIPTION

- Phase 2 project includes field testing of repaired frogs on Class 1 railroads.
- Development of metal cored electrode to reduce weld slag and eliminate inter-pass cleaning.
- Develop conceptual framework for field-deployable automated repair system.

RAILROAD IMPACT

- Automated, improved repair process for AMS frogs.
- Eliminates errors and inconsistencies in field repairs.
- Controlled process ensure high quality and extend life for repaired frogs.
- Automated process allows for off track rehabilitation, thus reducing time on track.

PROJECT PARTNER(S)

- Edison Welding Institute
- CSX
- NS

COST & SCHEDULE

- Funding: $300,000
- Project Duration: March 2016 – September 2018

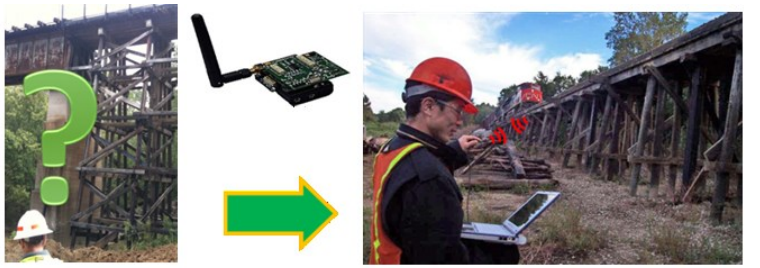
U.S. Department of Transportation
Federal Railroad Administration

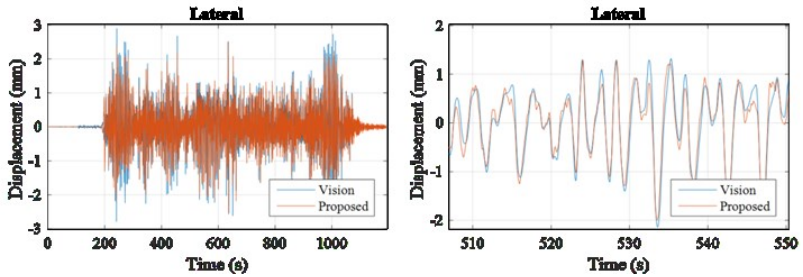
FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Bridge Condition Assessment Using Smart Sensors

PROJECT DESCRIPTION

- Phase 2 development effort.
- Field trials of equipment on multiple bridges in the Midwest United States.
- 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 PARTNER(S)

- University of Illinois at Urbana-Champaign
- FRA Office of Railroad Safety
- Class 1- CN, multiple short line railroads

COST & SCHEDULE

- Funding: $350,000
- Project Duration: January 2017 – Early 2019

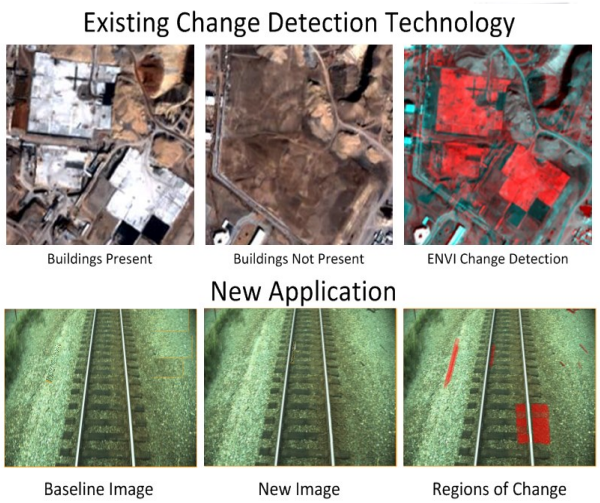
U.S. Department of Transportation
Federal Railroad Administration

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

Change Detection Technology for Track Inspection

PROJECT DESCRIPTION

- Leverage commercial software and hardware to create a change detection system applicable to the railroad track environment.
- Pre-production prototype testing with participating railroads.
- Develop technological framework for advancing change detection technology to practical application for track safety assurance.
- Results will be compiled and presented in reports and presentations to industry.



RAILROAD IMPACT

- Automated vision and laser inspection technologies that can highlight areas of track that have changed since previously inspected.
- Deep learning and artificial intelligence techniques that can accurate process data and report areas of relevant change to railroad decision makers.
- Today's image-based change detection technology offers the potential to automatically flag a broad range of unsafe conditions using one algorithm based on generalized principles.

PROJECT PARTNER(S)

- ENSCO, Inc.
- Exelis Visual Information Systems
- Pavemterics Systems, Inc.
- Amtrak

COST & SCHEDULE

- Funding: FY17 Approx. $300,000
- Project Duration: March 2017 – December 2017

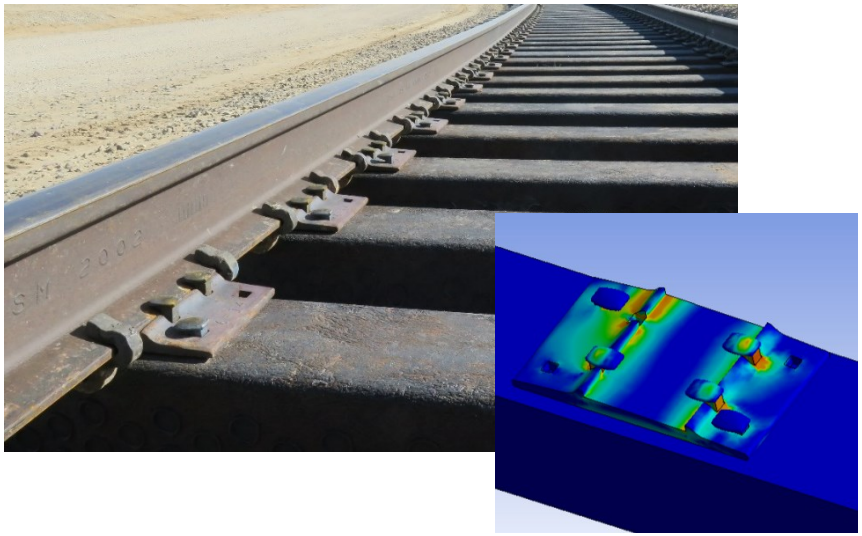
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGERS: Jay Baillargeon • (719) 584-7155 • jay.baillargeon@dot.gov
Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Improved Composite Tie Performance

PROJECT DESCRIPTION

- Develop and enhance design, testing and performance guidelines for engineered-polymer composite ties.
- Implementation into the AREMA Manual for Railway Engineering and collaboration with Committee 30 (Ties).
- Augmented laboratory testing, including center bending, fatigue testing and spike pullout.
- Material-level testing and characterization.
- NUCARS® and FEA modeling of composite tie and fastener loading environment.
- In-track instrumentation and verification of models.



RAILROAD IMPACT

- Development of a safe alternative to wood crossties.
- Better understanding of composite tie performance in-track.
- Better understanding of integration with existing fasteners.
- Better understanding of composite tie and fastener system loading environment.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Collaborative effort with Association of American Railroads (AAR)
- Volpe National Transportation Systems Center
- AREMA Committee 30, and tie suppliers

COST & SCHEDULE

- FRA Funding: $250,000
- Project Duration: September 2016 – September 2018

U.S. Department of Transportation
Federal Railroad Administration

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:
  - Improved In-Track Weld Performance.
  - Demonstration of Railhead Repair Weld Technologies.
  - Effects and Characterization of Moisture on Degraded Ballast.
  - Performance of Improved Frog Designs and Repair Strategies.

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 PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Collaborative effort with Association of American Railroads (AAR)
- Norfolk Southern Railway
- Union Pacific Railroad

COST & SCHEDULE

- FRA Funding: $651,000
- Project Duration: May 2017 – May 2020

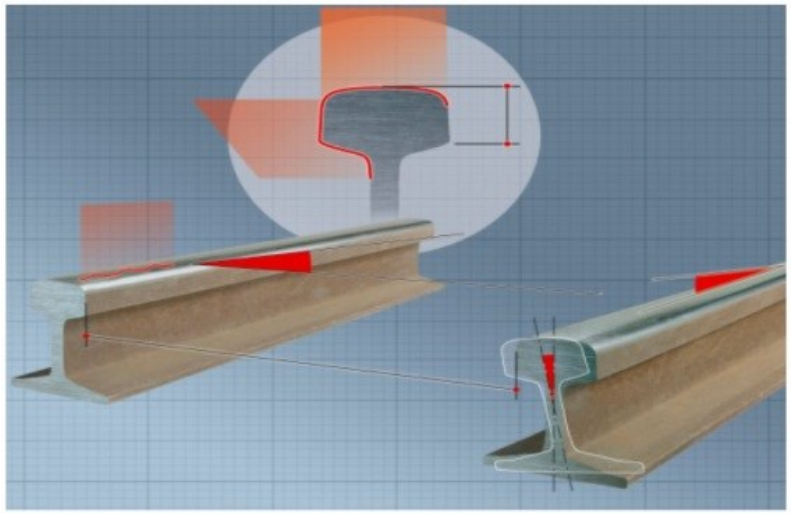
U.S. Department of Transportation
Federal Railroad Administration

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

Data-Driven Optimization and Planning of Track Maintenance with Defect Deterioration Modeling

PROJECT DESCRIPTION

- Model the degradation process of both track geometry defects and structural defects (i.e., rail cracks).
- Quantify the risk for track-related defects using an integrated risk model based on Spectral Risk Measures (SPM) to prioritize existing defects.
- Optimize the planning of track responsive maintenance activities and remediation schedules.
- Develop a Track Responsive Maintenance (TRM) tool to implement techniques for use by railroads.



RAILROAD IMPACT

- Better understanding of the joint growth of a variety of track-related defects.
- Better understanding of the risk-associated factors affecting track-related defects.
- Development of a new risk measure to identify high-risk track segments.
- Enhance the overall safety of U.S. rail transportation through optimized preventative inspection and maintenance planning.

PROJECT PARTNER(S)

- University at Buffalo
- The State University of New York
- CSX Transportation

COST & SCHEDULE

- FRA Funding: $256,000
- Project Duration: February 2017 – August 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Basalt Fiber-Reinforced Polymer for Tie Remanufacturing

PROJECT DESCRIPTION

- Apply computer-aided design (CAD) and finite-element analysis (FEA) techniques to optimize the final product design.
- Perform comprehensive laboratory testing (e.g., center bending, spike pullout) to prove the strength and durability of BFRP-wrapped ties meet AREMA standards.
- Validate simulation models with laboratory testing results, and further utilized FEA to predict BFRP-wrapped tie in-track structural performance under various working conditions.
- Investigate manufacturing feasibility and use life-cycle analysis modeling to predict performance in comparison to current designs.

RAILROAD IMPACT

- Utilize the remaining serviceability of wood crossties by encasing it with a low-cost, bondable, strength- and stiffness-enhancing basalt fiber-reinforced polymer (BFRP) wrap.
- Extend the service life of wood ties in general using in-track BFRP retrofit as well as provide protection from moisture, chemical leakage and mechanical impact.
- Evaluate the feasibility of producing recycling/remanufacturing discarded wood ties using the BFRP wrap.
- Provide a safe, environmentally friendly and economical alternative to discarding used creosote-treated wood crossties that is compatible with existing fastening systems.

PROJECT PARTNER(S)

- Intelligent Automation, Inc.
- University of Illinois at Chicago
- Volpe National Transportation Systems Center

COST & SCHEDULE

- FRA Funding: $150,000
- Project Duration: May 2017 – November 2017
- Small Business Innovation Research (SBIR) Program

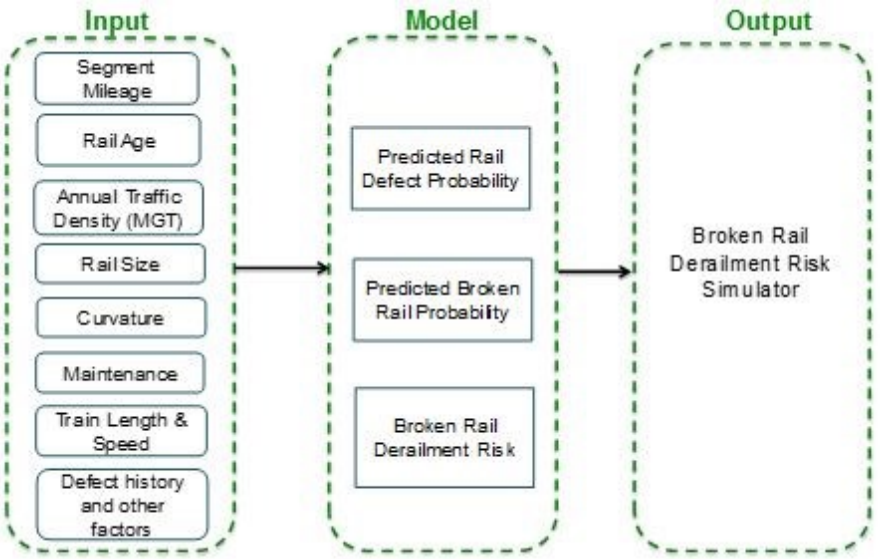
U.S. Department of Transportation
Federal Railroad Administration

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

Simulation-Based, Broken-Rail Derailment Risk Analysis

PROJECT DESCRIPTION

- Collect rail defect data from partner railroads.
- Develop Bayesian analytical framework for predicting the probability of broken rails.
- Predict derailment consequence using multivariate data analyses.
- Develop a broken rail derailment risk analysis simulation tool.
- Evaluate segment-specific risk and assess the impacts of various track risk management strategies.



RAILROAD IMPACT

- Development of an integrated broken-rail derailment risk analysis and simulation framework, and, in turn, a flexible simulation tool to analyze risk of broken rails.
- Creation of a new toolbox to aid in understanding the change in potential risk in response to changes in track condition, operations and regulations.
- New knowledge regarding risk of track failure, particularly derailment risk associated with broken rails, as well as the potential for safety improvement and optimization of inspection/maintenance.

PROJECT PARTNER(S)

- Rutgers
- The State University of New Jersey
- CSX Transportation

COST & SCHEDULE

- FRA Funding: $294,000
- Project Duration: January 2017 – January 2019

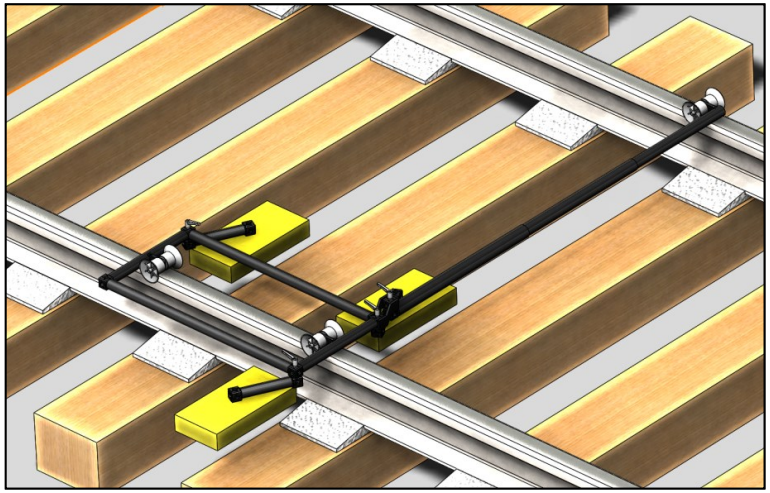
U.S. Department of Transportation
Federal Railroad Administration

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

Radar Ballast Inspection Tool (RABIT)

PROJECT DESCRIPTION

- Develop a man-portable, automated instrument to non-invasively determine fouling condition.
- Collect data on outdoor test track and existing live track.
- Compare GPR 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

- Provides real-time fouling measurement. No post-processing required. Eliminates the need for highly trained personnel to interpret the results.
- Maintenance can be planned based on fouling measurement and relationship between ballast condition and ballast performance (i.e., strength).
- An automated solution in the hands of railroad personnel allows track to be inspected on their schedule and to spot check problem areas.

PROJECT PARTNER(S)

- Earth Science Systems, LLC
- BNSF Railway
- University of Massachusetts
- Amherst

COST & SCHEDULE

- FRA Funding: $468,000
- Project Duration: July 2016 – July 2018
  - RABIT II Modifications: November 2017
  - ASTM Ballast Testing Symposium: January 2018
  - Live-Track Testing: March 2018
  - Final Report: July 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Support to the Office of Railroad Safety

PROJECT DESCRIPTION

- Support FRA Office of Railroad Safety with specialized expertise, technical advice, instrumentation, testing and related analysis.
- Provide rapid response analysis and test support for rail safety issues as they arise.
- Assist with FRA rule-making activities and the RSAC Passenger Safety Working Group Task Forces to re-assess and recommend revisions to the Track and Equipment Safety Standards as appropriate.
- Conduct cooperative analysis on rail wear and rail strength with industry stakeholders; assess performance of passenger equipment.

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.

PROJECT PARTNER(S)

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $220,000
- Project Duration: February 2017 – February 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Support for Third Parties

PROJECT DESCRIPTION

- Provide multiple university and third party-led research initiatives with testing services and equipment to support evaluation in “real world” settings.
- Recent activities focused on revenue service testing of real-time rail temperature measurement and continued support of internal rail flaw detection research conducted by the University of California at San Diego.
- Ongoing testing by UCSD rail flaw detection in FY18.
- Evaluation of real-time rail temperature measurement.

RAILROAD IMPACT

- Provide support for real-world testing with emerging technologies to advance them beyond the laboratory.
- Develop critical prototype for rail inspection technology.
- Focus on development and evaluation of advanced inspection technologies under revenue service conditions.

PROJECT PARTNER(S)

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $25,000
- Project Duration: February 2017 – February 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Autonomous Acceleration Measurement Units (AAMU) for Investigation of Railcar Dynamics and Track Geometry Conditions

PROJECT DESCRIPTION

- This project leverages research from ride quality research and development efforts previously performed by FRA.
- The AAMU implements modern technology system components, including high-speed GPS, tri-axial acceleration and inertial sensors.
- This project evaluates the value of instrumentation of an entire trainset (all cars) with ride quality monitoring systems.
- This project investigates approaches for correlating track geometry conditions with vehicle dynamics and ride quality information.

RAILROAD IMPACT

- Historically, track inspectors evaluated the ride quality of a train in a subjective manner by riding the train and feeling the "bumpiness" of the ride.
- The AAMU quantifies this process, thereby allowing for collection, analysis, and reporting of ride quality data on an enterprise/fleet level.
- The ride quality data will be beneficial in addressing immediate vehicle and track safety concerns, as well as long-term vehicle and track degradation and statistical studies.

PROJECT PARTNER(S)

- dFuzion, Inc.
- Amtrak

COST & SCHEDULE

- Funding: Approx. Cost to Date – $270,000
- Project Duration: 2014 – March 2018

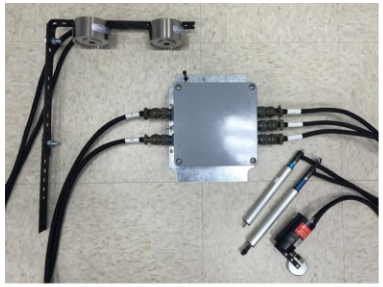
U.S. Department of Transportation
Federal Railroad Administration

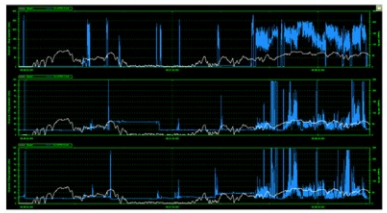
FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Portable Rail Suspension Displacement Monitoring System

PROJECT DESCRIPTION

- This system will have the capability to measure the displacement of any two points on the vehicle suspension, including, axle box to truck frame, truck frame to carbody, and truck rotation.
- This system will incorporate detachable mounting mechanisms and wireless sensors to facilitate displacement measurements on any rail vehicle at any time.
- This system will integrate with existing portable acceleration monitoring systems to determine correlations between vehicle/track interaction data and displacement data.





RAILROAD IMPACT

- Current rail suspension displacement monitoring systems are costly and unwieldy to install, configure, and operate.
- The portable rail suspension displacement monitoring system addresses these detriments to allow railroad companies to easily monitor rail suspension displacement with advanced wireless sensors.
- The displacement data will be beneficial in determining vehicle suspension problems and for model validation and qualification testing.

PROJECT PARTNER(S)

- dFuzion, Inc.

COST & SCHEDULE

- Funding: Cost to Date – $300,000
- Project Duration: 2016 – December 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Track Geometry Measurement System Evaluations

PROJECT DESCRIPTION

- Develop procedures for testing and evaluating track geometry measurement systems (TGMS) under controlled conditions to verify accuracy, repeatability.
- Known vertical and lateral track perturbations on TTC High-Speed Adjustable Perturbation Slab track (HS-APS) including "blind tests".
- Tests of DOTX 216 at speeds 15 to 105 mph.
- Combinations of perturbation wavelengths and amplitudes.
- FRA and Volpe Center: develop procedures and analyze test data.
- TTCI: assist with developing/reviewing procedures, install, measure perturbations, provide wayside measurements and operations support.
- ENSCO: test planning, operate DOTX 216 and collect TGMS data.

RAILROAD IMPACT

- Consistent method for evaluating and benchmarking TGMS cars.
- Reduce TGMS measurement error.
- Verify accuracy and repeatability, including effects of measurement speed and repeated/multiple deviations.
- Identify potential issues for measurement/analysis of certain types of track geometry (TG) perturbations.
- Increased confidence in TG data and exception reports.
- Improved TG data for input to vehicle-track dynamic interaction computer simulation models.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Volpe National Transportation Systems Center
- ENSCO, Inc.

COST & SCHEDULE

- Funding: $1,025,000
- Project Duration: May 2015 – December 2018
  - Phase 1 & 2 tests on vertical & lateral perturbations completed
  - Additional short warp perturbation test completed July 2016
  - Final report & improvements to HS-APS to be completed by December 2018

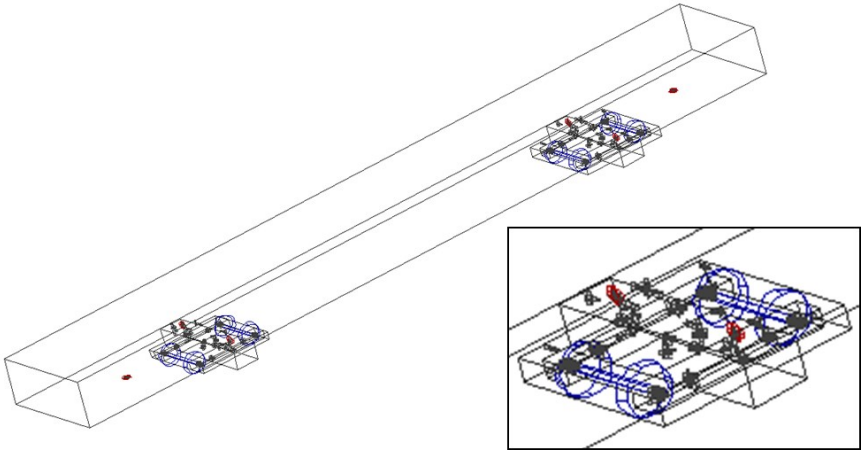
U.S. Department of Transportation
Federal Railroad Administration

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

Vehicle-Track Model Parameter Sensitivity Study

PROJECT DESCRIPTION

- This research is to perform a parameter sensitivity analysis using different validated and conceptual vehicle models. Research team will vary specific parameters in the representative vehicle models and perform various static and dynamic simulations. Results from the simulations will be used to determine the sensitivity of the different vehicle models to variations in parameter values and to evaluate the importance of accurate measurement values and model representations for the different parameters.



RAILROAD IMPACT

- Provides guidance related to the characterization, modeling, and testing of rail vehicles.
- Evaluates the sensitivity of different vehicle models to variations in parameter values.
- Evaluate the importance of accurate measurement/model values for different parameters.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- FRA Funding: $200,000
- Project Duration: June 2016 – May 2018

U.S. Department of Transportation
Federal Railroad Administration

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

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

PROJECT DESCRIPTION

- The RCFS has been installed in the Rail Dynamics Laboratory (RDL) at FRA's Transportation Technology Center (TTC) in Pueblo, Colorado.
- This facility is capable of testing full scale, standard-gauged freight and passenger wheelsets and rails under current and anticipated future load conditions with precisely controlled variables.
- Testing at varying traction forces under 36-ton axle load reveals plastic flow dominant, combination of plastic flow and wear and wear dominant damage modes.
- Relative RCF and wear performance of different class wheels and rails are investigated.

RAILROAD IMPACT

- Results will lead to reduction of RCF through optimization of wheel and rail materials, profiles, and maintenance procedures.
- High-speed passenger train operations on rails with RCF may lead to derailment.
- RCF may contribute to shattered and vertical split rims; it may also mask deeper seated cracks in rail from ultrasonic detection.
- Implementation of results will lead to lowered stresses and crack growth in rail.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Jointly funded by FRA and Association of American Railroads

COST & SCHEDULE

- FRA Funding: $1,274,636
- The RCFS was commissioned in March 2015
- Test program completed in 2017
- Second Phase testing is planned for 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Evaluation of Wheel/Rail Contact Mechanics & Dynamics

PROJECT DESCRIPTION

- Develop a test rig for evaluating wheel/rail contact mechanics, satisfying the needs of both freight and passenger rail industries.
- Provide the means for precise control of the dynamics associated with the wheel/rail interaction, under conditions that can be scientifically related to train operation.
- Provide the means for measuring various parameters that are necessary for practical evaluations, and are of interest to the FRA and U.S. rail industry.
- Second Phase the rig is being used for Wheel/Rail profile studies.

RAILROAD IMPACT

- Understanding the complex mechanics and dynamics that occur at the wheel-rail interface is critical for improving railway operational safety and efficiency.
- Introducing a new level of accuracy for measuring a multitude of contact parameters that are critical in VTI modeling and technology advancement for both passenger and freight trains, far beyond the means currently available to the FRA and rail industry.
- The test rig is fully commissioned and available for advanced studies.

PROJECT PARTNER(S)

- Virginia Tech
- Norfolk Southern Railroad

COST & SCHEDULE

- Funding: $300,000
- Project Duration: September 2017 – December 2018 (Phase II)
  - Performing pilot studies, gathering, and analyzing data.
  - Developing intermediate tools for interfacing the rig with common dynamic.

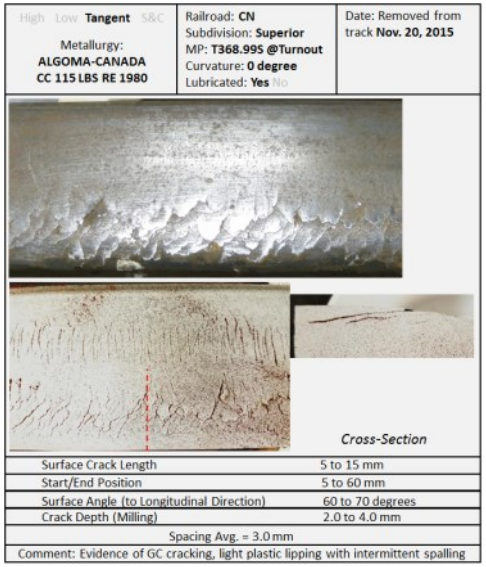
U.S. Department of Transportation
Federal Railroad Administration

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

Atlas of Rail Surface Fatigue

PROJECT DESCRIPTION

- A previous review identified that one of the most promising and important opportunities relates to the monitoring of RCF. There is a strong need to translate surface appearance to damage, and crack length to depth.
- Correlate features from surface crack photos, electromagnetic measurements and metallurgical sectioning in an “Atlas” or guidebook for understanding the severity of surface damage.



RAILROAD IMPACT

- Improved, more reliable and more effective management of rail surface condition.
- Reduction in surface initiated defects that lead to broken rails and some derailments.
- Supports proactive, preventive rail maintenance regime through automated surface condition assessment.
- Extended rail life and reliability.

PROJECT PARTNER(S)

- National Research Council Canada
- LORAM
- Class I freight Railroads (CSX, NS, CN)

COST & SCHEDULE

- Funding: $450,000
- Project Duration: September 2017 – September 2020
  - Field work to validate electromagnetic crack measuring.

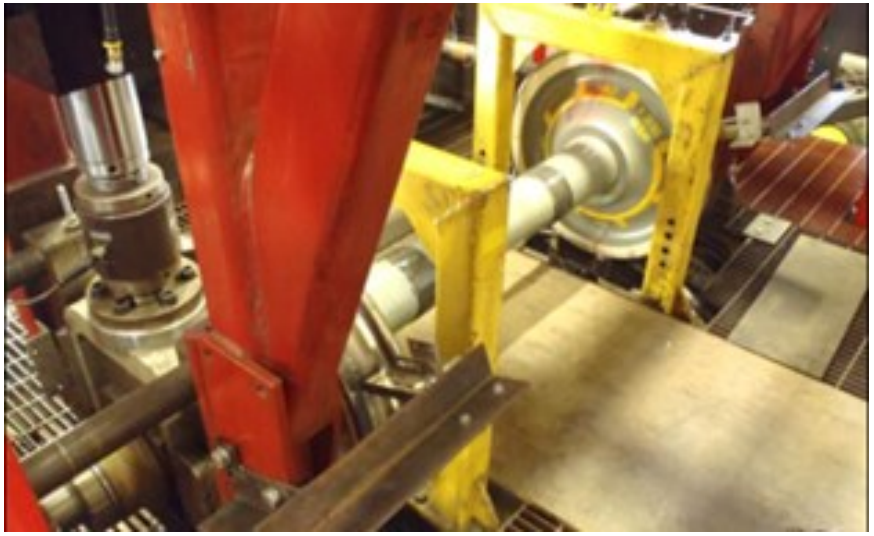
U.S. Department of Transportation
Federal Railroad Administration

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

Friction Characterization

PROJECT DESCRIPTION

- Friction has a controlling influence on nearly all aspects of the wheel/rail interaction including wear, fatigue, corrugation, noise and some derailments. NRC's has applied its friction measuring tools (rolling contact tribometer, instrumented wheelsets, full scale wheel/rail simulator) to address several questions concerning friction behavior under a variety of real world conditions.



RAILROAD IMPACT

- **Safety**: friction has a controlling influence on all safety issues associated with wheel/rail contact. These studies will contribute to a significant increase in the reliability and confidence for prediction of unsafe and costly wheel/rail conditions.
- **Economic competitiveness**: minimize wear and RCF through more reliable implementation of friction and the assessment of economic and environmental benefits.
- **Environmental**: much more reliable modeling of fuel consumption/energy loss.

PROJECT PARTNER(S)

- National Research Council
- Canada

COST & SCHEDULE

- Funding: $200,000 (total Cost over 3 years)
- Project Duration: September 2017 – December 2020
  - Experimental work and data analysis completed.
  - Technical report on the findings submitted to FRA.
  - Technical paper submitted.

U.S. Department of Transportation
Federal Railroad Administration

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

International Collaborative Research Initiative on Wear and Fatigue of Rails and Wheels

PROJECT DESCRIPTION

- There is work going on all around the world which, if coordinated and made available publicly, could significantly improve understanding and modeling, and speed the development of an effective methodology for minimizing losses associated with rolling contact fatigue and wear.
- Management of ICRI activities is ongoing with the Fall 2016 introduction of 12 new research projects, including topics related to friction management, reverse transverse defects, and risk and economics associate with RCF and Wear.

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.
- This ICRI has proven effective in coordinating in-kind efforts from railroads and suppliers to advance technologies and spawn collaborative research/analytical projects.
- The ICRI model is an efficient and economical way of undertaking research by pooling resources, leveraging work already underway, accessing test equipment and sharing field results promptly.

PROJECT PARTNER(S)

- National Research Council
- Canada
- Transport Canada
- 7 railroads, 5 universities, 6 suppliers and many others

COST & SCHEDULE

- Funding: $70,000 (annually)
- Project Duration: September 2017 – September 2020

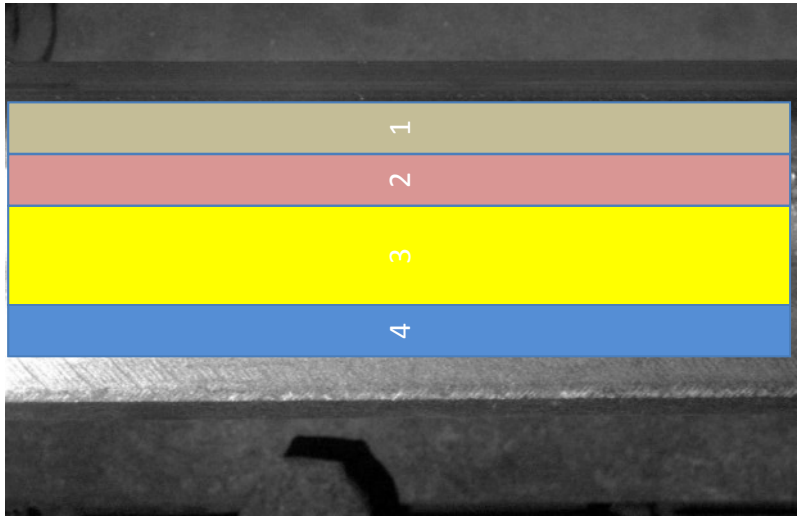
U.S. Department of Transportation
Federal Railroad Administration

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

Quantifying Rail Surface Damage

PROJECT DESCRIPTION

- Emerging technologies to capture rail surface condition (e.g. machine vision and electromagnetic systems) will be employed is developing a credible “surface quality index” which could then be correlated with risk, economic and safety.
- Test sites are already set up on a class 1 freight railroad that has agreed to support long term field work and provide data necessary to enable conclusions by the end of the third year.



RAILROAD IMPACT

- Track inspection is a laborious and inconsistent process – the inclusion of machine based system will improve reliability and frequency of inspection.
- Credible assessments of surface damage can be used to assess risk, costs and effectiveness of maintenance, allowing tuning of practices to mitigate surface damage (e.g. rail grinding, friction management, rail profiles, cant deficiency, rail removal, etc.).
- ICRI projects on economics and risk will be leveraged in developing a useable framework for decision making with respect to wear and RCF limits.

PROJECT PARTNER(S)

- National Research Council Canada
- LORAM
- CSX Railroad
- CN Railroad
- Rohmann
- Sperry
- Holland

COST & SCHEDULE

- Funding: $300,000
- Project Duration: September 2017 – September 2020

U.S. Department of Transportation
Federal Railroad Administration

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

Rolling Contact Fatigue (RCF), Wear and Rail Integrity

PROJECT DESCRIPTION

- Recent analyses of railroad data have controversially failed to show that rail failure has some correlation with the amount of rail wear and level of surface damage.
- Damage monitoring on CSX is already underway and data related to rail safety (defects, breaks, derailments) will be correlated with detailed rail condition, wear and VTI data.

RAILROAD IMPACT

- This project leverages several ongoing FRA and ICRI projects to specifically look at the risk of rail failure and derailment.
- Thorough analysis of service and detected defects for 1000 miles of freight track that is frequently monitored for surface condition will provide a data and science based foundation for drawing conclusions about the impact of rail wear and RCF on risk and failure.

PROJECT PARTNER(S)

- National Research Council
- Canada
- CSX
- Sperry
- LORAM
- Rohmann

COST & SCHEDULE

- Funding: $210,000
- Project Duration: September 2017 – September 2020

U.S. Department of Transportation
Federal Railroad Administration

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

Adjustable Precision 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 will design and construct a test track section on the high-speed test track at FRA's Transportation Technology Center where geometric track anomalies can be installed and adjusted.
- Feasibility study for building curved section.

RAILROAD IMPACT

- Track geometry testing is a critical function for safety and operations of railroads, especially for high-speed passenger trains.
- 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.
- This Track section can be used to validate a track geometry measurement system.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: $1,000,000
- Project Duration: May 2012 – December 2018
  - Design, build, and commissioning of the track section.
  - Design and feasibility of building curved section.

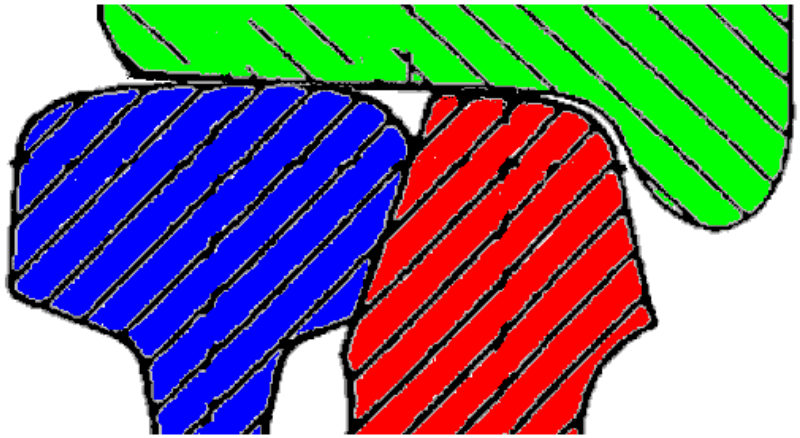
U.S. Department of Transportation
Federal Railroad Administration

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

Contact Geometry with Rail Profile Variations

PROJECT DESCRIPTION

- Develop wheel and rail profile representation based on cubic smoothing splines.
- Define contact location search algorithm for rigid body or deformable body cases.
- Implement rigid body and deformable body solutions in stand-alone wheel/rail interaction code.



RAILROAD IMPACT

- Contact geometry solution with rail profile variation will improve wheel/rail interaction modeling in sharp curves and turnouts under high angle of attack conditions
- Important for:
  - Prediction of vehicle response at critical track locations, including profile wear and contact fatigue.
  - Response under derailment or incipient derailment conditions.

PROJECT PARTNER(S)

- Vehicle Dynamics, LLC

COST & SCHEDULE

- Funding: $130,000
- Project Duration: September 2016 – December 2018

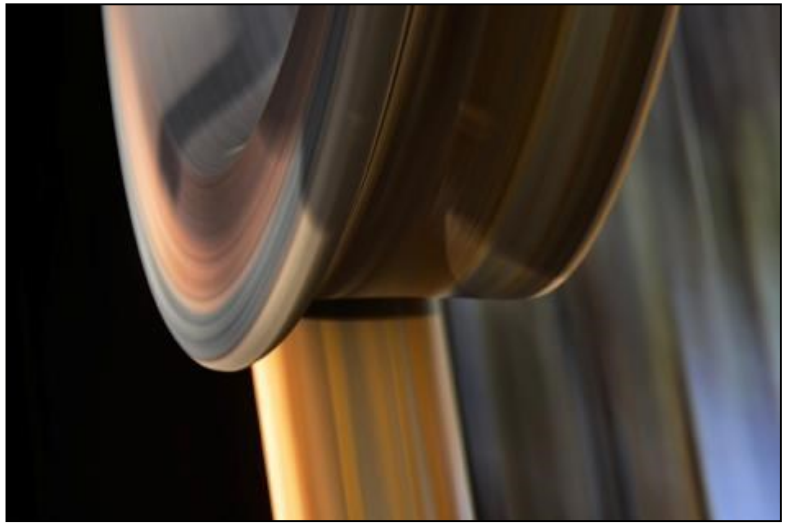
U.S. Department of Transportation
Federal Railroad Administration

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

Three-Dimensional Wheel/Rail Contact Geometry

PROJECT DESCRIPTION

- Develop wheel and rail profile representation based on cubic smoothing splines.
- Define contact location search algorithm for rigid body or deformable body cases.
- Implement rigid body and deformable body solutions in stand-alone wheel/rail interaction code.



RAILROAD IMPACT

- Three-dimensional contact geometry solution will improve wheel/rail interaction modeling under high angle of attack conditions.
- Important for:
  - Prediction of vehicle response under curving conditions, including profile wear and contact fatigue.
  - Response under derailment or incipient derailment conditions.

PROJECT PARTNER(S)

- Vehicle Dynamics, LLC

COST & SCHEDULE

- Funding: Cost – $100,000
- Project Duration: September 2016 – December 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Track Geometry Measurement System Evaluation Procedures

PROJECT DESCRIPTION

- Plan and coordinate testing on FRA adjustable test track at Transportation Technology Center (TTC) with DOTX 216.
- Support analysis and documentation efforts to compare DOTX 216-collected geometry data with ground truth measurements.
- Analysis and documentation of data collected with DOTX 216 Instrumented Wheel Sets.
- Writing a procedure for testing and measuring ground truth and testing track geometry Measurement systems.

RAILROAD IMPACT

- Current TGMS verification methods rely on a statistical measure of precision and periodic verifications of accuracy by comparing static and dynamic measurements.
- FRA can introduce precise geometry into a test track at TTC to provide controlled comparison to measured track geometry data.
- Project is first of several steps in establishing a procedure by which track assessment technology can be objectively evaluated.

PROJECT PARTNER(S)

- ENSCO, Inc.
- Transportation Technology Center, Inc. (TTCI)
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $800,000
- Project Duration: April 2015 – June 2018
  - DOTX 216 TTC Testing – 2015, 2016

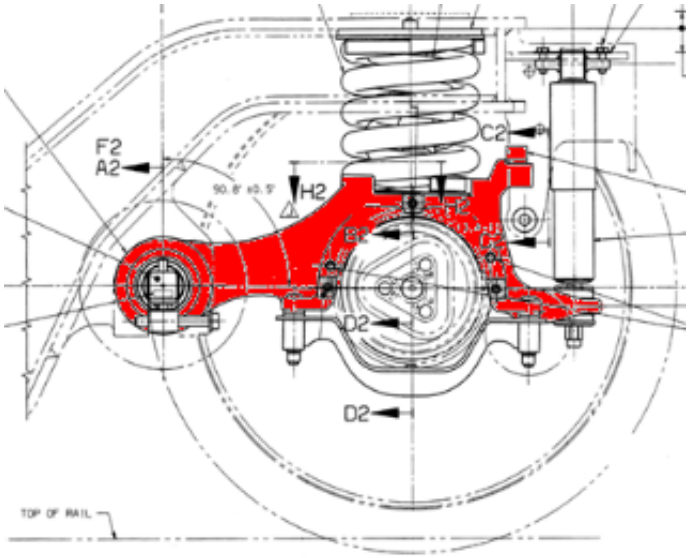
U.S. Department of Transportation
Federal Railroad Administration

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.
- First phase is to procure the test machine.
- 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.



RAILROAD IMPACT

- Provide guidelines how to measure Spring properties.
- Provide information on how to model springs in multibody simulation program.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center
- Zwick

COST & SCHEDULE

- Funding:
  - Phase I – Procure the test machine: $500,000
  - Phase II – Perform testing to characterize springs: $200,000
- Project Duration: 2014 – 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Modeling of Wheel/Rail Friction Modifier

PROJECT DESCRIPTION

- To develop a wheel/rail creep force model that incorporate effects of the third body layer or TOR.
- WP1- data on TOR products; operating, contact and surface conditions.
- WP2- tribological tests to determine creep stress relationships for a range of FMs and contact and surface conditions for inputting to model.
- WP3- develop and parameterization of the model.

RAILROAD IMPACT

- With integration of model into Vehicle-Track Interaction simulations, a tool that can help define TOR product choice and application protocols.
- Provide more accurate force prediction that will improve vehicle dynamics, wear and RCF assessments.
- Experimental tests for benchmarking TOR products performance.

PROJECT PARTNER(S)

- University of Sheffield
- LBF
- ViF

COST & SCHEDULE

- Funding: Phase I – 12 months, Approx. $300,000
- Project Duration: September 2017 – December 2018

U.S. Department of Transportation
Federal Railroad Administration

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

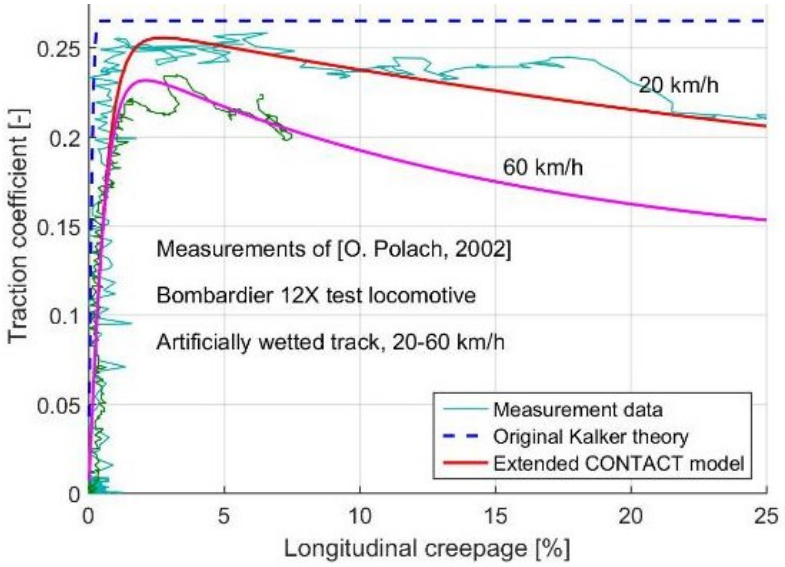
Advanced Modelling of Wheel/Rail Friction Phenomena

PROJECT DESCRIPTION

- Improvement the friction modelling in the Extended CONTACT model.
- Validate the model against available measurements.
- Improved, physics-based modelling.
- Integration of the model in in the main VTI simulation packages.

RAILROAD IMPACT

- Our simulation technology will improve computer simulation of:
  - The influence of humidity on vehicle stability.
  - The influence of falling friction on flange climb derailment.
  - The influence of friction modifiers on curving behavior, traction control and energy efficiency.
  - The loads exerted on the track, in a wide range of circumstances.



PROJECT PARTNER(S)

- VORtech BV

COST & SCHEDULE

- Funding: $225,000
- Project Duration: March 2017 – March 2019

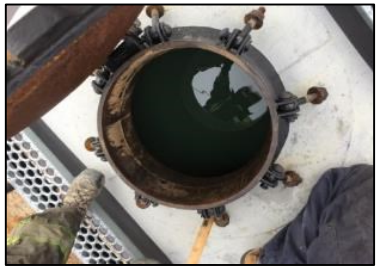
U.S. Department of Transportation
Federal Railroad Administration

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

Track Geometry and Vehicle Performance, Phase II

PROJECT DESCRIPTION

- Phase II focus as tasked by FRA consists of improving the tank car model developed in Phase I of the project.
- Conduct full-scale tank car tests on TTC test tracks including High Tonnage Loop (HTL), Precision Test Track (PTT) and Wheel/Rail Mechanism (WRM) loop and Railroad Test Track (RTT). For the loaded condition, crude oil is to be used as lading choice. Data acquired from the various tests will be utilized for tank car model improvement.
- Work on developing liquid slushing model in the tank car and study effects of liquid slushing on vehicle dynamics behavior.



RAILROAD IMPACT

- Conduct on-track testing for empty and loaded conditions of a DOT-117 tank car to better understand its dynamic behavior and to provide critical data for improving the NUCARS tank car model developed under Phase I of the project.
- The lading choice for the loaded condition testing is crude oil.
- The improved tank car model can be reliably deployed to enhance applicable track geometry limits for safer tank car performance.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: $963,000
- Project Duration: September 2016 – March 2019

U.S. Department of Transportation
Federal Railroad Administration

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

US – China Railway Technology Exchange

PROJECT DESCRIPTION

- Support FRA effort in arrange and participate of the United States – China Transportation Forum and its associated rail group meetings and communications.
- Facilitate technical exchanges with China institutions in various areas of FRA interests.
- Organize rail technology and standards exchange meetings and technical visits.

RAILROAD IMPACT

- Enable technical exchanges especially on high-speed rail infrastructure and equipment inspection and maintenance.
- Enhance FRA presence at the United States – China Forum

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $179,219
- Project Duration: August 2012 – December 2018

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Luis Maal • (719) 584-0551 • luis.maal@dot.gov

SECTION TWO

ROLLING STOCK

U.S. Department of Transportation
Federal Railroad Administration

Raking Impact Testing of DMU Fuel Tanks

PROJECT DESCRIPTION

- Develop the test method.
- Design and construct the test fixture.
- Prepare and test three retired passenger locomotive fuel tanks.
- Analyze and provide the data for model validation.
- Extended on two tests on new design DMU fuel tanks.

RAILROAD IMPACT

- Development of performance-based scenarios intended to be used to evaluate the puncture resistance of modern fuel tank designs, such as the fuel tank found on a diesel multiple unit (DMU) locomotive.
- Evaluation of the crashworthiness of passenger fuel tank designs.
- Evaluation of performance under dynamic loading conditions, and recommendations for improved fuel tank protection strategies.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: FY18 – $261,000
- Project Duration: September 2017 – December 2018

U.S. Department of Transportation
Federal Railroad Administration

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

Fire Safety Research

PROJECT DESCRIPTION

- Support rulemaking activities associated with Fire Safety and emergency preparedness.
- Develop a fire growth model that will interface with time-based performance egress standards.
- Work will focus on developing alternative fire standards based on the Heat Release Rate of the various materials used in design of passenger rail cars.
- Evaluate alternative strategies and relating to evaluating passenger rail car fire safety.

RAILROAD IMPACT

- Provide objective minimum and industry standards for equipment.
- Continue to expand system design to evaluate fire safety beyond current emphasis on materials.
- Provide cost-effective test alternative based on Heat Release Rate to existing flammability and smoke emissions requirements.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center
- Jensen Hughes

COST & SCHEDULE

- Funding: FY18 – Not currently funded
- Project Duration: November 2014 – October 2018

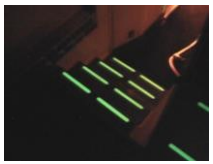
U.S. Department of Transportation
Federal Railroad Administration

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

Emergency Preparedness Research

PROJECT DESCRIPTION

- Support the development of new regulations relating to emergency lighting, signage, and egress.
- Investigate and evaluate alternative strategies and technologies relating to passenger rail system emergency preparedness
- Provide sound technical basis for revising the content of FRA passenger train emergency preparedness / equipment requirements.
- Interface with industry to develop and revise APTA passenger rail equipment safety standards.
- Determine feasibility of time-based performance based egress standards.
- Determine impact of Amtrak Conductors on passenger safety.



RAILROAD IMPACT

- Provides objective minimum criteria for meeting FRA regulations and industry standards for new and existing passenger equipment.
- Uses systems approach for rail car emergency design to locate, reach, and operate emergency exits.
- Provides a cost-effective alternative to electrical powered emergency lighting, signs, and path marking.
- Reorganizes CFR to consolidate all emergency equipment to 238 to assist RR in following all regulations.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: FY18 – Not currently funded

U.S. Department of Transportation
Federal Railroad Administration

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

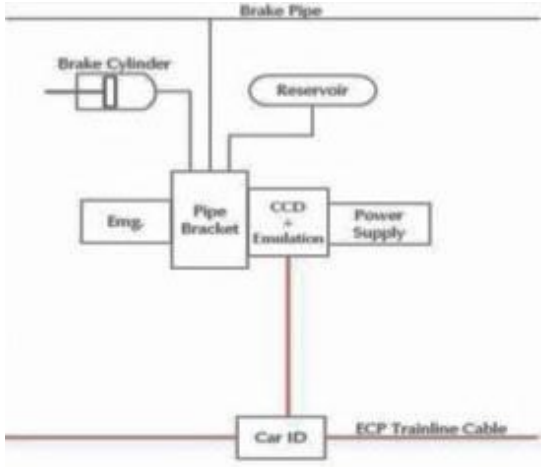
Accelerating Implementation of Electronically Controlled Pneumatic (ECP) Brake Technology

PROJECT DESCRIPTION

- Assessment of available technology for their ability to accelerate the implementation of ECP brakes.
  - Conduct ECP emulator technology review to identify potential candidate(s) for accelerating the ECP implementation.
  - Conduct cost-benefit analyses for the identified candidate emulators.
  - Evaluate compatibility of the Zeftron emulator with existing equipment, AAR standards, and specifications.
  - Modify the emulator design and develop test plans to take the emulator to prototype stage.
  - Complete the required mechanical, electrical, and communication development work for technology compliance with existing industry standards.
  - Develop plans and complete needed AAR/industry required compliance testing.
  - Prepare a final development, test, and analysis report with recommendation for industry-wide implementation.

PROJECT PARTNER(S)

- Sharma & Associates, Inc.



ECP with emulation of pneumatic control valve

RAILROAD IMPACT

- Increased railroad operation safety due to more reliable and effective braking.
- Higher average operating speed.
- Increased line-haul speeds due to reduced terminal and in-service train delays.
- Improved safety for both crew and public with better performance equipment.

COST & SCHEDULE

- Funding: FY18 – Not currently funded

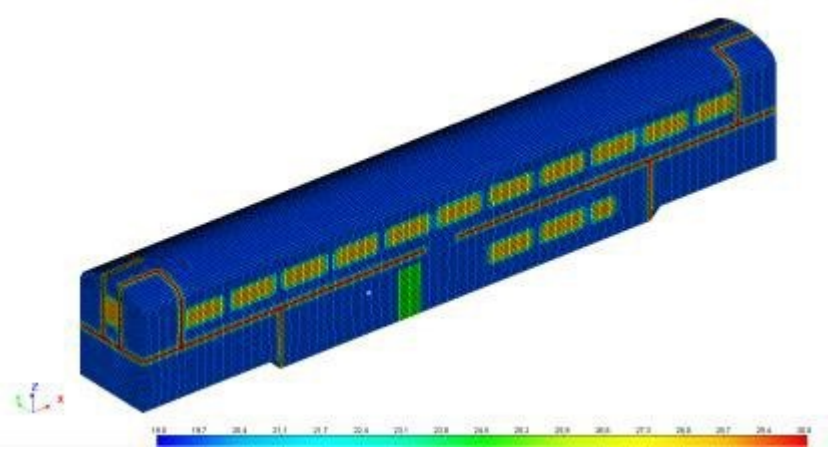
U.S. Department of Transportation
Federal Railroad Administration

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

Feasibility of Load-Shedding to Improve Efficiency and Reduce Energy Consumption on Passenger Rail Vehicles

PROJECT DESCRIPTION

- Investigate the energy savings and improved efficiency associated with the concept of load-shedding as a means of reducing the power draw from some components on the HEP system. The project will identify the impact of load shedding on:
  - Reduction of peak power demand of primer engine.
  - Cooling capacity for railcars within the train.
  - Performance and reliability of air conditioning components, such as compressors.
  - Ambient noise level within passenger compartments.
  - Reduction of life cycle costs.
- Determine barriers to implementation and how should they be overcome.



RAILROAD IMPACT

- Improves efficiency of passenger rail locomotives.
- Reduces energy consumption.
- Identifies innovative technologies.

PROJECT PARTNER(S)

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: FY18 – Not currently funded

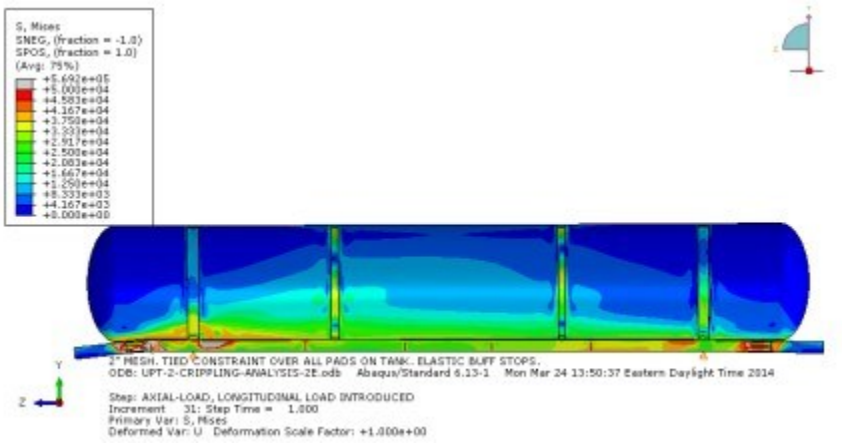
U.S. Department of Transportation
Federal Railroad Administration

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

Evaluation of the Structural Integrity of Natural Gas Fuel Storage Equipment for Locomotives

PROJECT DESCRIPTION

- Develop Crashworthiness Standards for CNG Tenders.
- Evaluate structural performance, puncture resistance, and fitting integrity with simplified analyses of legacy natural gas fuel tender.
- Apply results of simplified analyses to estimate performance in scenarios.
- Evaluate safe speeds in scenarios.



RAILROAD IMPACT

- Improve the state of the art of knowledge on natural gas fuel tenders and other storage equipment.
- Assess crashworthiness of legacy natural gas fuel tenders.
- Develop strategies for structural analyses of next generation of natural gas fuel tenders.
- Collaborate with railroad industry in development of specifications for next generation of natural gas fuel tender.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: FY18 – Not currently funded

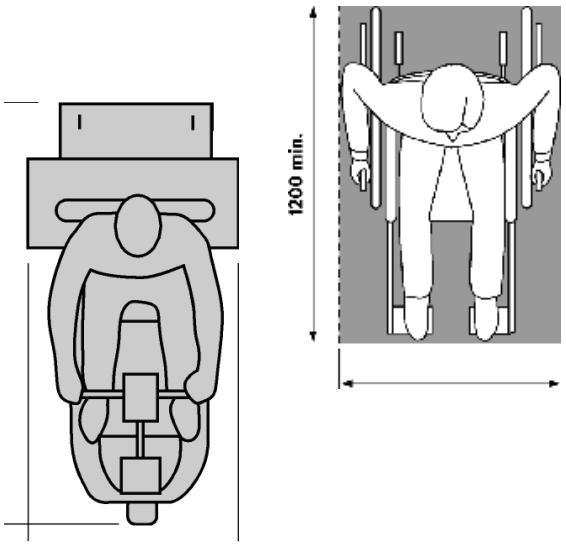
U.S. Department of Transportation
Federal Railroad Administration

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.



RAILROAD IMPACT

- Inclusion of enhanced accessibility requirements on PRIIA bi-level equipment.
- Enhanced train travel for passengers who are disabled Improved communication with all passengers during normal and emergency operations.
- Establishment of US Access Board Rail Vehicle Access Advisory Committee to develop guidance for new regulations for improved accessibility on passenger rail vehicles.

PROJECT PARTNER(S)

- Oregon State University
- PRIIA Next Generation Equipment Committee

COST & SCHEDULE

- Funding: FY18 – Not currently funded

U.S. Department of Transportation
Federal Railroad Administration

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

Evaluate Displacement for Locomotive-Tender Interconnections

PROJECT DESCRIPTION

- Measure the tri-axial displacement environment that interconnections (gas, cooling system loop, electrical, air, etc.) between the locomotive and adjacent tender vehicle will face during train operations in revenue service.
- Testing was conducted on the CN Region – the test route was Chicago to Memphis, and return. Under this project, instrumentation was developed and installed for testing, and time history and rainflow analysis were performed.
- AAR will continue processing the data by selecting and appending the worst events in time, and will provide this data to suppliers working to supply gas, glycol and electrical connections for tenders.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: FY18 – Not currently funded

RAILROAD IMPACT

- The AAR NGFT TAG is developing Standard(s) for future Natural Gas Fuel Tenders for the railroad industry to support the use of natural gas (methane) as an alternative locomotive fuel. The FRA is contributing expertise via membership of this TAG.
- FRA also supported testing to acquire tri-axial displacement data for the interconnections of the locomotive and tender.
- This data is extremely important to the process of developing hose and connection requirements for materials flowing between the locomotive and tender vehicle.

U.S. Department of Transportation
Federal Railroad Administration

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

Advanced Devices Train & Test Bed

PROJECT DESCRIPTION

- Facilitate the creation of an Advanced Devices Train and Test Bed (ADT&TB) in order to test advanced devices either developed or under development for functionality and ergonomics.
- Advanced devices include 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 network.
- Advanced devices can be operated either on the side of the car or remotely from within the locomotive.

RAILROAD IMPACT

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

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: FY18 – $152,000
- Project Duration: April 2014 – April 2016

U.S. Department of Transportation
Federal Railroad Administration

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

Improved Truck Castings Phase II

PROJECT DESCRIPTION

- Evaluate ultraweldable steels, which eliminate the need for weld preheating or postheating.
- Laboratory scale testing will simulate a variety of welding parameters.
- Investigate and test steels that retain ductility at low temperatures.
- Conduct extensive mechanical testing on these low service temperature steels.

RAILROAD IMPACT

- Prevent accidents by reducing brittle phases formed during repair welding.
- Reduce accidents caused by brittle failure of side frames and bolsters at very low temperatures.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: FY18 Funding Level – $151,000
- Project Duration: June 2016 – October 2017

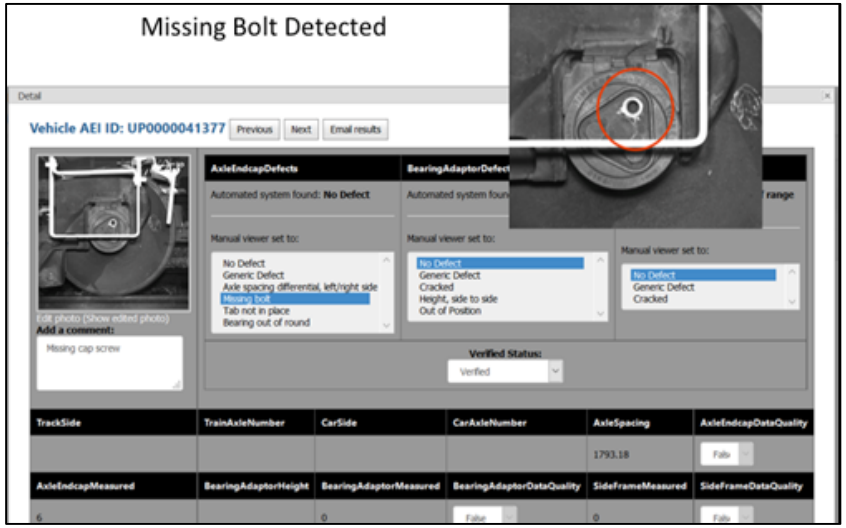
U.S. Department of Transportation
Federal Railroad Administration

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

Advanced Machine Vision of Truck Components

PROJECT DESCRIPTION

- The KLD truck component inspection system has been under development at FRA's Transportation Technology Center (TTC) in Pueblo, Colorado since 2013.
- The KLD truck component inspection system has demonstrated capability to detect missing bearing end cap bolts, broken and missing springs, and can make dynamic measurement of axle spacing.
- A two phased revenue service test is underway:
  - Phase 1: Develop a manual review interface for creating vetted inspection data that will aid algorithm developers.
  - Phase 2: Install a KLD system at a revenue service site for performance validation of the new algorithms.



RAILROAD IMPACT

- Machine vision technology improves the efficiency of train component inspection.
- Machine vision inspection produces a searchable data trail that can be analyzed for trends to determine optimal maintenance intervals for each rail car.
- Automated inspection can reduce yard dwell times and lead to improved capacity and efficiency for the railroads while improving safety.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Jointly funded by AAR and FRA

COST & SCHEDULE

- FRA Funding: $425,000
  - FY18 – Not currently funded
- Project Duration: September 2015 – September 2018
  - Revenue service testing of the KLD Truck Component Inspection system began in 2017/Manual viewer software completed at the end of 2016

U.S. Department of Transportation
Federal Railroad Administration

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

Bearing Grease Degradation Related to Water and Roller Bluing

PROJECT DESCRIPTION

- Grease samples will be collected from a population of bearing lubrication identified as having water related damage, and a second population as a control set from bearing service locations. Primary grease analysis will be per ASTM 7918 which provides metrics of wear, contamination, consistency, and oxidative properties.
- 'Bluing' or 'lube stain' bearing components will be examined through analysis of lubrication and metallurgical metrics. Testing of bearing steel will include hardness and micro-hardness of polished samples, metallographic examination to compare microstructural features, and residual stress.

RAILROAD IMPACT

- Improve safety by investigating the properties of grease degradation from bearings at the end of service life, focusing on water related lubrication degradation.
- Reduce accidents by investigate the metallurgic and grease property changes related to roller bluing.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: FY18 Funding Level – $151,000
- Project Duration: July 2016 – December 2017

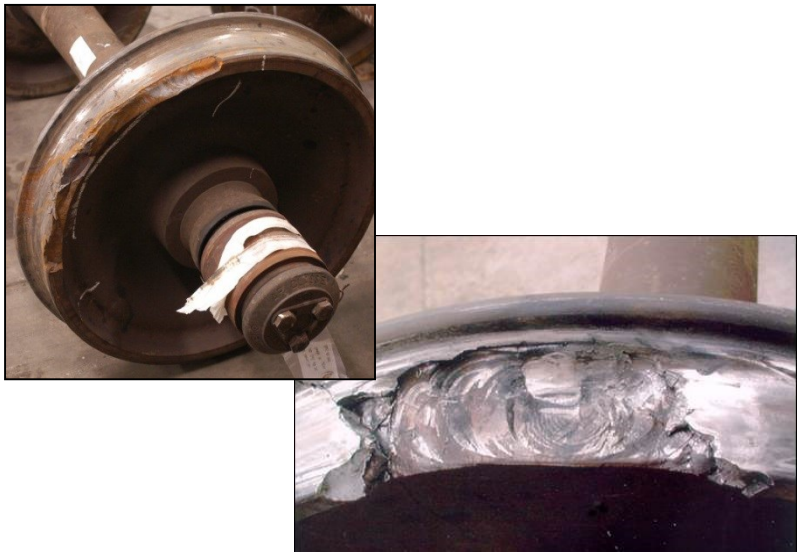
U.S. Department of Transportation
Federal Railroad Administration

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

Wheel Failure Research and Development Program

PROJECT DESCRIPTION

- Overall goal to reduce wheel failures including Vertical Split Rims (VSRs) and Shattered Rims.
- An industry-wide stakeholder working group (SWG) will focus on evaluating current failure modes and characteristics.
- The SWG will also develop research strategies to mitigate failures and reduce risks to achieve overall safety improvement.



RAILROAD IMPACT

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

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Jointly funded by AAR and FRA

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - February 2016 – February 2018: $499,560
- Project Duration: February 2016 – September 2018 (Phase II)

U.S. Department of Transportation
Federal Railroad Administration

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

Wireless Digital Train Line (WiDTL) for Passenger Trains

PROJECT DESCRIPTION

- Current analog Train Line system is outdated, error prone, and at the limit of its capabilities.
- Wireless technologies can contribute to enhancement of Digital Train Line in providing high performance communications in support of passenger services and control and communications of train management elements, and needs to be explored.
- Investigate the current state of Train Line system, assist involved organizations with development of DTL, and explore Wireless Extension to DTL.
- Work closely with Next Generation Equipment Committee (NGEC), Association of American Railroads (AAR), American Association of State Highway and Transportation Officials (AASHTO), AMTRAK, etc.

RAILROAD IMPACT

- Investigates an in-depth analysis of Digital Train Line in utilizing Wireless technology.
- 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, on-demand services.

PROJECT PARTNER(S)

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

COST & SCHEDULE

- Funding: Not currently funded
  - Cost: $100,073
- Project Duration: August 2015 – July 2018

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGERS: Tarek Omar • (202) 493-6189 • tarek.omar@dot.gov
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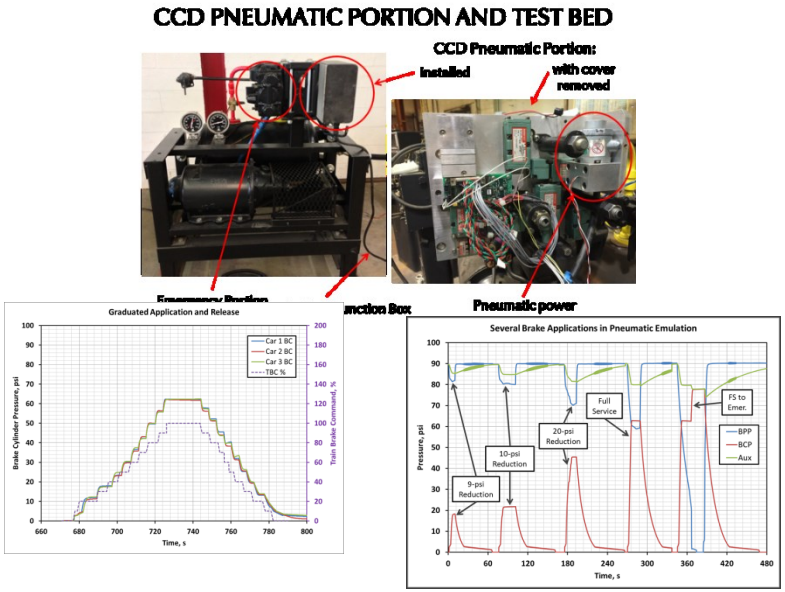
Accelerating Electronically Controlled Pneumatic (ECP) Brakes

PROJECT DESCRIPTION

- The safety and economic benefits of ECP brakes are well known, and yet the technology has not been widely adopted by North American railroads. This project focused on one of the strategies identified in a previous effort devoted to understanding the barriers to ECP brake system implementation. The current focus is on:
  - Investigation of potential emulation technologies to help ECP acceptance.
  - Upgrading and enhancement of ECP emulation technology as alternative to overlay ECP.
  - Laboratory testing of the selected emulator technology per requirements of the existing industry accepted standards S-4200.



PROJECT PARTNER(S)

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: Not currently funded
- Project Duration: August 2013 – October 2016

RAILROAD IMPACT

- ECP implementation is expected to result in:
  - Increased railroad operating safety due to inherently more reliable and effective braking.
  - An alternative to overlay ECP.
  - Increased line-haul speeds due to reduced 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.

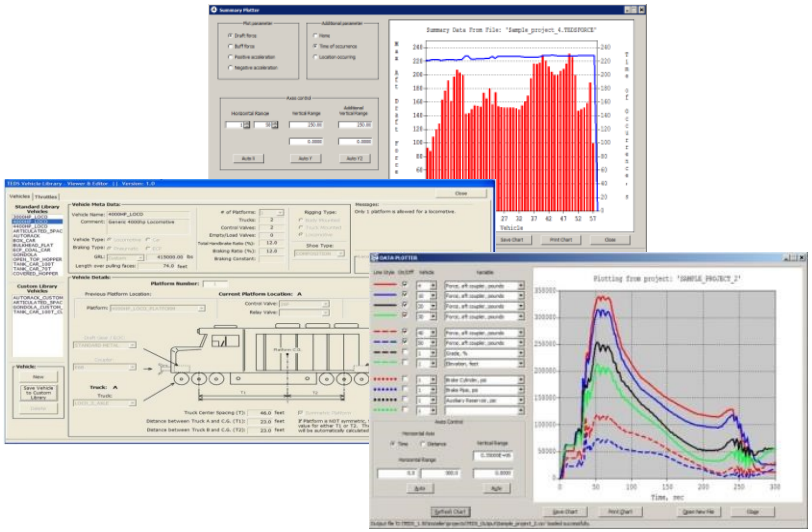
U.S. Department of Transportation
Federal Railroad Administration

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

Train Energy & Dynamics Simulator (TEDS)

PROJECT DESCRIPTION

- The Train Energy and Dynamics Simulator (TEDS) is a computer program developed by the FRA for conducting longitudinal train dynamics simulations. Such simulations may be used to assist development of guidelines and recommendations to improve train operating safety.
- TEDS is capable of simulating train handling, train makeup, head-end and distributed power, ECP and automatic brake applications for speed control, stopping distances, and emergency stops.
- TEDS has been validated and an FRA report published (DOT/FRA/ORD-15/01).
- TEDS was used successfully for several simulations to assist FRA's Office of Safety in its investigations.
- TEDS is now available for use to industry under a service agreement FRA has formulated with Sharma & Associates, Inc.



PROJECT PARTNER(S)

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: Phase I – $199,338; Phase II – $254,767
  - FY18 – Phase III: $151,000
- Project Duration: September 2011 – September 2020

RAILROAD IMPACT

- TEDS facilitates identification and quantification of safety risk 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 drop.
  - Derailment/incidence investigation.

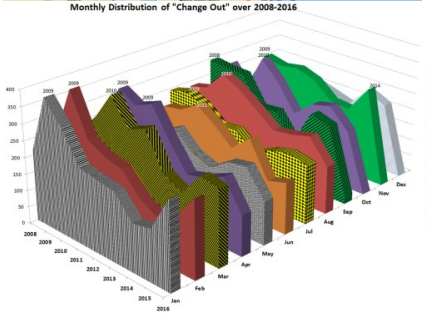
U.S. Department of Transportation
Federal Railroad Administration

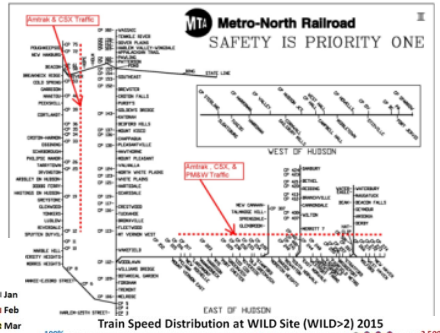
FRA PROJECT MANAGER: Monique Stewart • (202) 493-6358 • monique.stewart@dot.gov

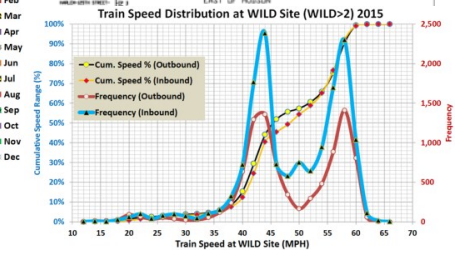
Wayside Advanced Technology Systems (WATS) Pilot Demonstrations

PROJECT DESCRIPTION

- The key focus of this program is to partner with and assist railroads with pilot demonstrations of new wayside technologies to detect defects and precursors to safety critical defects in railroad rolling stock. Among other FRA efforts in wayside detection research area, this program has focused on working with Metro-North Railroad (MNR) to:
  - Review MNR's existing and new/proposed detectors and corresponding data analysis and control protocols.
  - Identify alternate data sources for car performance, such as data for foreign traffic.
  - Develop recommendations for wayside system enhancement and further research/study.







PROJECT PARTNER(S)

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: FY18 -- $51,000 (Phase II)
- Project Duration: February 2016 – February 2018

RAILROAD IMPACT

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

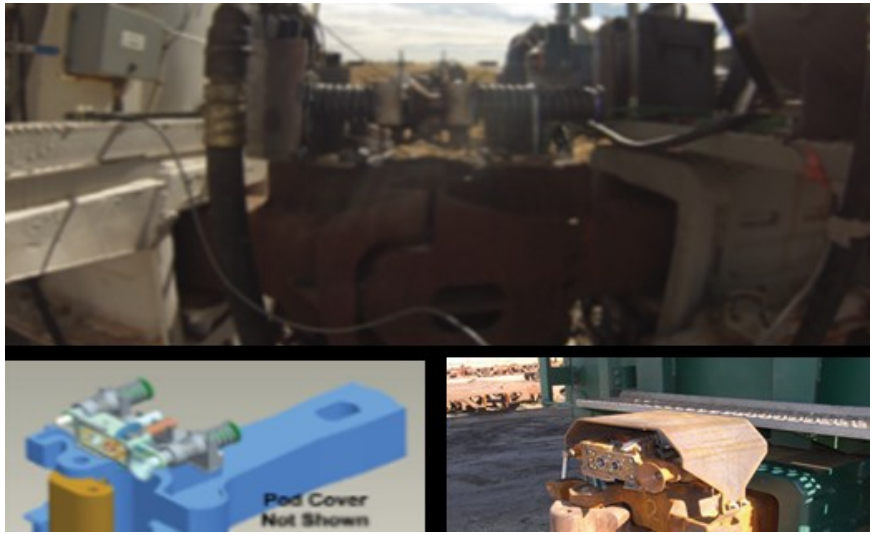
U.S. Department of Transportation
Federal Railroad Administration

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

Advanced Tri-Coupler

PROJECT DESCRIPTION

- This advanced component provides automatic mechanical, pneumatic (brake pipe), and electrical (electronically controlled pneumatic brake (ECP) or electrical power supply system (EPSS)) coupling between two freight cars. This is expected to significantly improve the safety and efficiency of coupling operations.
- The Advanced Tri-Coupler prototype was successfully field tested verifying its reliability when subjected to on-track extreme geometry, extreme temperature, and impacts.
- Current focus is on developing isolated electrical contacts designs and verifying pod performance under extreme wear and limiting mechanical conditions. A Knuckle-Open-Feature (KOF), which further improves safety has been developed and tested successfully. Long-term field tests are planned.



PROJECT PARTNER(S)

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: Not currently funded
- Project Duration: August 2013 – November 2015

RAILROAD IMPACT

- Eliminates the need for crewmembers to access unsafe areas of the train to perform coupling/uncoupling and connecting/disconnecting of air and electrical lines (including electric and pneumatic brake lines), etc.
- Serves as a catalyst for remote controlled car coupling/uncoupling when combined with remote controlled cut-levers, angle cocks, and hand brakes (EDHB).

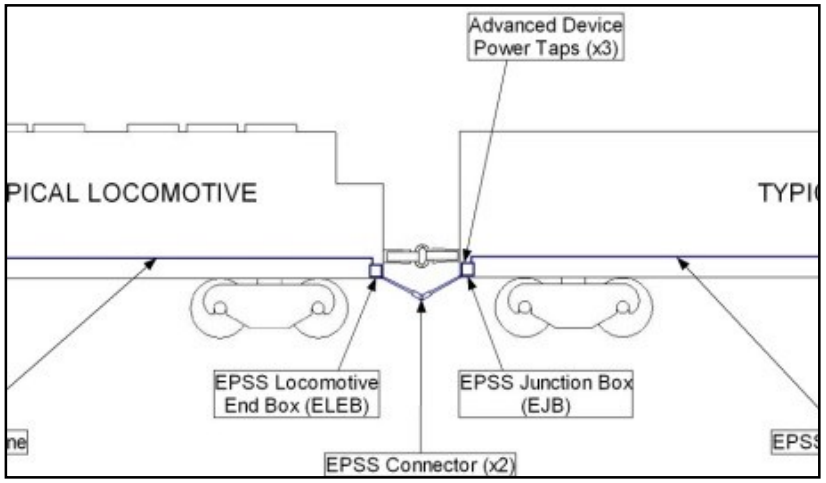
U.S. Department of Transportation
Federal Railroad Administration

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

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.
- A limited SA designed prototype system was successfully tested and demonstrated at TTCI in Pueblo, Colorado, on one locomotive and two freight cars that utilized advanced devices including EDHBs.
- SA designed, prototyped and tested an EPSS DC access / battery charger. The interface/charger provides a standard 24 VDC interface to safety devices that is powered by the EPSS AC powerline.
- SA completed a full-scale field test of the EPSS on a one-locomotive and eight freight car train. The system worked flawlessly.
- Currently, SA is designing and building a 50-car simulator in-lab EPSS test rack for hardening of the EPSS design.



PROJECT PARTNER(S)

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: Not currently funded
- Project Duration: September 2016 – November 2018

RAILROAD IMPACT

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

U.S. Department of Transportation
Federal Railroad Administration

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

Electrically Driven (Set & Release) Hand Brake (EDHB)

PROJECT DESCRIPTION

- EDHB is a remotely controlled, electrically driven, set and release, vertical wheel hand brake that keeps all normal manual AAR Group N and related Groups' specified functions and requirements. Subsequent to successful prototype development, this work has included:
  - Development of a draft performance specification template for AAR review and successful prototype testing and validation have been accomplished.
  - Long term field exposure testing on three (3) prototype EDHBs installed on freight cars at the Facility for Accelerated Service Testing at TTCI is completed.
  - Currently working on optimizing the controller/motor interface design and efficiency, and implementing an improved means for feedback of chain load for communications and control.

PROJECT PARTNER(S)

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: $151,000
  - FY18 – Not currently funded
- Project Duration: April 2014 – October 2017

RAILROAD IMPACT

- Reduces risk of operator injuries and the need to go in-between/climb rail cars.
- Reduces the potential for runaway trains by allowing more straight-forward and effective hand-brake application and release.
- Reduces damage to hand brakes due to controlled application and release forces.
- Mitigates slid flat and out-of-round damage to wheels.
- Mitigates damage to lading, track, vehicles and bridges due to damaged wheels.
- Reduces railroad operating costs.

U.S. Department of Transportation
Federal Railroad Administration

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

Operating Practices Research to Reduce Derailment/Optimize Fuel Use

PROJECT DESCRIPTION

- This project seeks to identify opportunities for risk reduction through evaluation of significant derailments attributed to train make up and train handling causes. Some specific activities include:
  - Establishing train make up rules/guidelines using simulation tools.
  - Proactively researching route specific train handling for difficult territory and different train types to reduce risks.
  - Evaluating the benefits of alternate configurations such as ECP brakes and distributed power.
- Report on 5 recent accidents is being published.

Shown here: Train Derailment

RAILROAD IMPACT

- Better understanding of train make up and train handling practices with respect to derailment risk reduction.
- Significant reduction in train derailment risks.
- Reduced fuel consumption and emissions.
- Operator assist software may result, making engineers' jobs less stressful.

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - FY11 – Conducted TEDS simulations to demonstrate ECP brakes' improved safety potential wherever airbrake applications were involved: $250,000
- Project Duration: September 14, 2011 – September 30, 2013

U.S. Department of Transportation
Federal Railroad Administration

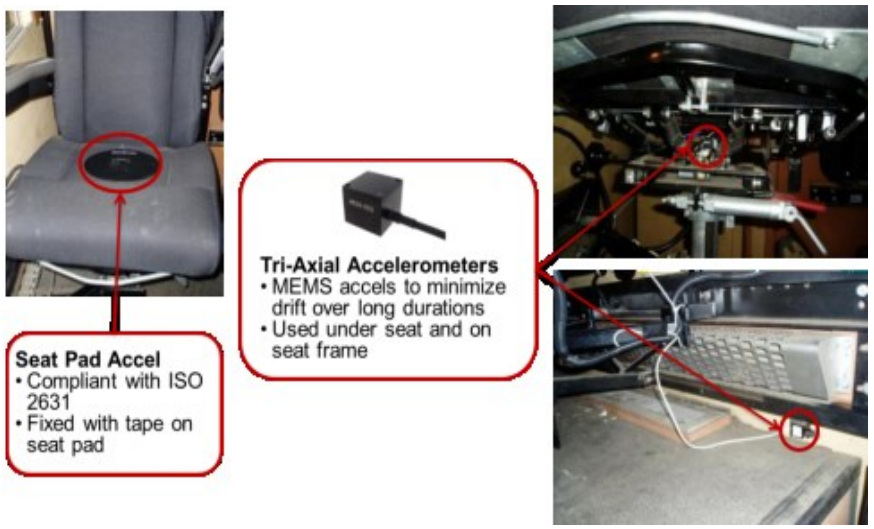
FRA PROJECT MANAGER: Tarek Omar • (202) 493-6189 • tarek.omar@dot.gov

Whole Body Vibration

PROJECT DESCRIPTION

- Determine ride quality on North American freight locomotives using the independent assessment of a third-party contractor
- Determine risks, if any, for physical health effects.
- Compare ride quality with ISO 2631 standards for whole body vibration.
- Nearly 4,000 miles of data has been collected from different locomotives on different railroads. Report is being prepared for publication.

Shown here: WBV Instrumentation



RAILROAD IMPACT

- Establish new or modified ride quality standards.
- Identify characteristic vibration frequencies in locomotive cabs to inform future seat design.
- Optimize seat configuration for comfort and ergonomics.

COST & SCHEDULE

- Funding: FY18 – Not currently funded.
  - FY09 – Literature Review and began noise and vibration measurements: $500,000
  - FY11/12/13 – Continued vibration measurements (4000 mile) frequency analysis, cab ergonomics health assessment, survey, collecting and processing the data: $1,150,000
  - FY13/FY14 – Final analysis of data collected and reports: $200,000
  - FY15 Est. – Specification requirements will be updated: $150,000
- Project Duration: June 2013 – May 2014

U.S. Department of Transportation
Federal Railroad Administration

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

Next Generation Locomotive Cab

PROJECT DESCRIPTION

- Partner with industry and labor to establish new cab design standards for the next generation locomotive.
- Use an integrated systems approach to guide the development of cab design standards.
- Key elements include:
  - Displays
  - Controls
  - Seat
  - System Architecture
- Evaluate prototypes using design standards in FRA Cab Technology Integration Laboratory (CTIL).
- Solicit engineer feedback from new design.
- Develop Next Generation Cab for safety and comfort.

RAILROAD IMPACT

- Standardize cab design across Industry.
- Integrate engineer-friendly in-cab controls, displays, and seating.
- Reduce engineer fatigue and discomfort.
- Improve operating safety and efficiency.
- Develop common system architecture and communications protocol.

Shown here: Next Generation Locomotive Eye Tracker

COST & SCHEDULE

- Funding: FY18 – Not currently funded. No further research is anticipated in FY18.
  - FY12 – Requirements analysis and development of information display rapid prototyping software tool: $950,000.
  - FY13/FY14 – Study to identify critical operating display elements using non-obtrusive eye-tracking technology: $500,000.
  - FY15 Est. – Work with Stakeholders on Cab of the future: $650,000.
- Project Duration: May 2015 – May 2016 (Phase I)

U.S. Department of Transportation
Federal Railroad Administration

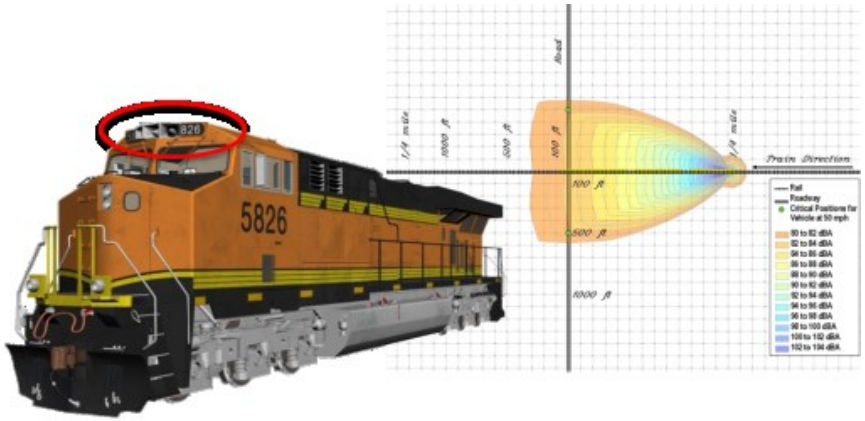
FRA PROJECT MANAGER: Tarek Omar • (202) 493-6189 • tarek.omar@dot.gov

Optimized Acoustical Warning Device (AWD) as a Train Horn

PROJECT DESCRIPTION

- Implement AWD in a Pilot Implementation Program at the Maryland Transit Authority (MTA).
- Optimize GPS controlled sound patterns approaching a grade crossing to meet required dB sound levels while minimizing environmental noise.
- Demonstrate dynamic performance at TTCI.
- Compile responses of several stakeholders, including railroad, wayside community, local government officials, and FRA to the system performance.
- Evaluation of the optimized system will be done with benchmark level system evaluation as well as a suite of environmental tests to validate durability.
- Tests will be conducted in transit at MTA and freight lines in cooperation with BNSF and other railroads.

Shown here: AWD and Acoustic Sound Wave



RAILROAD IMPACT

- Decreased wayside sound levels away from the grade crossing.
- Minimize cabin sound levels.
- Ensure required sound levels at the grade crossing.
- Reduce accident risk at crossings.

COST & SCHEDULE

- Funding: FY18 – Not currently funded. No further research is anticipated in FY18.
  - FY10/FY11 – Feasibility study of using LRAD as train audible warning device: $400,000.
  - FY12 – Prototype developed and tested: $300,000.
  - FY13 – AWD prototype optimized and dynamically tested at TTCI: $400,000.
  - FY14 – Tests will be conducted in transit at MTA and freight lines in cooperation with BNSF and other railroads: $300,000.
  - FY15 Est. – Continue demonstration to evaluate community noise reduction: $250,000.
- Project Duration: July 2014 – July 2016

U.S. Department of Transportation
Federal Railroad Administration

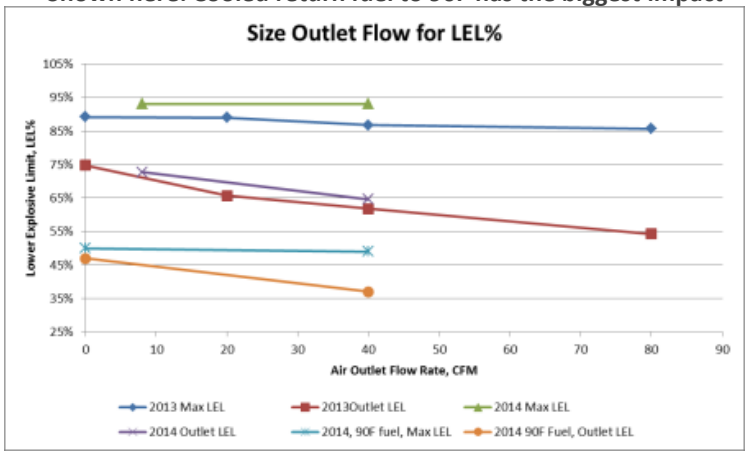
FRA PROJECT MANAGER: Tarek Omar • (202) 493-6189 • tarek.omar@dot.gov

Benefits of Fuel Vapor Reclamation System

PROJECT DESCRIPTION

- The goal of the research is to minimize the diesel vapor content in locomotive fuel tanks with the combined benefits of mitigating fire hazards, increasing fuel use efficiency and reducing environmental pollution.
- QinetiQ developed a fuel vapor reclamation device known as the Diesel Vapor Reclamation Unit (DVRU) under FRA funding, that is adapted to the locomotive fuel tank during overhaul.
- This research extends the system usage baseline through extending the geographic routes and climatic conditions.
- The Phase 3 work optimizes the DVRU for an revenue locomotive deployment, validates the updated unit and installs and verifies performance on several locomotives.
- Field test will be done to measure actual fuel savings.

Shown here: Cooled return fuel to 90F has the biggest impact



COST & SCHEDULE

- Funding: FY18 – Not currently funded. No further research is anticipated in FY18.
  - FY10/FY11 – Literature search and laboratory-scale proof-of-concept demonstration: $750,000.
  - FY12 – Vapor reclamation unit design, integration, and testing with locomotive: $300,000.
  - FY13 – Optimization of vapor reclamation unit, installation and monitoring: $350,000.
  - FY14 – Bench top and environmental validation tests, field evaluations: $400,000.
  - FY16 Est. – Continue field evaluations and develop a cost benefit analysis: $200,000.
- Project Duration: February 2014 – November 2016

RAILROAD IMPACT

- Fuel tank leaks, caused by collision, derailment, or foreign object penetration are major fire hazards in locomotive accidents that can be prevented with the reclamation of fuel vapor.
- Improve safety by reducing fire hazards.
- An anticipated 2% to 5% in fuel savings.
- Reduce emissions.

U.S. Department of Transportation
Federal Railroad Administration

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

Locomotive Emergency Response Training

PROJECT DESCRIPTION

- To develop training protocols instructing first responders on how to successfully and safely respond to locomotive crashes.
- The training encompasses three main topics: locating and accessing the incident scene, conducting rescue operations, and maintaining scene safety.
- Conducted emergency egress experiments using donated locomotives to determine best tools and methods for rescue operations.
- Pilot tested training at six locations to assess effectiveness and knowledge transfer. An average improvement of 54% per participant was found.
- Working with operation Lifesaver to disseminate course information.

RAILROAD IMPACT

- In the last five years, 30 major accidents requiring emergency egress have occurred.
- Responders have lacked adequate training and appropriate tools.
- The original version of this this course has already been requested by 20,000 fire departments, railroads, and other emergency responders to date.

Shown here: Locomotive Emergency Egress Experiments

COST & SCHEDULE

- Funding: FY18 – Not currently funded. No further research is anticipated in FY18.
  - FY10/FY11 – Developed and conducted pilot training for firefighters to learn how to respond to a locomotive accident: $450,000.
  - FY13 – Tested various firefighting tools and techniques in extricating, obtained and added video of extraction in training , developed train-the-trainer course: $350,000.
  - FY14 – Develop training for dispatcher response to a locomotive emergency: $400,000.
  - FY15 Est. – Develop crew emergency survival training for locomotive emergencies: $200,000.
- Project Duration: August 2013 – April 2015

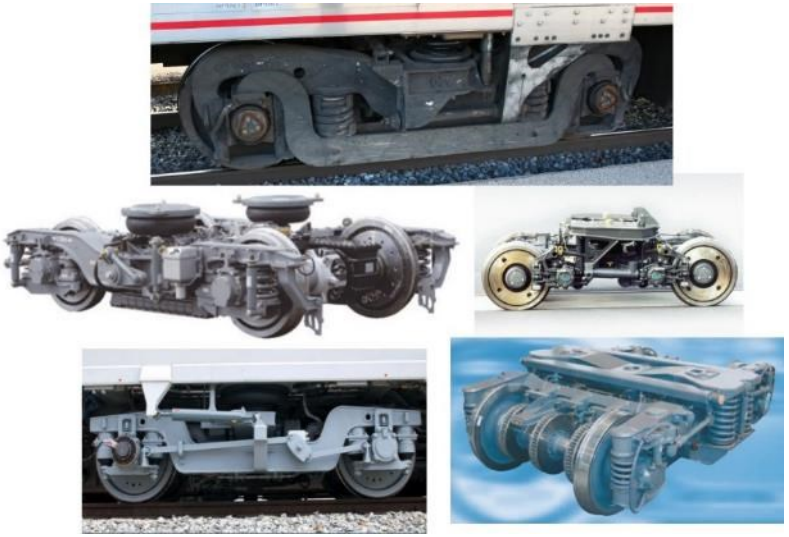
U.S. Department of Transportation
Federal Railroad Administration

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

Design Considerations for High-Speed Passenger Trucks

PROJECT DESCRIPTION

- This project aims to develop general design guidelines for high-speed passenger trucks for shared operations, and to identify one or more potentially viable trucks for use in North America by:
  - Addressing braking systems and bearing monitoring systems used in high-speed trucks.
  - Quantifying track conditions and load environments that rail vehicles are expected to encounter on representative shared routes.
  - Examination of FRA Low Speed Safety Advisory for high-speed trains and various evaluation methods and criteria.



RAILROAD IMPACT

- Impacts both safety and quality of high-speed passenger rail by stipulating passenger truck design parameters which assure optimized operation in a mixed traffic environment.
- Identifies track design and maintenance requirements for both safety and passenger comfort (ride quality).
- Helps to establish a sensible low-speed evaluation criteria for high-speed trains.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: $153,000 Total Cost
  - FY18 – Not currently funded
- Project Duration: March 2012 – May 2015

U.S. Department of Transportation
Federal Railroad Administration

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

Higher-Speed Freight Truck (HST)

PROJECT DESCRIPTION

- Safe increases in freight operating speeds have significant capacity, efficiency, and economic benefits. The focus of this program is the development of a freight truck capable of higher speed operations. Past efforts have resulted in the design and fabrication of a pair of prototype HSTs. Current focus is on the following:
  - Dynamic performance of the prototype was recently completed at TTCI and validated.
  - Truck design will be extended for use with 286,000 pound Gross Rail Load (GRL) cars.

Shown here: HST Prototype

RAILROAD IMPACT

- Development of the HST is expected to result in:
  - Increased line-haul speeds that will allow sharing of routes and costs with passenger service.
  - Reduced track damage due to improved dynamic performance and lower un-spring mass.
  - Increased track and rolling stock life-cycles due to better dynamic performance.
- Higher speed freight operations would produce beneficial services for the railroad industry by opening up certain market sectors for freight rail service.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: FY18 – Not currently funded.
  - FY14 – Modifying refrigerated container car for higher speed freight: $400,000.
  - FY15 – Extend design to 110-ton and design brake arrangement for the truck: $300,000.
- Project Duration: June 2014 – September 2014

U.S. Department of Transportation
Federal Railroad Administration

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

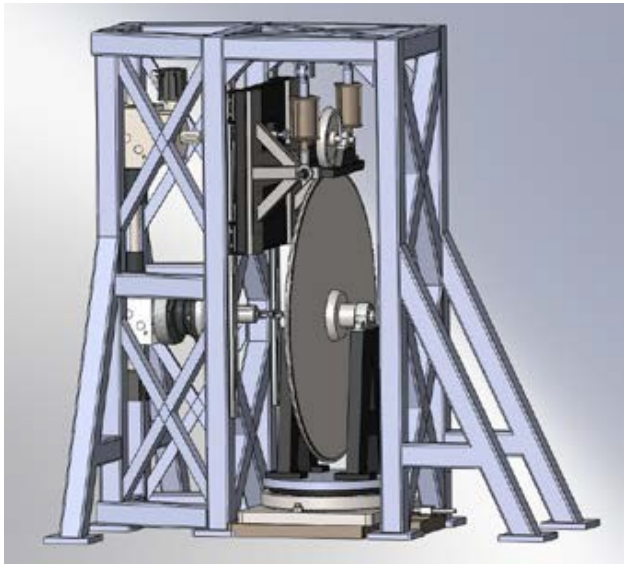
Effects of Temperature on Wheel Shelling

PROJECT DESCRIPTION

- Investigate and quantify relationship between temperature and wheel shelling to allow future research to focus on the root causes and solutions of wheel shelling.
- Create the test samples as described in Phase I test matrix.
- Perform thermally controlled twin disc testing in accordance with a test matrix to maximize the utility of the testing.

RAILROAD IMPACT

- Increase railroad safety and reliability by identifying root causes of wheel shelling, which lead to high impact loads, defects, and wheel removal.
- Reduce cost by identifying the effects of temperature which can ultimately reduce wheel shelling and wheel change-outs.



PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: FY18 – Not currently funded.
- Project Duration: August 2013 – June 2015
  - Phase I complete
  - Awaiting approval for Phase II Testing of twin discs as described in the Literature Review

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

Vertical Split Rim (VSR) Wheel Failure Mode

PROJECT DESCRIPTION

- Investigate root causes of vertical split rim failures using the following methods:
  - Finite element analysis to model fatigue crack initiation.
  - Creation of vertical split rim under controlled conditions.
  - Measurement of residual stresses in new wheels.
- Compare VSR trends in freight car and locomotive wheels.

RAILROAD IMPACT

- Fewer vertical split rim accidents.
- Improved detection of vertical split rims before failure.

COST & SCHEDULE

- Funding: FY18 – Not currently funded.
  - Finite element modeling and residual stress testing.
  - 2014 – Reporting and project conclusion.
  - Total FRA cost $200,000.
- Project Duration: March 2013 – June 2014

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- AAR
- Texas A&M University
- Jointly funded by FRA and AAR

U.S. Department of Transportation
Federal Railroad Administration

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

Improved Truck Castings

PROJECT DESCRIPTION

- Investigate and test ultraweldable steels, which eliminate the need for weld preheating or post heating.
- Investigate and test steels that retain ductility at low temperatures.

RAILROAD IMPACT

- Prevent accidents by reducing brittle phases formed during repair welding.
- Reduce accidents caused by brittle failure of side frames and bolsters at very low temperatures.

COST & SCHEDULE

- Funding: FY18 – Not currently funded.
  - Budget of $164,000.
  - 12 Month Project (Phase I).
- Project Duration: October 2014 – September 2015

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

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

Effects of Temperature on High Impact Wheels

PROJECT DESCRIPTION

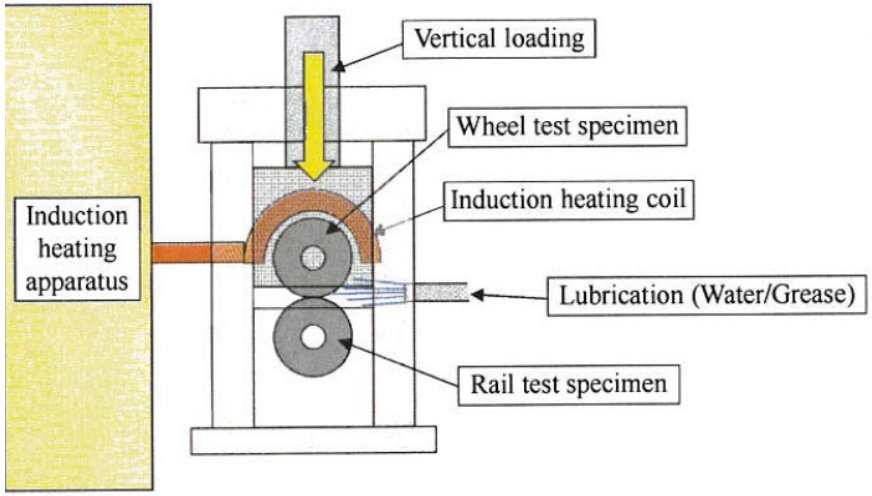
- The purpose is to increase the understanding and quantify the effects of temperature on high impact wheel generation.
- NSSMC (Nippon Sharyo and Sumitomo Metal Co.) has a twin disc test machine with temperature control option to quantify crack initiation and growth.
- Different class forged and cast wheel metallurgies can be tested under different temperature.

RAILROAD IMPACT

- Results will lead to the comparison of cast and forged Class C wheels, using twin disc based rolling contact fatigue performance under different temperature level.
- Results of surface and near-surface crack initiation due to temperature and crack growth with application of liquid performance will lead to the prevention of wheel RCF.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- NSSMC



COST & SCHEDULE

- Funding: FY18 – Not currently funded. Total FRA cost: $98,000.
  - FY 2013 – Initial research and literature review
  - FY 2104 – Visit to NSSMC laboratory, initial report
  - FY 2015 – Meetings with NSSMC and test design and scheduling
- Project Duration: August 2013 – June 2015

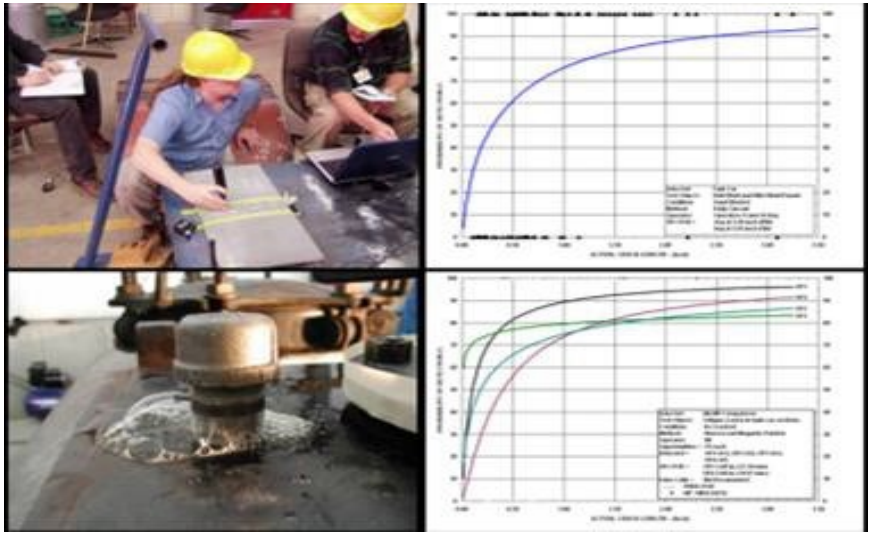
U.S. Department of Transportation
Federal Railroad Administration

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

Non-Destructive Evaluation in Lieu of Hydrostatic Testing of DOT Specification Tank Cars

PROJECT DESCRIPTION

- Evaluate and quantify Non-Destructive Testing (NDT) methods authorized under 49 Code of Federal Regulations Section.
- 180.509 for use in replacing the hydrostatic pressure test in the qualification or re-qualification of railroad tank cars.
- Quantify NDT methods using the probability of detection (POD) approach.



RAILROAD IMPACT

- Increases safety through technological development Addresses industry needs in the areas of maintenance, inspection, and damage tolerance.
- Increases reliability of inspections.
- Provides for operator and procedure qualification.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - 2015 – Small Tank car shop NDT testing: $100,000.
- Project Duration: FY02 – FY18

U.S. Department of Transportation
Federal Railroad Administration

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

Non-Destructive Testing of Tank Cars and Probability of Detection (POD)

PROJECT DESCRIPTION

- The rulemaking issued by USDOT requires the replacement of the hydrostatic pressure test with appropriate NDT methods:
  - Test methods must be quantified to demonstrate the sensitivity and reliability of the inspection and testing.
  - POD evaluations of these NDT methods by industry technicians and company procedures.
  - Evaluate and quantify Non-Destructive Testing (NDT) methods authorized for use in replacing the hydrostatic pressure test in the qualification or re-qualification of railroad tank cars.
  - Quantify NDT methods using the probability of detection (POD) approach.

RAILROAD IMPACT

- NDT reliability is a key consideration in the safety and operations of tank cars.
- Quantification of the test methods through POD to provide direction and insight into the current capabilities of the industry when using the allowed NDT methods.
- Provides reliability of inspections.
- Provides for operator and procedure qualification.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Tank car shops

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - $300,000 Projected Costs
- Project Duration: 2013 – 2017

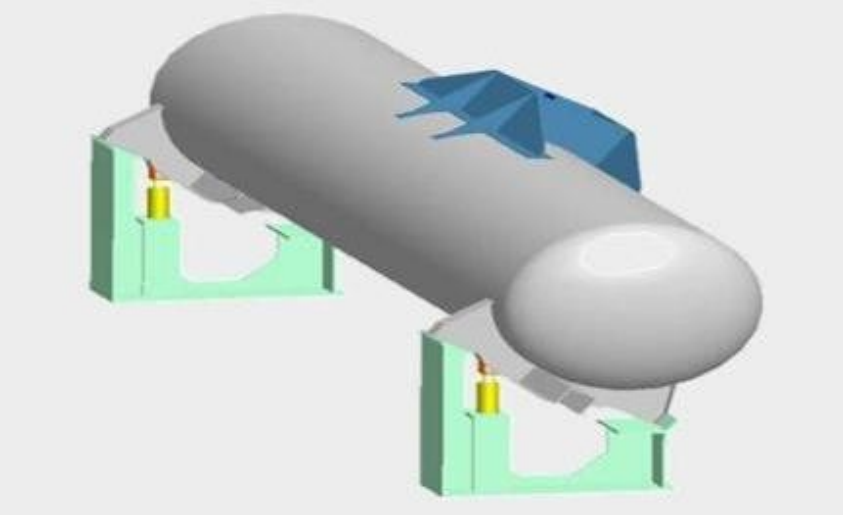
U.S. Department of Transportation
Federal Railroad Administration

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

Improving Safety of Tank Car Fittings in Hazmat Service

PROJECT DESCRIPTION

- Perform full scale static and dynamic testing of tank car fittings under rollover conditions.
- Evaluate effectiveness of three types of protective devices:
  - base case.
  - top skid.
  - reinforced protective housing.
- Calibrate analytical models to test results.
- Develop criteria and protocols for future industry research.
- Evaluate the performance of a new AAR design for non-pressure tank cars.



RAILROAD IMPACT

- Improve overall safety of tank car operations by mitigating the release of hazardous material in tank car rollover derailments.
- Develop recommendations for future design and testing of fittings for industry use.

PROJECT PARTNER(S)

- Sharma & Associates, Inc.

COST & SCHEDULE

- Funding: FY18 – $150,000
  - 2015 – Evaluate retrofit techniques for DOT 111: $150,000

U.S. Department of Transportation
Federal Railroad Administration

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

Instrumented Tank Car

PROJECT DESCRIPTION

- Conduct research into issues being faced by the industry using testing or analytical efforts.
- Evaluate coupling forces through simulations and testing to arrive at potential combinations of speeds and masses which provide an elevated risk of stub sill failure.
- Assess the possibility of low cost sensors to measure vertical and longitudinal coupler forces.

RAILROAD IMPACT

- Create better understanding of the operational environment and forces exerted on tank cars in the creation of fractures.
- Develop speed and mass combination curves to limit stub sill failures and tank car damage.
- Develop low cost approach to measure the forces on a tank car during regular operations.
- Conduct dynamic testing to target a variety of issues being faced by the industry.

PROJECT PARTNER(S)

- ENSCO Inc.
- GE Rail
- Union Tanks
- Amsted Rail

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - 2015 – Yard impact testing: $75,000
  - Over the road test-crude oil route – $100,000
  - Switch impact test – $75,000

U.S. Department of Transportation
Federal Railroad Administration

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

Renewable Fuels Non-Accident Releases Research

PROJECT DESCRIPTION

- The objective of this task is to reduce the number of product releases in the renewable fuels industry as a result of failures in the assembly of bolted joints and threaded connections.
- The project will focus on people, processes, and equipment in the bolted and threaded assembly joint process.
- Case studies – emergency response and mitigation strategies.

RAILROAD IMPACT

- Reduces the non-accident releases.
- Reduces the exposure of railroad employees to chemical releases.
- Develops guidelines on loading and unloading procedures

PROJECT PARTNER(S)

- Renewals Fuels Foundation

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - 2015 – Best practices guideline: $50,000

U.S. Department of Transportation
Federal Railroad Administration

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

Tank Car Total Containment Fire Testing

PROJECT DESCRIPTION

- Tank cars are required to have a pressure relief device (PRD) to protect the tank car when they carry hazardous materials.
- The objective is to demonstrate by scale testing that there is a regulation-grade alternative to PRD by loading rail cars with Sodium or Potassium hydroxide in a pool fire environment for 100 minutes without rupture or otherwise release any lading.

RAILROAD IMPACT

- USDOT wants to determine if these tank car safety systems will protect the tank car from rupture for 100 minutes in a defined engulfing fire, 30 minutes in a defined torching fire.
- If it is proved that the tank car survives the experiment, then these materials can be transported without a PRD, thus reducing the non-accident releases during transportation.

PROJECT PARTNER(S)

- Sharma & Associates, Inc.
- ARA
- Transport Canada
- The Chlorine Institute
- BAM

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - 2015 – 1/3 scale test report: $100,000

U.S. Department of Transportation
Federal Railroad Administration

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

Tank Car Structural Integrity

PROJECT DESCRIPTION

- Conduct engineering analyses and develop computational tools to evaluate structural performance of railroad tank cars under accident loading conditions.
- Conduct material testing to determine mechanical properties and fracture behavior of tank car steels.
- Risk ranking to prioritize tank cars most vulnerable to catastrophic failure.

RAILROAD IMPACT

- There are 28,116 pre-1989 pressurized tank cars in service today.
- Address safety concerns and NTSB recommendation arising from Minot, North Dakota train derailment and subsequent tank car ruptures in January 2002.
- National Rail Safety Action Plan (2005) calls for accelerated tank car structural integrity research.
- Develop standardized methodology to evaluate new tank car designs.

PROJECT PARTNER(S)

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

COST & SCHEDULE

- Funding: FY18 – $200,000
  - 2015 – Full scale testing and modeling: $150,000

U.S. Department of Transportation
Federal Railroad Administration

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

Full Scale Tank Car Testing

PROJECT DESCRIPTION

- Develop the test method.
- Design and construct the test fixture.
- Prepare and test four tank cars.
- Analyze and provide the data for model validation.

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 PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $1,079,000 Project Cost
  - FY18 – $300,000
- Project Duration: August 2013 – December 2015

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

Hazmat Risk Assessment

PROJECT DESCRIPTION

- Identify and characterize baseline risks and metrics associated with the operation and transportation of hazmat by rail under current conditions.
- Determine the potential benefit of various risk reduction strategies (e.g. enhanced tank cars, PTC, re-routing, ECP brakes, and speed restrictions).
- Identify future research needs to support industry and governmental efforts to further reduce risk.

RAILROAD IMPACT

- Understand the risks involved with all aspects of hazmat transportation by railroad tank cars.
- Understand the impact of varying operational conditions on the risk of accidental release of hazmat during transportation.

PROJECT PARTNER(S)

- Dr. Alan Bing, Private Consultant

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - 2015 – Final report: $50,000
- Project Duration: June 2014 – November 2015

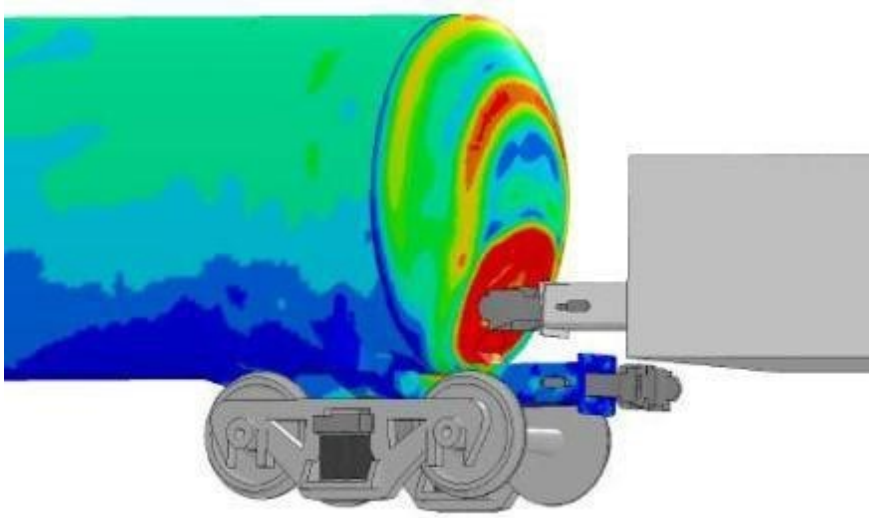
U.S. Department of Transportation
Federal Railroad Administration

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

Industry Interaction

PROJECT DESCRIPTION

- Evaluate the puncture behaviors of tanks under a more general range of impact conditions. This includes analyses using three different impactor sizes (3x3, 6x6, 12x12) and real impactor shapes (coupler, coupler shank, and a section of rail).
- Task 1: Analysis of Different Sized Impactors.
- Task 2: Analysis of Real World Impactors: extends Task 1 to include different complex impactors (e.g. coupler head, broken rail, etc.)
- Task 3: Analysis of real world impacts
- Task 4: Analysis of real world threats
- Coordinate with DHS and FRA to evaluate protection system concepts under Tasks 1 and 2 impact conditions.



RAILROAD IMPACT

- This research is in cooperation with tank car, shippers and railroads.
- These analyses will help to better understand the damaged caused by the different impactors on different tank cars and should provide us with conclusions/recommendations for performance tests for tank head and shell for each impactor.

PROJECT PARTNER(S)

- AAR
- Tank car manufacturers
- Chemical industries
- PHMSA

COST & SCHEDULE

- Funding: FY18 – $50,000
  - Full scale test of pressure tank cars 2015 – $150,000. Develop testing procedures for new designs 2015 – $150,000.
- Project Duration: March 2013 – April 2020

U.S. Department of Transportation
Federal Railroad Administration

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

Fire Performance of a Cryogenic ISO UN-T75 Tank

PROJECT DESCRIPTION

- Conduct a full scale fire test on an ISO UN-T75 tank.
- Obtain experimental data.
- Provide a realistic fire exposure of the ISO tank on a flat car, simulating a fire exposure in an accident conditions.
- Conduct a computer simulation of the experiment data.
- Use nitrogen as a commodity and a diesel fire.

RAILROAD IMPACT

- Evaluate the survivability of the ISO tank in fire conditions.
- Evaluate the performance of the pressure relief device.
- Obtain important data for future design improvements.

PROJECT PARTNER(S)

- Southwest Research Institute
- Sharma & Associates, Inc.
- FECR
- Transport Canada
- PHMSA

COST & SCHEDULE

- Funding: FY18 – Phase II: $400,000
  - 2017 – Full scale fire test: $300,000

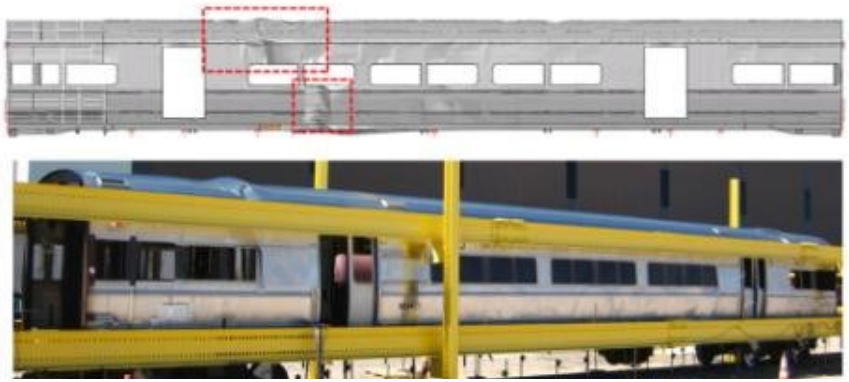
U.S. Department of Transportation
Federal Railroad Administration

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

Passenger Equipment Structural Crashworthiness

PROJECT DESCRIPTION

- The goal of the passenger equipment safety research program is to develop design strategies for improving the structural crashworthiness of passenger railcars relative to existing designs.
- Data and information derived from this research are used in the development of specifications and regulations, and to support various waiver requests and evaluations of compliance with FRA regulations.
- Occupied Volume Integrity (OVI) describes the ability of a passenger railcar to support a large longitudinal load without compromising the space occupied by passengers and crew.
- Program focus is on developing reliable techniques for the timely evaluation of the structural crashworthiness of a passenger railcar's OVI using a combination of testing and analysis.



COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - Funding Level: $25,000
- Project Duration: September 2017 – December 2018
  - Presentation of ASME paper on crippling test and analysis: April 2014.
  - FRA report on overall testing program: March 2014 (draft), March 2015 (publication).
  - Technical Report on 1- and 2-car CEM Tests - "Crash Energy Management One and Two-Car Passenger Rail Impact Tests," August 15, 2014

RAILROAD IMPACT

- The current longitudinal loading requirement for passenger cars requires the structure to experience no permanent deformation while an 800,000 pound load is placed along the line of draft.
- NPRM under development contains alternative OVI requirements that are applicable to passenger cars designed to alternate standards.
- The alternative requirements move the evaluation load from the line of draft to the collision load path, permit evaluation of the structural capacity of car according to one of three loading conditions and pass/fail criteria, and permit a combination of elastic testing and elastic/plastic analysis to be used in demonstrating OVI.
- 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(S)

- Volpe National Transportation Systems Center

U.S. Department of Transportation
Federal Railroad Administration

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

Locomotive Structural Crashworthiness

PROJECT DESCRIPTION

- Research will demonstrate effectiveness of crashworthy components in preventing override of locomotives by impacted equipment in a collision.
- The performance of the combination of a push-back coupler and deformable anti-climber will be evaluated under full-scale dynamic impact scenarios.
- Components are to be re-designed as a retrofit to existing locomotives.
- Individual component testing has been performed to demonstrate performance and develop technical information to inform finite element modeling.
- Routine coupling tests to be performed to develop range of expected.
- Impact forces and characterize behavior.
- Activities to also include evaluation of iso-cab designs and locomotive crashworthiness standards.

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 23-mph collision that occurred in Red Oak, Iowa on April 17, 2011 (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.

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - Funding level: $480,000
- Project Duration: February 2016 – April 2017
  - FRA Report on Component Re-designs, December 2014
    ASME Paper on Component Re-designs, April 2015
    Summary Report on Coupling Tests, July 2015

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center
- TIAX
- Transportation Technology Center, Inc. (TTCI)
- Canarail

U.S. Department of Transportation
Federal Railroad Administration

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

Interior Occupant Protection

PROJECT DESCRIPTION

- FRA performed research to develop an industry safety standard to address the crashworthiness of workstation tables in passenger rail cars.
- The safety standard requires dynamic sled testing with an advanced anthropomorphic test devices (ATDs) to evaluate abdominal injuries.
- The H3RS ATD was developed in the UK specifically to assess abdominal injuries due to impacts with tables in trains.
- Further ATD research and development is necessary to improve the biofidelity, reliability, and repeatability of the performance of the H3RS ATD.
- Additional activities include development of a simulation model representative of the H3RS ATD and a study to identify additional interior arrangements prone to cause occupant injury.

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - Funding Level: $160,000
- Project Duration: September 1, 2017 – December 1, 2018
  - Develop test requirements for parametric impact tests to evaluate the H3RS abdominal instrumentation, September 2014.
  - MADYMO model of H3RS ATD, validated with 2012 sled test data, November 2014.
  - MADYMO model of H3RS ATD, validated with parametric test data (and 2015 sled test data, if conducted), March 2015.
  - Test Report on parametric testing (and 2015 sled tests, if conducted), March 2015.

RAILROAD IMPACT

- Impacts with fixed workstation tables can cause significant abdominal injuries to passengers.
- Both the UK and US have safety standards for workstation tables that rely on ATDs that are capable of assessing abdominal injury – in partnership with UK researchers, costs to improve the H3RS ATD can be shared.
- Planned parametric studies form the basis to develop a globally acceptable test device which would present an opportunity to exploit advances in ATD instrumentation since the ATD was first developed (ca. 2002).

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center
- Rail Safety and Standards Board (UK)
- Transportation Research Laboratory (UK)

U.S. Department of Transportation
Federal Railroad Administration

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

Field Investigations

PROJECT DESCRIPTION

- Accident investigations are conducted at the request of the FRA.
- 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, fuel tank integrity and other safety features.
- A technical presentation of the field investigation is produces from the preliminary findings.
- A technical report or paper is written from the technical presentation and reconstruction of the field investigations.

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - Funding Level: $40,000
- Project Duration: September 2017 – December 2018
  - 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; and Spuyten Duyvil, NY in December 2013

RAILROAD IMPACT

- Passenger equipment safety research program areas of focus cannot be developed absent information derived from real-world conditions.
- Field investigations of actual accidents can assist in identifying deficiencies related to equipment performance and operating practices.
- Program direction is tuned based on the findings of the field investigations to ensure maximum application and effectiveness of research results.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center

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

Regulatory Development, Waiver Support and Technology Transfer

PROJECT DESCRIPTION

- FRA is currently supporting development of crashworthiness standards for high-speed passenger trains, revisions to safety standards for conventional speed passenger trains, and revisions to safety standards for high-speed passenger trains used in mixed service.
  - 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 and standards development, and verification of required performance.

RAILROAD IMPACT

- FRA has been supporting rail equipment standards development since the advancement of Amtrak's technical specification for the Acela in 1993.
- These requirements evolved into FRA's Tier II equipment standards, the first national standards requiring Crash Energy Management.
- Additional standards supported include the Passenger Equipment Safety Standards, the Locomotive Crashworthiness Standards, and the Cab Car End Frame Standards.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: FY18 – Not currently funded
  - Funding Level: $1000,000
- Project Duration: September 2017 – December 2018
  - Editing and commenting on Notice of Proposed Rulemaking for High-Speed Passenger train crashworthiness: September 2014.
  - Editing and commenting on Addendum A: Suggested Practices - Technical Criteria and Procedures for Evaluating the Crashworthiness and Occupant Protection Performance of Alternatively-Designed Passenger Rail Equipment for Use in Tier I Service: September 2014.
  - Draft regulations for alternatively designed single locomotives and single cab cars for use in Tier I service: August 2014.
  - Draft regulations for alternatively designed single coach cars for use in Tier I service: August 2014.

U.S. Department of Transportation
Federal Railroad Administration

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

Vehicle-Track Interaction Research

PROJECT DESCRIPTION

- Technical support and coordination are provided to develop regulations and industry standards to promote the safe interaction of rail vehicles with the track over which they operate.
- Technical support includes conducting analyses, simulation studies designed to examine vehicle response to track geometry irregularities, reviews of vehicle qualification and revenue service test data, and consideration of international practices focusing on the following:
  - Development of Tier III regulations in support of ETF II Inspection, Testing and Maintenance (ITM) and Trackworthiness Working Groups.
  - Revision/update of APTA Standards including the Truck Equalization Standard.
  - Support of PRIIA Specification Development Efforts.
  - Development of methods for condition monitoring and inspection of critical suspension components.
  - Specification of vehicle curving performance.

COST & SCHEDULE

- Funding: FY18 – $100,000
- Project Duration: September 2017 – December 2018
  - Summary report on Tier III and APTA Safety Standards development.
  - Summary report on methods for condition monitoring and inspection of critical suspension components and specification for vehicle curving performance.

RAILROAD IMPACT

- The vehicle's suspension system has a significant effect on the ability to provide safe motion of equipment along the track over which it operates.
- Suspension systems should be designed to control and damp the motions of both the sprung and unsprung masses to ensure the vehicle remains on the track, the vehicle motions are stable, the effects of irregularities in track geometry are filtered out to provide ride quality within acceptable limits, and wayside clearances are met.
- As components of the suspension system degrade or fail, unsafe operating conditions may develop.
- Track Safety Standards require vehicles to be qualified per § 213.345 in order to demonstrate safe operation for various track conditions, but these requirements are limited and examine the performance of the vehicle and its suspension in new or near new condition.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center

U.S. Department of Transportation
Federal Railroad Administration

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

SECTION THREE

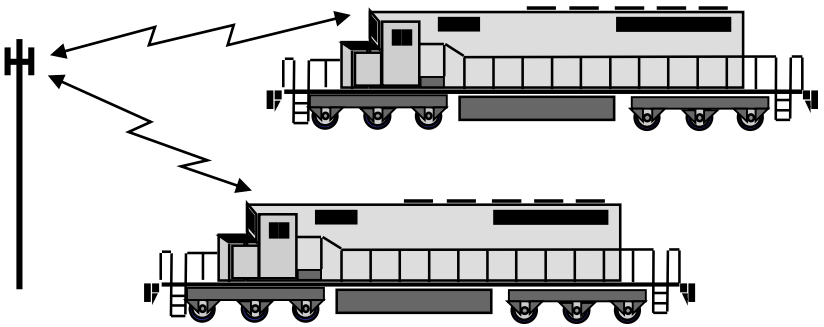
TRAIN CONTROL & COMMUNCATIONS

U.S. Department of Transportation
Federal Railroad Administration

Railroad Wireless Communications Roadmap

PROJECT DECSCRIPTION

- Work with railroad advisory group to identify projected future wireless needs of the railroads.
- Develop message models for all wireless applications identified by advisory group projected out to 20 years.
- Draft a technology and spectrum acquisition plan to ensure railroad communications needs are met.



RAILROAD IMPACT

- Develop a vision and plan for the railroads' RF spectrum needs as related to their safety, operational, and business applications.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: $338,000 overall cost
- Project Duration: May 2015 – December 2017

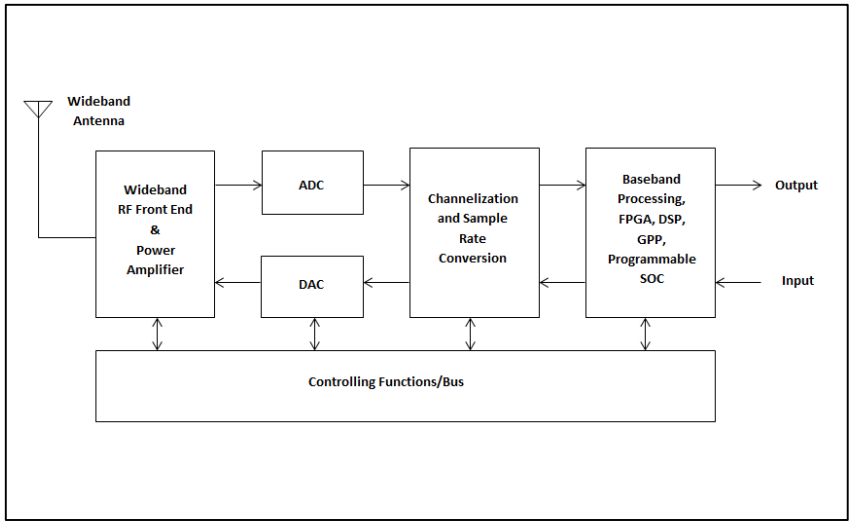
U.S. Department of Transportation
Federal Railroad Administration

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

Rail Software-Defined Radio (SDR)

PROJECT DECSCRIPTION

- Define overall requirements for an industry-standard SDR.
- Perform trade studies to select best type of solution for each major component (e.g., power amplifier, antenna, front end, modem), including high-level reliability analysis.
- Generate specifications for each major component to support development.
- Develop and test prototypes of the major components.



RAILROAD IMPACT

- Reduced hardware count – one SDR substitutes for multiple radios, reducing hardware and support required.
- Migration support – when migrating an application to a new protocol, waveform or frequency band.
- Dynamic adaptability – ability to adapt to changing environment and/or availability of spectrum.
- Upgradeability and flexibility for future expansion – expand capabilities and support changing or new requirements without replacing hardware.
- Sparing – one SDR spares for many other radio types in the event of a radio failure.
- Availability – Increase availability by adding 1 hot spare radio in cases where would previously have required several.

PROJECT PARTNER(S)

- Transportation Technology Center Inc. (TTCI)
- MeteorComm, LLC (MCC)

COST & SCHEDULE

- Funding: $518,188
- Project Duration: August 2016 – December 2018

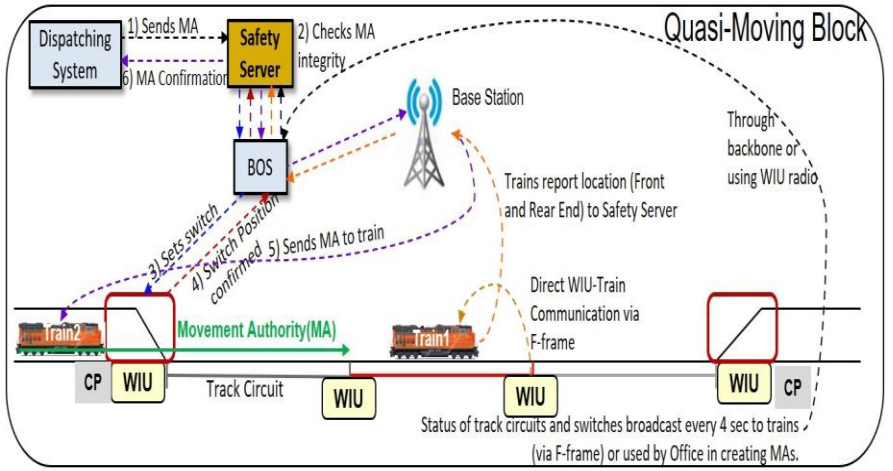
U.S. Department of Transportation
Federal Railroad Administration

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

Quasi-Moving Block Train Control

PROJECT DECSCRIPTION

- Develop a Concept of Operations (CONOPS), with industry input and review, describing the technical approach for implementing quasi-moving block train control.
- Identify new functions, key design details, interfaces, and issues requiring resolution.
- Analyze communication, hardware, and software needs and identify potential technology gaps.
- Develop safety analysis and draft implementation plan.



RAILROAD IMPACT

- Improve operational efficiency and network capacity by safely reducing train headways.
- Improve safety by preventing train collisions under restricted speed operation.
- Test and evaluate remote sensing suite that will influence the feasibility of automated train operation in the future.

PROJECT PARTNER(S)

- Transportation Technology Center Inc. (TTCI)

COST & SCHEDULE

- Funding: $400,013
- Project Duration: September 2017 – September 2019

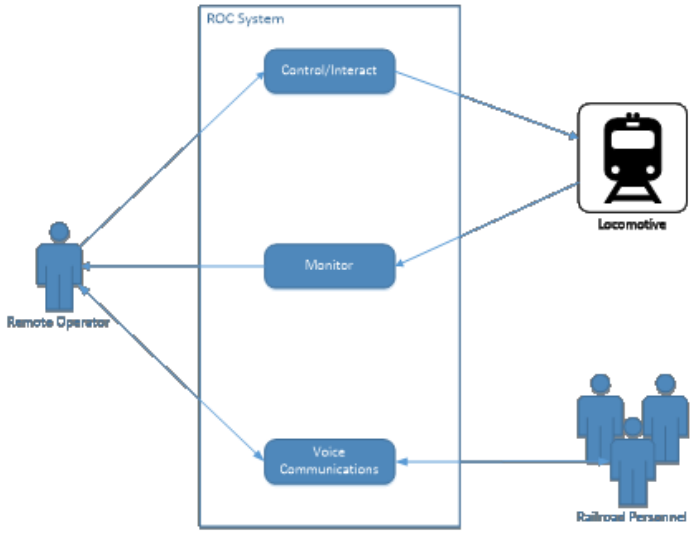
U.S. Department of Transportation
Federal Railroad Administration

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

Flexible Operator Location Feasibility Analysis

PROJECT DECSCRIPTION

- Develop a Concept of Operations (CONOPS), with industry input and review, describing the technical approach for implementing human-in-the-loop, remote operator-controlled, line-of-road locomotive operations.
- Identify and document representative sensor, data link, and other high-level technical system requirements for implementing human-in-the-loop, remote operator-controlled, line-of-road, locomotive operations.
- Evaluate the technical feasibility of implementing the proposed system.
- Provide recommendations and data for future analyses.



RAILROAD IMPACT

- Improve operational efficiency and network capacity by reducing the number of hand brake applications and allowing railroads to change crews at any time, irrespective of train location.
- Improve safety by reducing overtime hours ensuring locomotive crews remain alert, preventing fatigue-related incidents.
- Test and evaluate remote sensing suite that will influence the feasibility of automated train operation in the future.

PROJECT PARTNER(S)

- Transportation Technology Center Inc. (TTCI)

COST & SCHEDULE

- Funding: $400,013
- Project Duration: September 2015 – December 2017

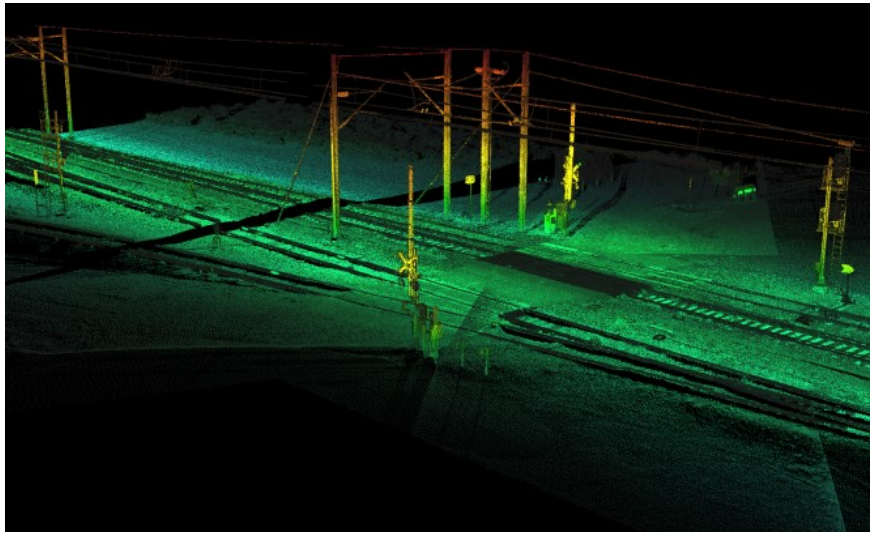
U.S. Department of Transportation
Federal Railroad Administration

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

PTC Critical Assets Machine Vision Track Map Auditing System Requirements

PROJECT DESCRIPTION

- Facilitate and document a railroad consensus for the functionality and requirements for a machine vision-based system to support PTC track map auditing.
- Develop system specification documentation based on stakeholder engagement and railroad need.
- Survey/evaluate technologies and concepts that could meet the documented requirements.
- Identify any significant gaps between requirements and available technology.



RAILROAD IMPACT

- Supports implementation of PTC and other safety-related systems that depend on accurate up-to-date track information.
- Supports automation of track database auditing for enhanced safety and efficiency.
- Supports development of a system to scan for PTC-critical track assets and detect and report discrepancies from the reference database.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: $317,206 project cost
- Project Duration: September 2015 – December 2018

U.S. Department of Transportation
Federal Railroad Administration

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

SECTION FOUR

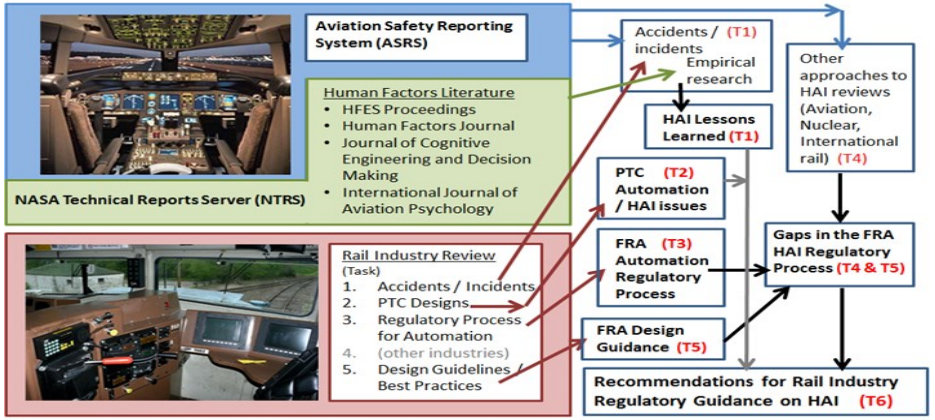
HUMAN FACTORS

U.S. Department of Transportation
Federal Railroad Administration

Human-Automation Interaction (HAI) Guidance

PROJECT DESCRIPTION

- Automated systems, such as Positive Train Control (PTC) are being developed for use in the locomotive cab. Human error analysis.
- Decades of operational experiences in the aviation industry, and empirical research on human-automation interaction (HAI), offer insights for implementing and integrating automated systems.
- Review empirical research and operational experiences regarding HAI to identify lessons learned; we will review regulatory guidance and design guidelines to identify potential gaps in the regulatory process.
- Develop recommendations for regulatory guidance regarding HAI for the rail industry.



RAILROAD IMPACT

- Guidance to human performance specialists for evaluating locomotive cab automation.
- Identification of factors that affect engineer performance.
- Provide technical bases for evaluating and comparing potential systems.
- Improve safety by helping ensure more usable systems in the locomotive cab.
- Can provide a basis for proposed new federal regulation related to cab technologies.

PROJECT PARTNER(S)

- Alion Science & Technology

COST & SCHEDULE

- Funding: $288,619
- Project Duration: July 2015 – August 2016
  - *Research completed. Final report in editing for publication*

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Mike Jones • (202) 493-6362 • michael.e.jones@dot.gov

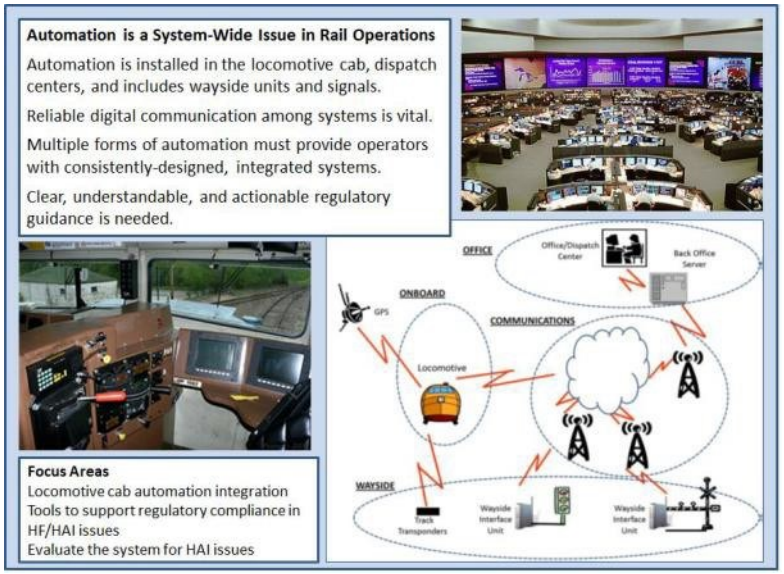
Human-Automation Interaction Aviation Lessons Learned

PROJECT DESCRIPTION

- Research implementation of automation in the aviation domain and provide lessons learned to the rail industry domain.

RAILROAD IMPACT

- Identification of system-wide factors that affect the implementation of automation (shared situation awareness).
- Provide technical bases for evaluating and comparing potential systems.
- Improve safety by helping ensure more usable systems in the locomotive cab.
- Can provide a basis for proposed new federal regulations related to cab technologies.
- Recommendations on the need for integration and consistency in locomotive cab automation.



PROJECT PARTNER(S)

- Alion Science & Technology

COST & SCHEDULE

- Funding: $295,000
  - *Research Completed. Final Report in Editing for Publication.*

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Mike Jones • (202) 493-6362 • michael.e.jones@dot.gov

Experimental Crew Station Evaluation

PROJECT DESCRIPTION

- Volpe evaluated the effectiveness of the experimental crew station.
- Assessed and documented any aspects of its design that could lead to confusion or mistakes in operation, and evaluated whether engineers found it intuitive and easy to use.
- Provided improvement recommendations that can be incorporated into future prototypes.
- Used the CTIL for this evaluation because of its ability to easily integrate new displays and controls into the simulated operating environment. Using CTIL also allowed VOLPE to make use of CTIL suite of ergonomic analysis tools.

RAILROAD IMPACT

- This crew station design suggests an alternative approach to the design of the engineer's seating, displays and controls in attempt to provide better performance.
- Conventional control stands for operating trains, such as the one from the Association of American Railroads (called the AAR-105), have evolved from models of locomotives dating back to the 1950s.
- Despite multiple systematic improvements and alternative designs (such as desktop-style controls), there is room to improve the seating and associated cab-display configuration to effect the health, safety, and performance of the crew.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $56,765
- Project Duration: Volpe HF-IAA, August 2014 – September 2015
  - *Research completed. Final report in editing*

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Mike Jones • (202) 493-6362 • michael.e.jones@dot.gov

Sustained Attention and Error: A Scientific Approach to Reducing Major Rule Violations

PROJECT DESCRIPTION

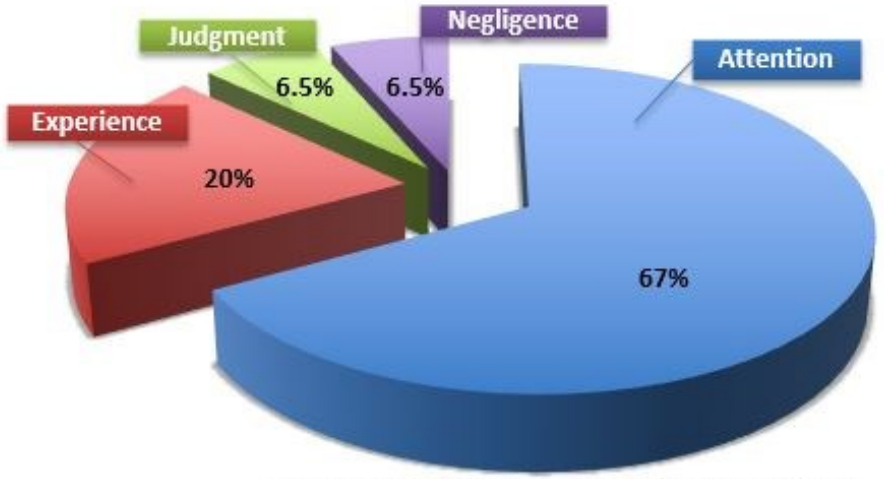
- Investigate attention related errors in train operations and analyze operator attention using the Cab Technology Integration Lab (CTIL).
- Develop a sustained attention/distraction training program and validate course content utilizing CTIL.
- Share knowledge with railroad industry.

RAILROAD IMPACT

- A collaborative effort with railroad industry to address sustained attention and human error related rule violations.
- Contributes to the understanding of accidents involving signals passed at danger (SPADs).

PROJECT PARTNER(S)

- Veolia Transdev, Inc.
- George Mason University
- Applied Cognition Research Program



Veolia Transportation Services Inc. Study

COST & SCHEDULE

- Funding: Cost-share agreement, $250,000, started May 2011
- Project Duration: Completed September 2014
  - Data collection completed mid-August 2014
  - Analysis completed September 2014
  - Pilot training course on distraction developed.
  - *Research Completed.* ***Final Report:*** *https://www.fra.dot.gov/eLib/details/L18438*

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Mike Jones • (202) 493-6362 • michael.e.jones@dot.gov

Wearable Technology Interface for Track Inspection

PROJECT DESCRIPTION

- Use google-glass or related technology to prototype goggles that provide track information to track inspectors.

RAILROAD IMPACT

- Speed manual track inspection process.
- Assist track inspectors by providing real-time recording capability, as well as access to past inspection data and records.

PROJECT PARTNER(S)

- Fulcrum Corporation
- Buckingham Branch Railroad

COST & SCHEDULE

- Funding: $149,280
- Project Duration: April 2016 – March 2017
  - *Research completed. Final report in editing*

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Mike Jones • (202) 493-6362 • michael.e.jones@dot.gov

New Jersey Transit Run Through Switch Project

PROJECT DESCRIPTION

- The goal is to identify factors that contribute to train crews running through switches at New Jersey Transit.
- New Jersey Transit requested assistance from FRA to learn why train crews continue to run through switches.
- A number of system and environmental conditions can contribute to these events, such as diverted attention, the level of expertise of workers, the design of switches, organizational constraints, safety culture, and training standards. Identifying the contributing conditions can lead to corrective actions that reduce these unwanted events.

RAILROAD IMPACT

- Identification of contributing factors leading to switch violations.
- Corrective action development.
- Less damage to infrastructure and equipment.

PROJECT PARTNER(S)

- FRA sponsored research
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: Approx. $200,000
- Project Duration: October 2016 – September 2017
  - *Research completed. Final report in editing*

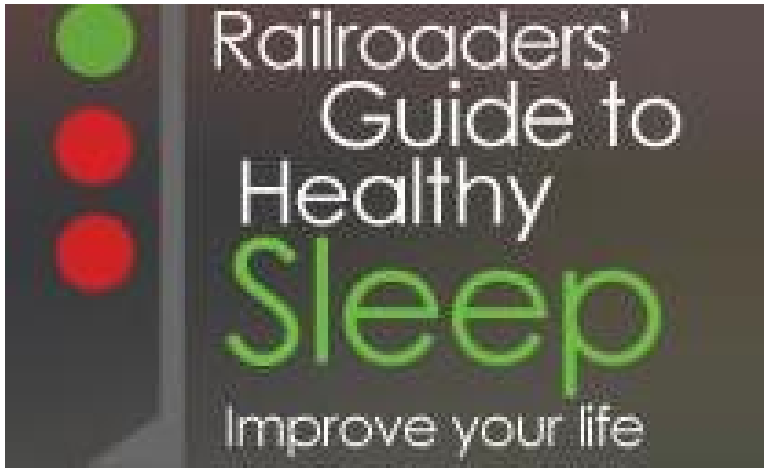
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Rachel Grice • (202) 493-8005 • rachel.grice@.dot.gov

Railroaders' Guide to Healthy Sleep Website
www.railroadersleep.org

PROJECT DESCRIPTION

- In 2012, the Volpe Center (in conjunction with Harvard Medical School) launched an interactive, multimedia educational website tailored towards providing train crews and other railroad employees:
  - Scientifically-valid information about the importance of sleep.
  - An anonymous self-assessment sleep disorders screening tool.
  - Proven, practical strategies for improving sleep health.
- Current key project efforts include a comprehensive redesign (look and feel that reflects current web standards), the reorganization of existing website content to better meet target user needs, and the creation of new content to address balancing work/life challenges.



RAILROAD IMPACT

- Fatigue in the transportation industry has been a top priority of the National Transportation Safety Board starting in 1990. The Rail Safety Improvement Act of 2008 includes a requirement for carrier fatigue education and training. The website can help carriers in their efforts to meet this upcoming requirement.
- This educational website intended for railroaders focuses on the causes of sleepiness and key mitigation strategies under an operator's control can help reduce sleepiness and fatigue-related incidents.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center
- AAR
- ASLRRA
- Harvard Medical School
- Division of Sleep Science
- BLET
- SMART-TD
- Rail carriers

COST & SCHEDULE

- Funding: Project Balance: $600,000 (including project evaluation effort); Received $310,000 in FY14
- Project Duration: April 2015 – March 2020
- Updating website

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Mike Jones • (202) 493-6362 • michael.e.jones@dot.gov

Maintenance-of-Way Worker Fatigue

PROJECT DESCRIPTION

- There is a high prevalence of human factors-related safety accidents among maintenance-of-way (MOW) workers.
- Because shift work and other irregular schedules can disrupt the circadian rhythm and introduce challenges to human performance, such as fatigue, we should optimize work schedules for MOW workers to mitigate these challenges.
- This project will analyze MOW employee accidents and incidents and the corresponding schedule data for the employees to determine if there is a correlation between fatigue and accidents and incidents.

RAILROAD IMPACT

- Education to industry and MOW workers concerning fatigue and accident patterns of MOW workers.
- May be used to determine optimal MOW worker schedules that reduce fatigue and related human performance errors.
- This effort may support changes to safety standards regarding regulations for MOW work/rest periods to be consistent with other railroad employee work/rest regulations.

PROJECT PARTNER(S)

- FRA-sponsored research, 10 major passenger railroads

COST & SCHEDULE

- Funding: Approx. $150,000
- Project Duration: May 2016 – November 2017
  - *Technical report in progress*

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Rachel Grice • (202) 493-8005 • rachel.grice@.dot.gov

Human System Integration E-Learning Website - Distraction

PROJECT DESCRIPTION

- Develop and implement an E-learning website to help improve audience awareness of and use of Human Systems Integration –human factors engineering addressing "distraction" and other HF safety related issues.

RAILROAD IMPACT

- Reduce human factors incidents/accidents due to distraction or lack of human factors engineering by informing audience about distraction in accidents and ways to mitigate distraction through awareness.

PROJECT PARTNER(S)

- Applied Research Associates

COST & SCHEDULE

- Funding: $455,000
- Project Duration: December 2013 – August 2016
  - *Website available at https://www.fra.dot.gov/Page/P0872*

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Mike Jones • (202) 493-6362 • michael.e.jones@dot.gov

A Head-Up Display (HUD) Alternative for Locomotives

PROJECT DESCRIPTION

- Anecdotal evidence from four train engineers indicate that the radio is the most distracting technology in the cab. This research would investigate the utility of a HUD in reducing dispatch radio distraction. This study will measure the performance in all conditions, examine the effect radio has, and use the HUD as an alternative technology to radio communication.
- Additionally, a Head-Up Display (HUD) for the CTIL can be used in subsequent human-in-the-loop experiments investigating the value of HUD symbology in terms of locomotive engineer workload, situation awareness and performance. Implementation of the hardware to overlay the HUD imagery onto the CTIL's simulated railroad scenery.

RAILROAD IMPACT

- Provides an alternative display resource for "eyes-out" use.
- May help reduce distraction effects from radio noise.
- Improves crew performance and safety of locomotive operation.

PROJECT PARTNER(S)

- FRA sponsored and led research
- MIT Man-Vehicle Lab
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: Approx. $150,000
  ($48,000 for MIT production of HUD)
- Project Duration: June 2016 – June 2017
  - *Prototype HUD display configured for install in CTIL lab*

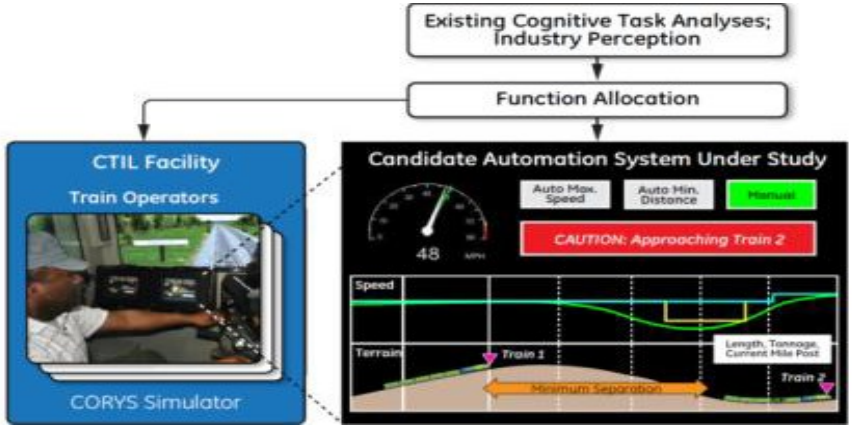
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Mike Jones • (202) 493-6362 • michael.e.jones@dot.gov

Investigation of New Roles for Humans and Automation in Next-Generation Rail Operations

PROJECT DESCRIPTION

- GEGR and MIT will establish a framework, or methodology for determining and evaluating the allocation of functions between human operators and in-cab automation performance.
- Develop and test a framework for human factors analysis of in-cab advanced automation technologies using GE's Trip Optimizer as a baseline automation platform; prototype system in the Cab Technology Integration Lab (CTIL)
- Explore alternative workload assignments among crew, dispatcher and automation.



RAILROAD IMPACT

- Framework for novel workflow and roles definition for, e.g., reduced workload and improved situation awareness, with emerging train automation (Trip Optimizer, PTC, etc.).
- Tools to evaluate impact of *integrated* information outside the train to improve human and system performance metrics (dispatcher roles, nearby trains, etc.).
- Path toward standards for human factors requirements for current and future advanced automation systems.

PROJECT PARTNER(S)

- GE-Global research
- MIT Man-Vehicle Lab
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding:
  - Phase 1 cost share $350,000 Analysis, Function allocation
  - Phase 2 Cost Share $360,000 Research in FRA's CTIL
- Project Duration: Overall 2-year study, started May 2014
  - *Research completed. Final report in editing*

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Mike Jones • (202) 493-6362 • michael.e.jones@dot.gov

Human Systems Integration Acquisition Guidance Document

PROJECT DESCRIPTION

- Provide guidance document and contract language examples for acquisition of HSI processes in large scale railroad acquisitions.
- Document provides guidance how railroads can use their contracting and acquisition processes to incorporate human-centered design practices as part of systems engineering.

RAILROAD IMPACT

- Safer, better performing systems where human interaction needed.
- Less need for costly engineering design changes to accommodate human performance.
- Less risk of human error due to poor design decisions where human interaction concerned.

PROJECT PARTNER(S)

- Integrated Product Team - Volpe National Transportation Systems Center – Human Factors Div.

COST & SCHEDULE

- Funding: $216,356
- Project Duration: Volpe HF-IAA, October 2012 – September 2016
  - *Research completed. Final report in editing*

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Mike Jones • (202) 493-6362 • michael.e.jones@dot.gov

Suicide Countermeasures

PROJECT DESCRIPTION

- Better understand potential countermeasures to mitigate suicides on the rights-of-way.
- Develop rail specific guidelines for reporting on suicides on the rights-of-way.
- Track suicide and trespass rates and identify potential regions of concern (e.g., hotspots) using Geographic Information Systems (GIS) mapping.
- Continue to gather information about the prevalence of suicides on the rights-of-way as well as demographic characteristics of the individuals involved and characteristics of the time and location that may impact countermeasure development.
- Continue working with railroad carriers to implement pilot tests of various countermeasures.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center
- Various railroad carriers

COST & SCHEDULE

- Project Duration: January 2018 – March 2020

RAILROAD IMPACT

- Reduction in the number of suicide casualties that occur on the railroad rights-of-way.
- 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.

U.S. Department of Transportation
Federal Railroad Administration

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

Short Line Safety Institute

PROJECT DESCRIPTION

- FRA is partnering with the SLSI to help short line and regional railroads enhance and improve safety practices and to increase their culture of commitment to safety.
- FRA worked with the SLSI to develop and test safety culture assessment tools and provide on-going program improvement.

PROJECT PARTNER(S)

- SLSI
- University of Connecticut (UConn)
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: FY18 –
  - $1.9 million grant to SLSI
  - $100,000 to Volpe

RAILROAD IMPACT

- The Short Line Safety Institute (SLSI) was formed to improve safety practices and safety training for Class II and Class III freight railroads to build a stronger, sustainable safety culture.
- The 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.

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Federal Railroad Administration

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

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