FRA Office of Research, Development and Technology

Current Projects

Research Sections

Section 1: Track

Section 2: Rolling Stock

Section 3: Train Control and Communications

Section 4: Human Factors

Section 1

Track Division

Low Solar Absorptivity Coating for Rails

Railroad Impact

- Based on FRA accident statistics, most of the T109 (rail sun kink / buckling) derailments occur near fixed structures (such as open deck bridges and switches), which indicates that rail neutral temperature may be decaying more rapidly near fixed structures.
- Lowering rail temperatures near these fixed structures could help reduce the number of track buckle derailments.

Project Description

- This project investigates the effectiveness of topical thermal control coatings in reducing the maximum daily rail temperatures and therefore reducing the risk of track buckles.
- Several (3 or 4) commercial coatings used in other industries will be tested on rail.
- A section of rail will be coated with each of the chosen commercial coatings, and rail temperature data will be collected over the course of a couple months.
- The effectiveness of the coatings will be determined by comparing the temperatures of the coated rail sections to the temperature of an uncoated rail section.

Project Partner(s)

- EWI

Cost & Schedule

- Project duration: 2013 – Present
- Approximate cost to date: $100k

FRA Project Manager

- Leith Al-Nazer, (202) 493-6128, leith.al-nazer@dot.gov

Support to the Office of Safety

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 Description

- Support FRA Office of Safety by providing specialized expertise, technical advice, instrumentation, testing and related Provide rapid response analysis and test support for high speed rail safety issues as they arise;
- Participate in 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;
- Evaluate qualification test plans, test results and waiver requests to assess safety of proposes operations and practices.

Project Partner(s)

- ENSCO Inc.

Cost & Schedule

- Feb 2016 – Feb 2017, $140K
  Evaluate qualification plans for higher speeds, assess national rail wear

FRA Project Manager

- Mahmood Fateh, (202) 493-6361, Mahmood.Fateh@dot.gov

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Support for Third Parties

Railroad Impact

- Provides support for real world testing otherwise limited to settings such as labs.
- Efforts focus on support for development of advanced technologies to enhance current track inspection technologies.
- Activities under this task critical for development of prototype rail inspection technology.

Project Description

- Task provides multiple university and third party-led research initiatives with testing services and equipment to support evaluation in “real world” settings.
- Current 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.

Project Partner(s)

- ENSCO Inc.

Cost & Schedule

- Feb 2016 – Feb 2017, $130K
  Evaluation of real-time rail temperature measurement;
  Ongoing testing by UCSD rail flaw detection in GY16.

FRA Project Manager

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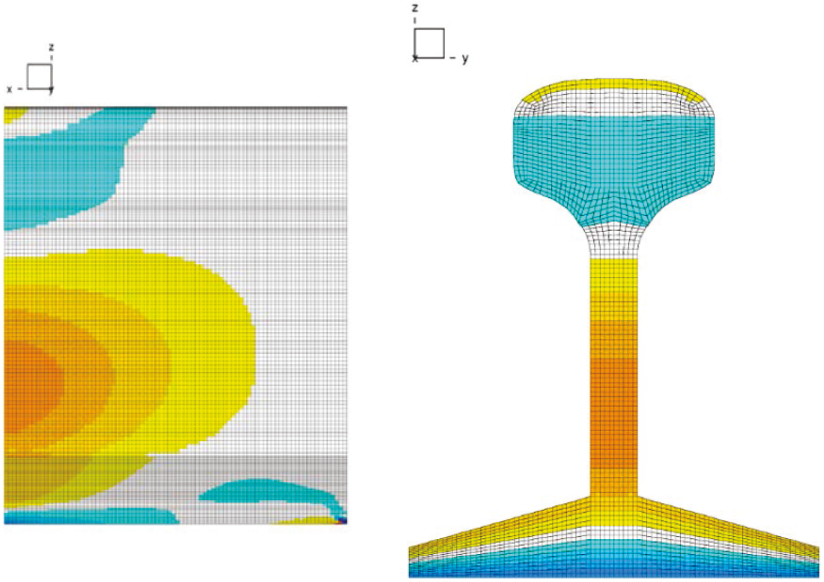
DEFECT GROWTH CHARACTERIZATION IN MODERN RAIL STEEL



Railroad Impact

- 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 Description

- **Task 1:** Influence of microstructural gradient on crack growth rate in head-hardened rail: hardness → microscopy → CT specimens from key locations → toughness and crack growth testing
- **Task 2:** Residual stress distribution → neutron diffraction / contour method
- **Task 3:** Influence of wheel-induced bending stress gradient on crack growth rate in head-hardened rail - variable amplitude loading
- **Task 4:** Data analysis and formulation of **The Framework** → testing best practices, crack growth rates, life evaluation, decision tree → safe and commercially viable inspection interval

Project Partner(s)

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

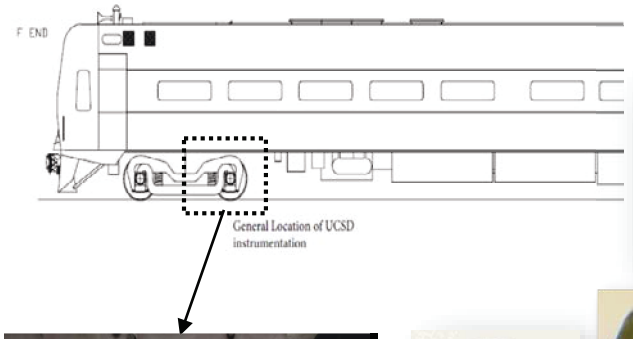
Cost & Schedule

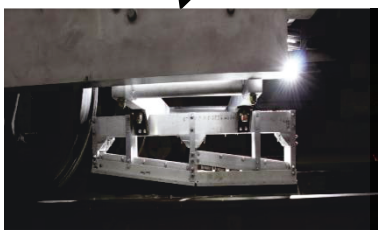
- $417,016 through 1/7/2018

FRA Project Manager

Robert Wilson, (617) 494-2265, robert.wilson@dot.gov

Non-contact Rail Inspection Prototype Improvements (passive-only system for high speed rail inspection)





Railroad Impact

- A non-contact system that can operate at regular train traffic speed can tremendously increase the frequency of inspections for a given track. Moreover, the lower frequencies used should allow to penetrate surface conditions hence improve the detection of internal defects under shelling. Finally, a statistical signal processing approach is needed to maximize the probability of true detections while minimizing false positives.

Project Description

- The new approach relies on the acoustic/ultrasonic excitation of the rail by the running train wheels through the natural rail/wheel contact. It then utilizes special signal processing algorithms and placement of a series of non-contact air-coupled sensors to extract a stable Transfer Function (or Green's Function) of the rail between two points.
- First-generation "passive-only" system mounted on FRA T-16 test car was tested at TTC in September 2016 at speeds as high as 80 mph. Preliminary results show the potential for successful extraction of a stable Transfer Function at both low and high speeds. The results also show the successful detection of 3 known joints in the test track, although some other anomaly indications remain to be verified.

Project Partner(s)

- University of California San Diego (grantee), ENSCO (test support), TTCI (test support)

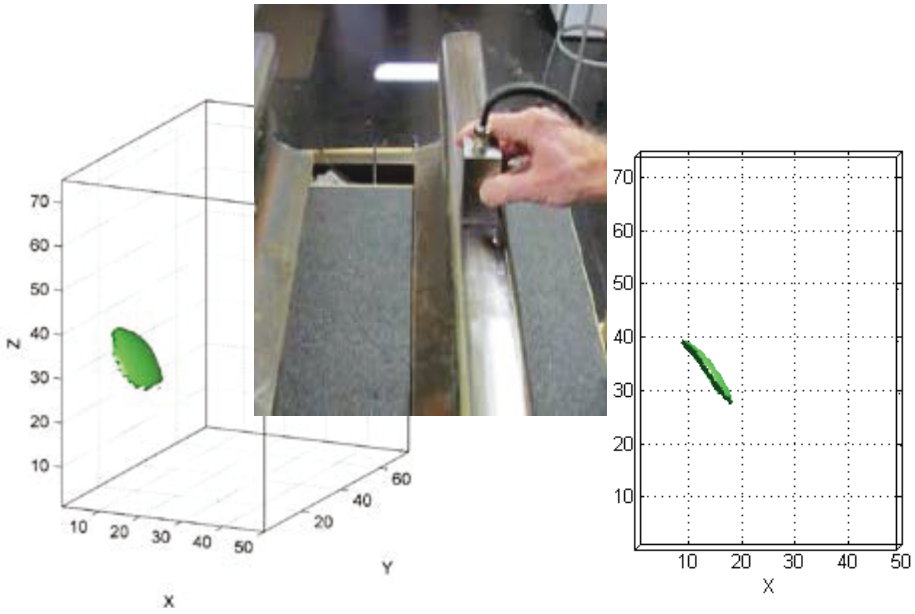
Cost & Schedule

- $286,361 - Current grant expires on 09/30/2017.

FRA Project Manager

- Robert Wilson, (617) 494-2265, robert.wilson@dot.gov

Rail Flaw Imaging - Ultrasonic Tomography



Railroad Impact

- More accurate rail flaw assessment - better internal flaw verification and sizing.

Project Description

Using a transducer array unit:

- Optimize test configurations and algorithms for rail flaw detection.
- Evaluate detector performance on known man-made and natural internal rail flaws including samples at the FRA Rail Defect Library managed by TTCI.
- Refine the prototype (hardware and software) based on the outcome of the experimental testing.

Project Partner(s)

- University of California, San Diego

Cost & Schedule

- Period of Performance: 09/01/2016 – 02/28/2018
- Amount: $149,024.00

FRA Project Manager

- Robert Wilson, (617) 494-2265, robert.wilson@dot.gov

Rail Integrity Research

Railroad Impact

- More robust repairs of railhead defects
- More comprehensive internal rail flaw library at TTCI for development and evaluation of internal rail flaw detection systems.
- Increased understanding of ultrasonic testing capabilities, limitations and opportunities for improvement taking into account flaw characteristics and rail conditions.

Project Description

Welding Repair of Railhead Defects (Tuskegee University)

- Patent No. US 20140166766 A1 - June 17, 2016
- A multi-pass gas metal arc weld ("GMAW") approach is used for in-situ repair of railhead defects

Expand the Internal Rail Flaw Matrix of Master Gauges at TTCI by 32 samples (TTCI)

- Manufacture 32 more internal defect samples at different angles, locations and under different surface conditions.

Ultrasonic Modeling/Simulation (TTCI)

Statistical analysis of commonly (10%) missed flaws in the revenue service. ♦ Generate CAD model to represent these missed flaws

♦ Conduct UT simulation in CIVA at various inspection scenarios

Project Partner(s)

- Tuskegee University, Nucor Steel Corporation, Lincoln Electric
- TTCI

Cost & Schedule

- Tuskegee University - FY 2016: ~$150k
- TTCI – FY 2016: ~$150k

FRA Project Manager

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Enhanced Acoustic Birefringence Method For Measuring Longitudinal Rail Stress

Railroad Impact

Prevent derailments from heat buckles & pull-aparts due to incorrect setting of Neutral Temperature

- Typically 20 to 50 heat buckle derailments per yr
- >$90M per year associated costs (Derailments, track repairs, and slow orders)

Non-destructive solution uses Acoustic Birefringence

- Absolute measurement of longitudinal rail stress
- No permanent rail or wayside installation
- Calculation of Neutral Temperature to ± 5 ^{o}F
- Less than 5 minutes per test

Project Description

This project will apply proprietary Variable Polarization Shear Wave technology to the task of measuring rail stress so that Neutral Temperature can be calculated.

- Advanced Acoustic Birefringence using Steered Polarization demonstrated in NSF SBIR R&D ± 200 kips rail test fixture will be designed & built to simulate thermally-induced rail stress
- Testing performed on representative range of rail sizes and head wear conditions
- Signal processing methods to eliminate errors due to residual stress and texture

Project Partner(s)

- Analogic Engineering, Inc.
- University of Wyoming, College of Engineering and Applied Science

Cost & Schedule

- $134,510 through 3/20/2016

FRA Project Manager

- Robert Wilson, (617) 494-2265, robert.wilson@dot.gov

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Rail Force Management Research

Railroad Impact

- Provide industry with a tool to issue heat slow orders and inspections in a more effective and targeted way
- Characterization of RNT in revenue service track
- Characterization of rail force at the time of weld failure under “real world” conditions.
- Evaluation of new methods to monitor curve movement.
- Understand how rail neutral temperature behaves over long periods of time next to fixed structures in revenue service track.

Project Description

Rail Temperature Prediction (ENSCO)

- Extend prediction up to 36 hours in advance
- Support implementation with industry partners

Rail Force Management Research (TTCI)

- Analysis of Available RNT Data: review of industry data on RNT monitoring to determine relevant track factors in RNT changes.
- Rail/Weld Breaks and RNT: Determination of rail longitudinal stresses when welds fail.
- Automated Monitoring of Curve Breathing and Rail Creep: evaluation of methods to monitor curve movement.

Rail Neutral Temperature Decay (QinetiQ)

- Measure rail neutral temperature over long periods of time next to fixed structures in revenue service track.

Project Partner(s)

- ENSCO, Inc.
- CXT, BNSF, Amtrak, MBTA
- QinetiQ

Cost & Schedule

- Rail Temperature Prediction (ENSCO) thru Sep 2017, $306K
- Rail Force Management (TTCI) thru Nov 2017, ~215K
- RNT Decay (QinetiQ NA) thru Sept 2016, ~381K

FRA Project Manager

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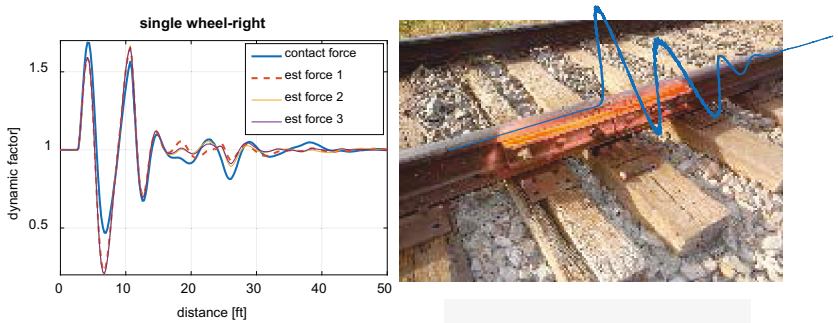
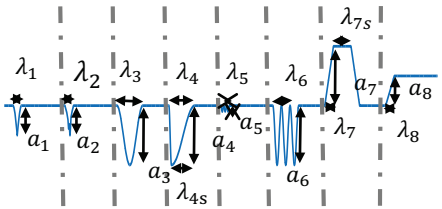
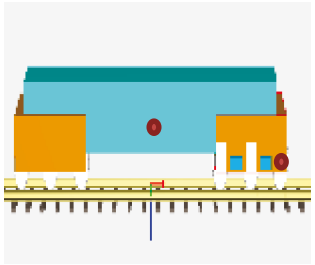
Feasibility of Track Energy Metric







Railroad Impact

- Provide new track characterization metric that accounts for both defects wavelength dependency and train–track interaction forces to identify track damage and locations at risk for track failure and future derailments.
- Capturing information from a broader wavelength range when compared to traditional Track Quality Indices - alternative to traditional classification methods as TQI, roughness, or RMS values.

Project Description

- Develop an initial formulation for track energy metric (TEM) in vertical direction and evaluate its effectiveness to predict track degradation based on modeling.
- Determine if the approach effectively captures energy transferred into track.
- Determine optimal segment lengths and wavelength limits for track characterization
- Investigate speed normalization approaches

Project Partner(s)

- ENSCO, Inc.

Cost & Schedule

- Jun 2016 – June 2017, $99K

FRA Project Manager

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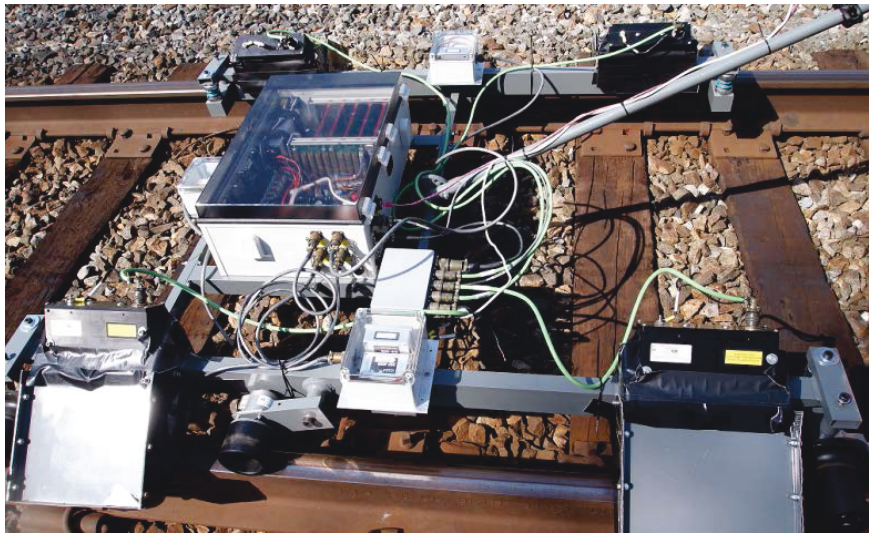
Portable Track Geometry Measurement System



Railroad Impact

- Current portable geometry measurement systems cannot provide MCO information at chord lengths applicable to high speed operations.
- Resulting technology will advance state-of-the-art of portable geometry measurement platforms to facilitate assessment of maintenance/construction activities and improve ability to simulate vehicle movements through special track work for general research and derailment investigations.
- End user product cost estimated to be $110K.

Project Description

- Under this project, a new Portable Track Geometry Measurement System (PTGMS) will be refined, and tested.
- Additional testing will be conducted to assess the accuracy of the system in sharp curves as well as over special track features.
- Space curve estimation research to be conducted in order to provide data that can be used in modeling applications.

Project Partner(s)

- ENSCO, Inc.

Cost & Schedule

- **FY 14-16** – **$148 K** Space curve estimation and additional testing - Total Duration – 14 Months **FY 15-16** – **$41 K** Upgrade hardware to SPU and TMU configuration - Additional Duration – 10 Months

FRA Project Manager

- Robert Wilson, (617) 494-2265, robert.wilson@dot.gov

Assessment of Rail Seat Abrasion Patterns & Environment

Railroad Impact

- Better understanding of rail seat load environment
- Better understanding of rail seat deterioration mechanisms
- Identification track geometry conditions that increase stresses at the rail seat and may exacerbate RSD

Project Description

- Explore the effect of track geometry on the load environment at the rail seat of concrete ties
- Vehicle-track modeling simulations to lead to:
- Installation of specific perturbations in-track and measurement of track and vehicle response

Project Partner(s)

- TTCI

Cost & Schedule

- 2012-2014 – NUCARS Vehicle-track simulations completed 2015 – Installation of four track geometry perturbations and in- track testing under dynamic loading
- Fall 2015 – Reporting
- Awarded: $413,000

FRA Project Manager

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Concrete Tie Railseat Deterioration Detection

Railroad Impact

- Rail Seat Deterioration (RSD) affecting concrete ties has occurred in track. It has compromised tie integrity and has contributed to derailments
- Better understanding of the performance track inspection technologies should improve detection capability Results: Earlier detection and remediation

Project Description

- This is a two-phase project. Lab tests evaluated the effects of various magnitudes of rail seat deterioration (RSD). Five in-track test zones have been installed at the Transportation Technology Center (TTC) to evaluate the ability of inspection systems to detect concrete tie rail seat deterioration. Four test zones are exposed to minimal traffic, while the fifth zone is located on the High Tonnage Loop (HTL) at FAST

Project Partner(s)

- TTCI, FRA, Volpe National Transportation Systems Center, various vendors

Cost & Schedule

- 2012 Tie selection and installation at FAST
- 2013 Tie preparation and installation on facility track, lab testing
- 2014 Lab testing and report, initial in-track tie characterization (T-18, railroad geometry car, TrackStar)
- 2015 Tie modifications and additional in-track tie characterization (T-18, TLV, Pavemetrics, NxGen Rail)
- 2016 Final report
- Current funding $235K, Estimated total cost $300K

FRA Project Manager

- Hugh Thompson , (202) 493-6383, hugh.thompson@dot.gov

Ground Penetrating Radar (GPR) Technology Evaluation and Implementation

Railroad Impact

- GPR will be utilized to advance research in track support and track substructure investigations, particularly at revenue service locations that have been jointly identified by FRA and industry as problem areas of concern.
- GPR on an FRA platform will allow for correlation and better alignment between existing measurement systems such as track geometry, vertical track deflection, gage restraint measurement and GPR, so as to assist in determining main root causes of track geometry defects and degradation over time and give an indication of the performance and lives of other track components such as rails and ties.
- GPR testing assists in proactive planning of maintenance activities before substructure and support problems become more visible and severe. As such, performance and safety of the track substructure become more predictable and reliable.

Project Description

- Develop recommendations and improved guidelines for use of GPR in North America based track substructure parameters. GPR system procurement for FRA research vehicle.
- Conduct evaluation tests of data collected in revenue service, including Ballast layer thickness, Ballast layer fouling, Ballast layer moisture content, and Subgrade analysis.
- Provide an assessment of the track substructure degradation conditions identified by GPR at the revenue service locations. Evaluate the relationship between the GPR based substructure
- parameters and the track condition in terms of stiffness and track geometry.
- Project end date: Mid FY2017.

Project Partner(s)

- TTCI

Cost & Schedule

- FY 2014 funding $375k, http://www.fra.dot.gov/eLib/details/L05318#p1_z50_gD_lRS

FRA Project Manager

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Concrete Tie Rail Seat Deterioration (RSD) Mechanisms

Railroad Impact

- RSD has been identified as a cause in several recent high profile derailments.
- RSD is difficult to detect when in early stages, leaving little opportunity for repair before failure.
- Detection of RSD in its early stages will allow time for remediation and prevent derailments.
- Current methods utilize visual inspection (slow) and cant measurements (cant not unique to RSD).

Project Description

- Rail seat deterioration remains a risk to track operations that is a challenge to inspect for visually.
- The root cause of RSD has still not been demonstrated, although analysis of RSD through literature review, field evaluation, and modeling continues.
- Inspection techniques targeting this problem are critical because the problem will not likely be eliminated until the the cause is known
- Inspection technology builds on existing FRA R&D capabilities Builds on initial survey of RSD detection methods by AAR in 2008
- showing wide range of measured rail cant from different inspection methods.
- With the cooperation of AAR and member railroads the basic measurement of rail cant will be improved to develop correlation of actual cant to measured.
  - Measure actual RSA and resulting cant.
  - Determine acceptable cant limits.

Project Partner(s)

- TTCI

Cost & Schedule

- FY 2014/2015 funding $250k

FRA Project Manager

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Portable Track Loading Fixture (PTLF)

Project Description

- Gage Widening defects are a leading derailment cause The project goal is:
  - To improve detection and verification of tie-fastener defects
  - Provide inspectors with an unbiased and reliable tie,
  - Fastener, and gage widening assessment tool
- A modification of the PTLF design will result in two prototype PTLFs for field validation testing.
- Improvements to the PTLF include improved consistency of the PTLF measurement and improved correlation to GRMS.
- In the future, PTLF standards will be evaluated and issues addressed to improve acceptance in the industry.

Railroad Impact

- Improve inspection of track gage widening conditions Provide more reliable validation of GRMS identified defects An digital PTLF that uses the return load-deflection
- characteristics will:
  - Improve gage widening detection capability
  - Improve repeatability by four (4) times that of the current PTLF
- Improved detection and reliability will lead to greater acceptance in the industry of the PTLF as a gage widening assessment tool. Ease of measurement would result in more widespread use by
- Industry.

Project Partner(s)

- ENSCO

Cost & Schedule

- FY 2013 funding $200k (through 2/2015)
- http://www.fra.dot.gov/eLib/details/L04119#p1_z50_gD_IRS

FRA Project Manager

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Assessment and Analysis of Track Measurements Systems

Railroad Impact

- Changing environmental conditions and rail service trends require rapid, reliable, and actionable track condition data to identify emerging risks.
- This track structural assessment technology could provide actionable results for further inspection or repair
- Research in this task has allowed for the possible application of performance based track strength evaluation.
- Methods accessed through this task are targeting the identification of rail seat deterioration for concrete ties to minimize the risk of rail rollover derailments.
- Approaches for the overall assessment of track developed through this
- task will directly bear on the evaluation of track rehabilitation projects.

Project Description

- Evaluate gage widening due to rail roll and seat translation including:
  - Load regime required to exercise the roll and translation modes
  - Identify locations exhibiting signs of rail seat deterioration on concrete ties,
- Support the development of class-based GRMS standards, especially for higher track classes.
- Improving the state of the art of GRMS technology. Demonstrate the safety benefits of track strength assessment to corridor condition assessment and rehabilitation efforts.
- Development of correlations between multiple track assessment technologies, such GRMS, TGMS, GPR, and vertical track deflection.

Project Partner(s)

- ENSCO

Cost & Schedule

- FY2015 funding $150k

FRA Project Manager

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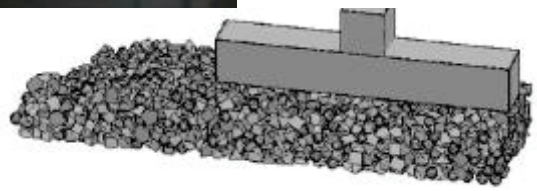
Ballast Inspection and Performance Characteristics



Project Description

- Support the development and validate the results from ballast related inspection technology including ground penetrating radar, track deflection, and track moisture assessment
- Develop track support and ballast information for simulations of track buckling / shift, tie / rail performance, and degradation Support, validate, and extend analytical techniques for ballast
- safety and mechanical performance
- Support development of failure criteria for ballast

Project Partner(s)

- Universities of Illinois, Nebraska, and Massachusetts Zetica/Balfour Beatty, Hyground Engineering, TTCI

Cost & Schedule

- $125k
- Ballast Discrete Element Model Assessment: May 2015 Paper on Ballast Performance Limits and Failure: May 2015 Deflection / GPR Deployment Recommendations: March 2015
- Review of TTCI GPR Assessment Results: Feb. 2015 Review of ballast moisture detection: Feb. 2015 Paper on tie deflection with UIUC: Jan. 2015

FRA Project Manager

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Railroad Impact

Adequate ballast performance is required to ensure the safety, longevity and economical performance of all track components Inadequate ballast performance reduces the economic benefits of rail transport and results in degradation that can affect safety Ballast maintenance is required to alleviate track geometry

problems and ensure adequate track support needed to realize the benefits of premium track structures like concrete ties

Improved detection of ballast condition and performance problem areas will result in safety and economic benefits resulting from improved problem detection, targeted maintenance, and quantifiable quality control criteria

Subgrade Inspection and Performance

Railroad Impact

- Adequate subgrade performance is required to ensure the overall stability and safety of the track structure
- Inadequate subgrade performance can result in particularly problematic failures that are slow to repair
- Few economical maintenance options exist for subgrade repair
- Guidelines for subgrade and embankment performance
- following inundating rainfall events may reduce the likelihood of washouts
- Detection of subgrade conditions and performance problem areas is critical to correct identification of the problem cause and development of targeted remedies

Project Description

- Support the development and validate the results from subgrade related inspection technology including spectral analysis of surface waves and combined GPR/deflection data
- Develop track support related subgrade information for simulations of tie / rail performance and track degradation
- Support development of failure criteria for subgrade including lower bound properties for operations

Project Partner(s)

- Universities of Illinois/Texas El Paso and Massachusetts

Cost & Schedule

- Budget $60k
- Transition Model Subgrade Deformation Analysis: March 2015
- Review of subgrade inspection techniques including SASW Subgrade Deployment Recommendations: July 2015
- Recommendations for combined GPR/deflection data for subgrade stability assessment: Feb. 2015

FRA Project Manager

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Track Gauge Widening and Strength Measurements

Project Description

- Help expand the Gauge Restraint Measurement System's (GRMS) failure mode detection capability, mainly to include the detection of rail seat deterioration (RSD)
- Support the extension of GRMS limits to different track structures and vehicle conditions
- Support the design and engineering of a new Portable Track Loading Fixture (PTLF)

Railroad Impact

- New loading strategy with PTLF will be evaluated for compatibility with the track strength limits set in the FRA track safety standard
- GRMS and PTLF will be tested for their capability to detect RSD failure in addition to gauge widening failure
- GRMS limits established for timber tie tracks will be evaluated for applicability in concrete tie, plastic tie, steel tie and slab tracks and in heavy haul and high speed operations

Project Partner(s)

- Volpe Center
- Ensco

Cost & Schedule

- $60k for 12 months

FRA Project Manager

- Hugh Thompson, (202) 493-6383, hugh.thompson@dot.gov

Radar Ballast Inspection Tool (RABIT)

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 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)

Project Partner(s)

- BNSF Railroad
- U. Massachusetts

Cost & Schedule

- FY16 Funding: $200k | Estimated Total Cost: $277k
- ASTM Paper: Mar. 2017
- RABIT Prototype Built: Mar. 2017
- Ballast Finite/Discrete Element Model: May 2017
- Test Track Built / Radar Data Collected: May 2017
- Data Analysis and Software Updates: Jun.2017
- Live Track Tests: Jul. 2017
- Final Report: Aug. 2017

FRA Project Manager

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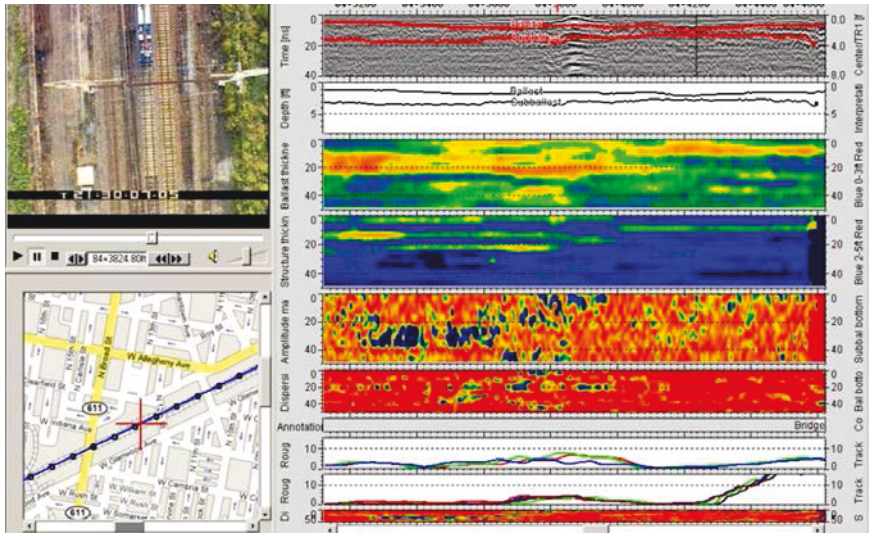
Relationship Between Track Geometry Defects and Measured Track Subsurface Conditions



Railroad Impact

- Track Geometry Cars are being equipped with additional inspection technologies to supplement the basic track geometry measurements.
- The ability to use these substructure inspection tools to identify potential rail defect initiation/development sites would be a valuable tool for railroads.
  - Provide additional information on where high risk track geometry could develop.
- Result in improved efficiency of track maintenance
  - Lower cost of maintenance

Project Description

- Develop engineering and/or statistical relationships between track substructure inspection parameters and track geometry defects
- Inspection technologies to include the different inspection technologies being developed by FRA and implemented on T-18 and/or railroad track geometry car.
- Provide for identification of track locations with potential for rail failure or development of track geometry defects that will grow to unsafe levels.
- Develop analysis algorithm(s) to correlate multiple inspection parameters, with track geometry defects

Project Partner(s)

- University of Delaware (Railroad Engineering and Safety Program)
- BNSF

Cost & Schedule

- 24 month schedule to include data collection and preparation, development of engineering relationships, statistical analysis, development of analysis algorithms
- Overall cost of $289,842.
- Partner participation for data collection and analysis (labor).

FRA Project Manager

- Hugh Thompson, (202) 493-6383 , hugh.thompson@dot.gov

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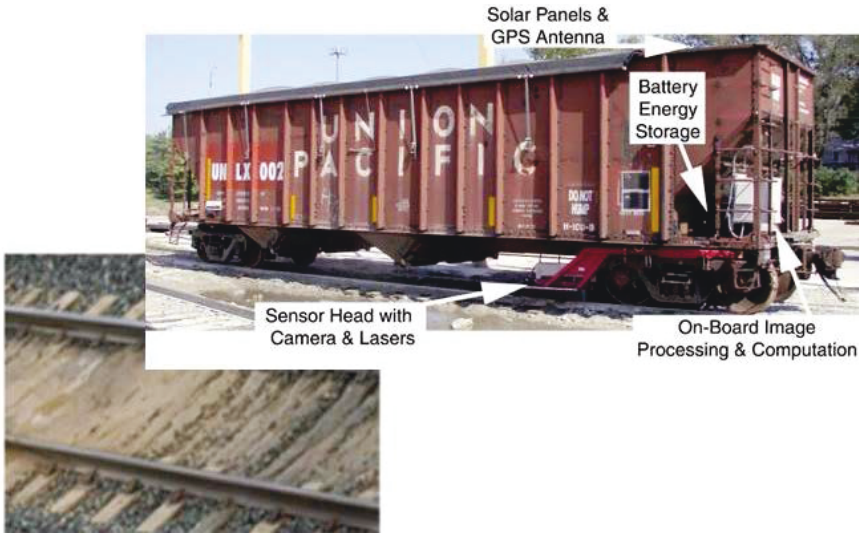
Categorizing Track Mud Spot Risk by Measurement of Vertical Track Deflection



Railroad Impact

- Mud spots currently evaluated qualitatively
- Vertical track deflection data offers a mechanism to quantify and monitor mud spots
- Identification of degradation, extent, and magnitude of mud spots can quantify risk
- Increased safety and improved maintenance philosophies with signification economic impact

Project Description

- Collect extended track deflection data for a defined mud spot territory for 9 months
- Collect additional railway operational and maintenance data
- Analyze mud spot data to develop quantitative risk guidelines
- Extended application of framework
- Extension to real time reporting and maintenance planning

Project Partner(s)

- Harsco Rail

Cost & Schedule

- 19 month schedule to include data collection and preparation, model development, and application of analytic framework
- Overall cost of $197,824
- Railway participation for data collection
  - CSX

FRA Project Manager

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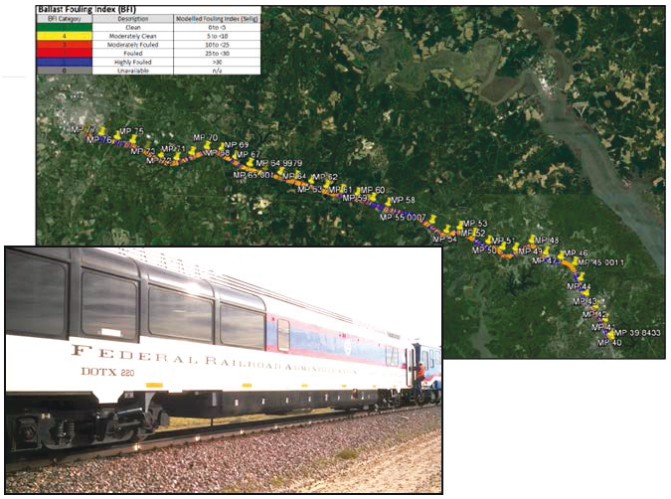
Federal Railroad Administration

Ground Penetrating Radar (GPR) on FRA Research Car



Railroad Impact

- FRA test car mounted GPR system for mobile track substructure testing
- FRA will work with GPR service providers to improve the capabilities and reliability of their track substructure condition assessments
- Identify potential problem areas in track to improve safety

Project Description

- 4 GPR Implemented to T220 Car
  - (3) 2-Ghz antennas – shoulders and center crib
    - Ballast degradation
    - Thickness of ballast layer
    - Wet areas and mud spots within the ballast
  - (1) 400 Mhz antenna – center crib area
    - Deep ballast pockets
    - Wet areas in sub-ballast and subgrade
- Initial testing completed
  - Eastern US: 30 mile test run
  - Calibration runs at TTC's FAST loop

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)
- Ensco; Zetica/Balfour Beatty Rail

Cost & Schedule

- $584,000, 2015-2016
- One more 30 mile data gathering event in 2017
- Report to the FRA in 2017

FRA Project Manager

- Hugh Thompson, (202) 493-6383 , hugh.thompson@dot.gov

Operations and Maintenance Support for DOTX 216 and DOTX 218

Railroad Impact

- DOTX 216/DOTX 218 are used as research platforms to develop, improve, and demonstrate track inspection technologies.
- FRA's fleet provides data for track related studies in the areas of high speed passenger operations track evaluations.
- DOTX 216/DOTX 218 also used by the Office of Safety to assist in the Automated Track Inspection Program.

Project Description

- DOTX 216 has supported various high speed rail initiatives by providing data and serving as an instrumentation platform.
- DOTX 218 is used to conduct research to address deficiencies in GRMS parameters of the Federal Track Safety Standards.
- Both cars have performed geometry testing to support the FRA Office of Safety, FRA field offices and railroad partners.

Project Partner(s)

- ENSCO Inc

Cost & Schedule

- Feb 2016 – Feb 2017 – $505K
- DOTX 216 TGMS Evaluation Testing
- DOTX 218 TTC Testing, GPR Evaluations, Heavy Axle Load Testing

FRA Project Manager

- Hugh Thompson, (202) 493-6383 , hugh.thompson@dot.gov

Portable Track Loading Fixture Redesign

Railroad Impact

- Introduce a redesigned PTLF with four times the repeatability of the current PTLF for use by the industry
- Increase greater acceptance in the industry for the PTLF as a more consistent and repetitive tool
- Improve ease of measurement for PTLF use

Project Description

- Develop improved PTLF hardware and new tablet-based software to improve functionality and ease-of-use as compared to traditional units;
- Support field testing and evaluation of new PTLF units;
- Present PTLF features and results of testing through various means including instructional video to promote greater acceptance in the industry.

Project Partner(s)

- ENSCO Inc

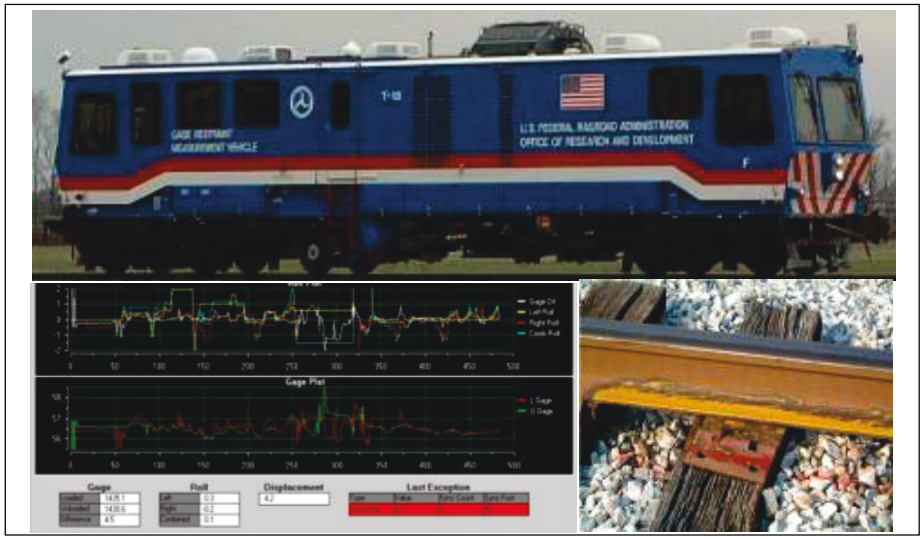
Cost & Schedule

- Aug 2013 – Dec 2016, $243K
- Product improvement, field testing and development of instructional material.

FRA Project Manager

- Hugh Thompson, (202) 493-6383 , hugh.thompson@dot.gov

Track Strength and Innovative Inspection Technologies



Railroad Impact

- Improve understanding of track behavior on concrete ties under load and offer methods for detecting weak restraint using GRMS.
- Assess method 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 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.

Project Partner(s)

- ENSCO Inc

Cost & Schedule

- May 2015 – May 2017, $282K
- Evaluation of GRMS Thresholds; Analysis of Vertical Track Deflection Measurements

FRA Project Manager

- Hugh Thompson, (202) 493-6383 , hugh.thompson@dot.gov

Ballast Waiver Study Data Collection

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 Description

- Better define reduced performance of fouled ballast related to enforcement of §213.103 of FRA Track Safety Standards.
- Collect pertinent information using track geometry measurements, long-term wayside instrumentation, GPR, and other available sources.

Project Partner(s)

- ENSCO
- AAR, BNSF, UIUC

Cost & Schedule

- Jun 2015 – Feb 2017, $888K
- Long-term test planning; test site identification; instrumentation implementation

FRA Project Manager

- Hugh Thompson, (202) 493-6383 , hugh.thompson@dot.gov

Monitoring pier stability to detect the onset of scour and the influence of undermining

Railroad Impact

- Scour is the leading cause for bridge failure.
- Detecting the onset of scour has proven to be a difficult undertaking; in part because the condition can develop very quickly, and because the period when scour is developing is the most difficult time to conduct an in-water inspection.
- A scour inspection method that allows bridge owners to continuously monitor and identify an impaired pier before a train traverses a bridge.
- An inspection methodology with the ability to detect other dangerous substructure conditions such as damage caused by earthquakes, vehicle collisions, vessel impacts, adjacent construction and acts of terrorism.

Project Description

- Use a new hybrid accelerometer/tiltmeter/temperature sensor to monitor pier stability and detect undermining before it influences bridge geometry.
- Monitor 6 railroad bridges and field test a new method for scour monitoring and scour warning based on sensing bridge pier stability.
- Analyze and correlate bridge performance data with inspection reports, traffic analysis and streambed conditions, in order to assess the real-world performance of the scour detection methodology.
- Produce a technology assessment report for the FRA and deliver a presentation to AREMA.

Project Partner(s)

- SENSR Monitoring Technologies

Cost & Schedule

- FY 2013 funding $399K (POP: Feb 2013 thru Apr 2017)

FRA Project Manager

- Hugh Thompson, (202) 493-6383 , hugh.thompson@dot.gov

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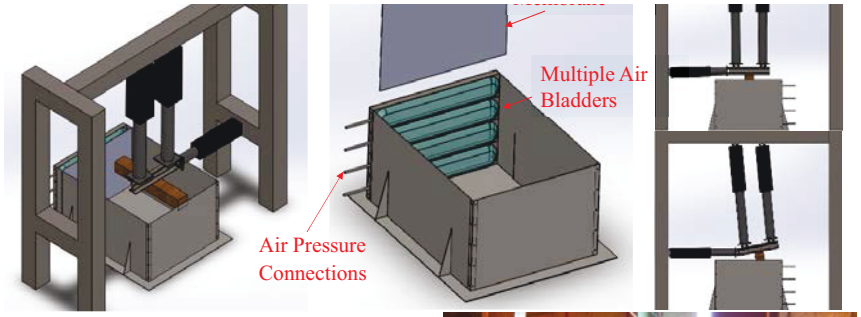
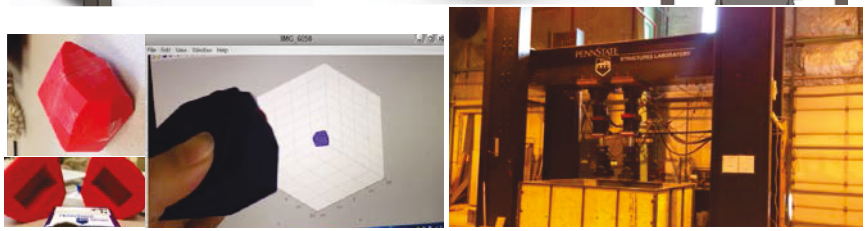
Laboratory and Field Evaluation of Ballast Failure Mechanisms Using “SmartRocks”





Railroad Impact

- A more comprehensive understanding of the different ballast failure modes and the mechanisms of each mode is essential in properly predicting track ballast performance and accurately assessing track safety.
- The expected findings of the proposed research will enable a more accurate means of determining the way that ballast becomes fouled and how the fouled track/ballast system will fail.
- Better assessment of performance and safety will result in more accurate means to make decisions about track maintenance, track usage, and allowable speeds.
- Ultimately, this should result in economic savings and safer operation recommendations.

Project Description

- The objective of this research is to demonstrate ballast failure and to understand the mechanisms behind the failure mode, by using the latest ballast box testing system and the most advanced ballast instrumentation technologies.
- The success of this research will provide information for use in developing inspection criteria and measurement systems to detect potential ballast failure in operational track.
- This study will also provide information for targeting effective remedial measures that reduce the risk of failure.

Project Partner(s)

- UMass,
- HyGround Engineering
- Norfolk Southern (NS)

Cost & Schedule

- Phase 1 is scheduled for 8 months with $100K FRA BAA funding.
- Granted in-kind support from:
  - -Larson Transportation Institute-graduate student tuition waiver
  - -Altoona Pipe and Steel-manufacturing the ballast box
  - -NS-field support

FRA Project Manager

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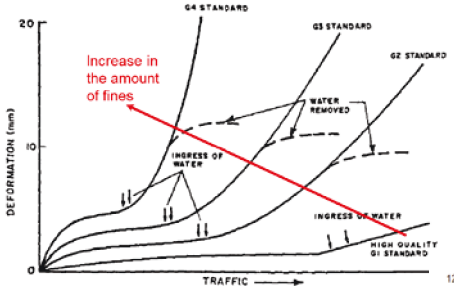
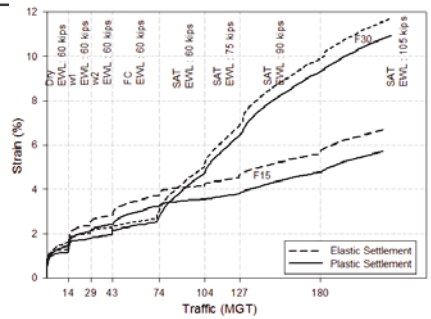
Laboratory Study of the Failure Characteristics of Fouled Ballast: Phase II





Railroad Impact

- A gained insight into the behavior of the types of fouled ballast under conditions that might be found in the field.
- The results should show the importance of particle shape, fouling material, fouling content and moisture content on the material behavior of the fouled ballast.
- This will lead to a better understanding of expected performance of track underlain with fouled ballast and the immanency of the need to repair/service identified sections of track with different fouling characteristics.

Project Description

- Conduct box tests on two samples of revenue track fouled ballast from the New England region. The purpose for this is that the ballast and the fouling material will be more representative of the particle roundness, grain size distribution and mineralogy that would be expected under actual track conditions.
- In addition, 10 in diameter triaxial compression tests will be conducted on the ballast to determine the strength and deformation properties of the ballast under the different fouling and moisture contents tested in the box test. This will provide a better understanding of the influence of moisture and fouling on track ballast performance.

Project Partner(s)

- Carlton Ho, University of Mass (Lead),
- Jim Hyslip, HyGround Engineering,
- Railroads (contacted and willing to contribute, to be identified when proper ballast is identified)

Cost & Schedule

- The project is planned for one calendar year.
- The estimated total cost is $132,999 for 12 months.
- Estimated contributions of $30,000 from Railroads in providing fouled ballast and access to the track..

FRA Project Manager

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Field Demonstration of Geocell Track Substructure Support System Under High Speed Passenger Railroad Operation

Railroad Impact

- Quantify the cost benefit of installation of geocell materials
- Determine reduction in maintenance cycle leading to cost savings
- Quantify the ability of geocells to reduce subgrade stresses and extend surfacing cycles
- Quantify the reduction in TQI degradation rate under geocell reinforced track

Project Description

- Demonstrate the effectiveness of a new generation of three-dimensional cellular confinement systems (geocell) in reducing track geometry degradation
- Monitor and quantify the condition of a stretch of high speed track (compared to its surroundings) which was renewed to include a subgrade stabilizing geocell material
  - Monitoring will include:
    - Subgrade interface pressure
    - Track geometry

Project Partner(s)

- Harsco Rail
- University of Delaware,
- Columbia University

Cost & Schedule

- 96 week schedule to include: site planning and renewal, historical data collection, site monitoring, data analysis, and reporting
- Overall cost of $182,591

FRA Project Manager

- Hugh B. Thompson .(202) 493-6383, hugh.thompson@dot.gov

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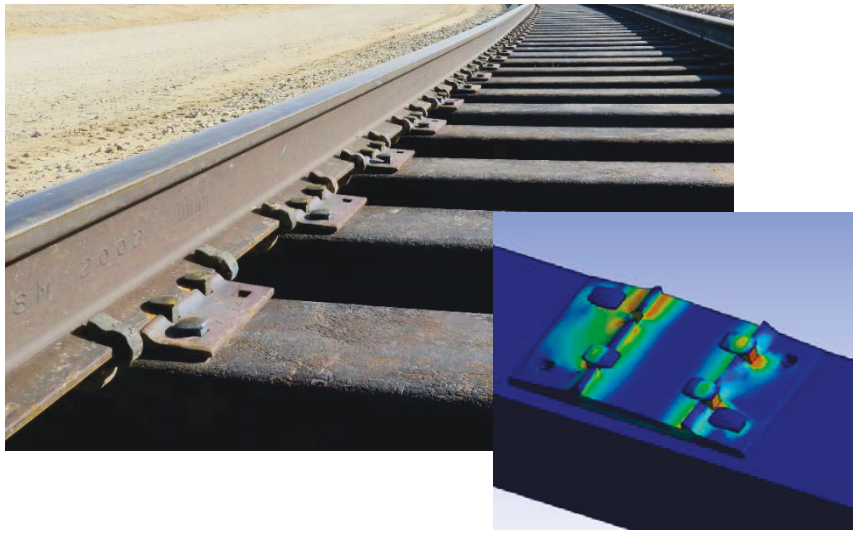
Federal Railroad Administration

Improved Composite Tie Performance



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 Description

- Developing and enhancing design, testing and performance guidelines for 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

Project Partner(s)

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

Cost & Schedule

- FRA Funding: $250,000
- Period of Performance through March 2018

FRA Project Manager

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

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Federal Railroad Administration

Heavy Axle Load (HAL) Revenue Service Testing

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
- Safer and more and reliable infrastructure for heavy-haul freight transportation

Project Description

- HAL revenue service testing provides an opportunity to evaluate HAL track infrastructure subjected to a range of track, operational, & climatic conditions under which to evaluate performance:
  - New & alternative track component designs & materials
  - Improved track maintenance procedures
  - Premium rail performance & strategies to prevent RCF
  - Special application of alternative crosstie designs
  - Improved welding strategies & performance monitoring
  - Special track work including frogs and joints
  - Bridge approach remedies
  - Track substructure

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)
- Collaborative effort with Association of American Railroads (AAR)

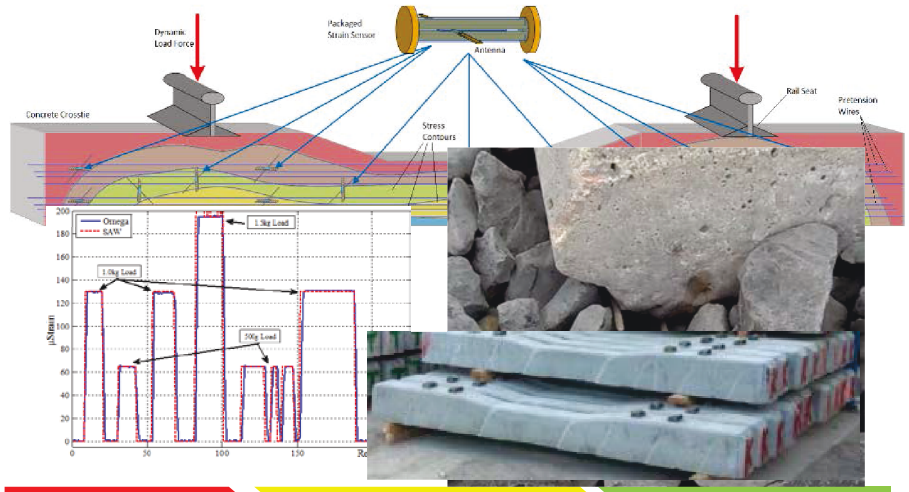
Cost & Schedule

- Project Ongoing: 2005 - Present
- Total FRA Funding: $1,180,215

FRA Project Manager

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

Concrete Tie Research



Quantify → **Analyze** → **Modify**

Railroad Impact

- Basic and applied research to establish sound design, construction and testing practices
- Advance the state of science in the area of concrete ties
- 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 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
- Create new technologies to asses the internal stress state of concrete ties

Project Partner(s)

- Universities – U Illinois, Kansas State, U South Carolina
- Mnemonics, Inc.
- Class I railroads (all), Rocla, CXT

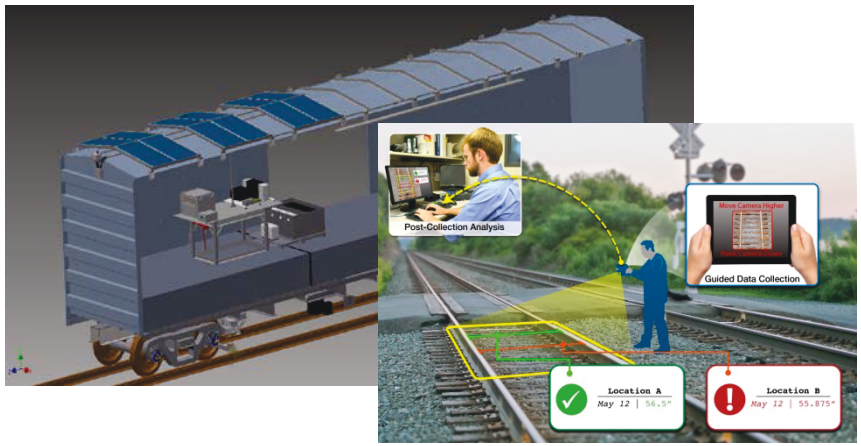
Cost & Schedule

- Universities – multiple 3 years projects ~$2.2M
- Mnemonics – 2 years ~$350k

FRA Project Manager

- Cameron Stuart, (202) 493-6384, cameron.stuart@dot.gov

Autonomous Inspection Technologies



Project Description

- Autonomous Track Geometry Measurement System (ATGMS)
  - 5 Stage development plan to develop and demonstrate
  - 2016 – Stage 5: Freight Service demonstration using DOTX225 boxcar platform
  - 25 shortlines, 4 Class 1, ~9000 miles
- Video-based 3D Automated Rail Inspection
  - Handheld 3D video record to collect track images
  - Advanced algorithms to measure track geometry parameters

Railroad Impact

- Low cost, efficient track geometry data to ensure track safety
- Automated inspection reduces errors , improves quality and increases productivity
- Systems adapt COTS technologies for railroad-specific applications

Project Partner(s)

- ENSCO, Inc.
- SRI International
- ASLRRA and member RRs, NS, BNSF, CSX, UP

Cost & Schedule

- ATGMS - FY 2016: ~$250k
- SRI FY 2016: ~$300k

FRA Project Manager

- Cameron Stuart, (202) 493-6384, cameron.stuart@dot.gov

Rail Repair and Protection Technologies

Railroad Impact

- Create improved processes and tools for repairing rail frogs.
- Extend service life over current methods and reduce time on track
- Research coating technologies to identify a method to protect rail from corrosion.
- Eliminate corrosion-induced rail breaks in tunnels and other areas where moisture and/or salt is present on track.
- Develop a portable, accurate method to count wheel passes over rail and to estimate wheel loads.

Project Description

- Automated Manganese Frog Repair and Revenue Service Testing - Phase 2
  - Phase 2 project includes field testing of repaired frog.
  - Development of metal cored electrode to reduce weld slag and eliminate inter-pass cleaning
  - Develop conceptual framework for field-deployable automated repair system
- Rail Base Corrosion Investigation - Phase 2
  - Field trail of corrosion protection coating on New York area railroads
- Wheel Load Cycle Tag – Phase 2
  - Develop field prototype and conduct testing

Project Partner(s)

- Edison Welding Institute
- Navmar Applied Sciences Corporation
- CSX, SEPTA, LIRR, PATH, NS, Amtrak

Cost & Schedule

- Frog Repair Phase 2– 3 years, $300k
- Rail Base Corrosion Phase 2 – 3 years, $150k
- Wheel Load Cycle Tag Phase 2 – 1 year, $150k

FRA Project Manager

- Cameron Stuart, (202) 493-6384, cameron.stuart@dot.gov

Unmanned Aerial Systems Research

Railroad Impact

- Facilitate railroad – related UAS research through support fof the DOT Transportation Technology Center (TTC)
- Coordinate activities with Federal Aviation Administration
- Ensure that TTCI is ready and able to conduct UAS research for the industry.

Project Description

- Establish communication link and coordination with FAA UAS office
- Create CONOPS and other documents necessary to establish safe and efficient UAS research operations at TTC.

Project Partner(s)

- ENSCO, Inc.
- TTCI
- FAA

Cost & Schedule

- ENSCO – 1 year ~$50k
- TTCI - 1 year ~$100k

FRA Project Manager

- Cameron Stuart, (202) 493-6384, cameron.stuart@dot.gov

US – China Railway Technology Exchange

Railroad Impact

- Enable technical exchanges especially on high speed rail infrastructure and equipment inspection and maintenance.
- Enhance FRA presence at the US-China Transportation Forum
  - An effort led by US DOT.

Project Description

- Facilitate communication with Chinese counterparts in organizing and participating the annual Transportation Forum to be held in US and in China
- Facilitate technical exchanges with China in the areas of track inspection and maintenance standards, track structure for high- speed rail (HSR), use of risk analysis for safety assurance, transportation capacity simulation for HSR networks, vehicle qualification.
- Organize rail technology and standards exchange meetings and technical visits.

Project Partner(s)

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

Cost & Schedule

- $100K 2012 - 2015

FRA Project Manager

- Luis Maal, (719) 493-6362, luis.maal@dot.gov

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

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 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.

Project Partner(s)

- dFuzion, Inc.
- Amtrak

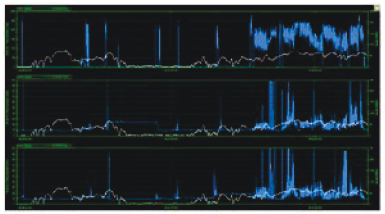
Cost & Schedule

- Project duration: 2014 – Present
- Approximate cost to date: $133K

FRA Project Manager

- Ali Tajaddini, (202) 493-6438, ali.tajaddini@dot.gov

Portable Rail Suspension Displacement Monitoring System



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 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.

Project Partner(s)

- dFuzion, Inc.

Cost & Schedule

- Project duration: 2015 – Present
- Approximate cost to date: $150K

FRA Project Manager

- Ali Tajaddini, (202) 493-6438, ali.tajaddini@dot.gov

Track Geometry Measurement System Evaluations

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 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

Project Partner(s)

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

Cost & Schedule

- Funding: $1,025k
- 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 in 2017

FRA Project Manager

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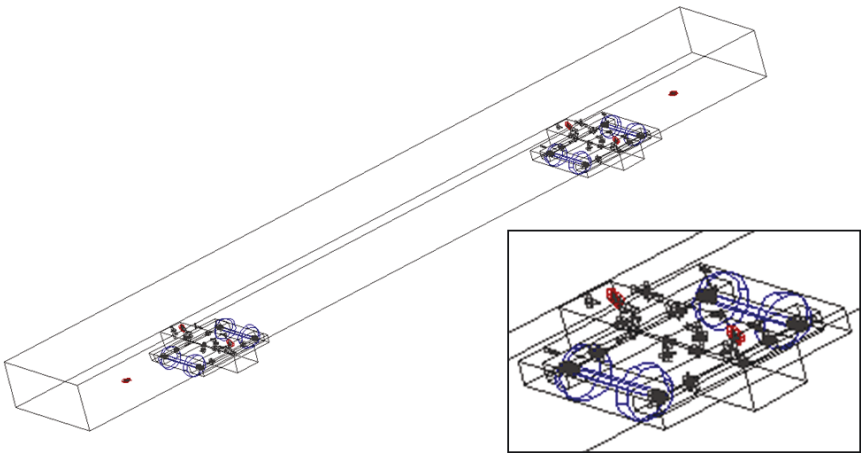
Vehicle-Track Model Parameter Sensitivity Study



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.

Cost & Schedule

- FRA Funding: $200,000
- Period of Performance: 6/1/2016 to 7/31/2017

FRA Project Manager

- Ali Tajaddini, (202) 493-6438, ali.tajaddini@dot.gov

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

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 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

Project Partner(s)

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

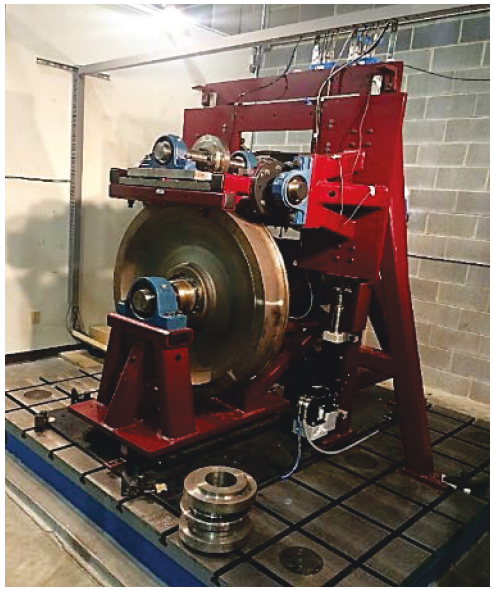
Cost & Schedule

- FRA funding: $1,274,636
- The RCFS was commissioned in March 2015
- Test program is planned to be completed in Jan 2017

FRA Project Manager

- Ali Tajaddini, (202) 493-6438, email: ali.tajaddini@dot.gov

Evaluation of Wheel/Rail Contact Mechanics and 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

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

- Performing pilot studies, gathering, and analyzing data
- Developing intermediate tools for interfacing the rig with common dynamic solver and simulation packages to perform advanced hardware-in-the-loop testing
- Project Duration: 15 months; Budget: $450k

FRA Project Manager

- Ali Tajaddini, PE, (202) 493-6438, Ali.Tajaddini@dot.gov

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

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 exists to identify and solve wheel/rail problems and advance technology developments that will improve safety and maintenance of railways.
- 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 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.
- This group undertakes joint research on wear and fatigue of rails and wheels. Teams are working on "Quantifying the Magic Wear Rate", "Friction Modelling", "Wheel Damage", "Quantifying Surface Damage", with 12 new topics introduced in the Fall 2016.

Project Partner(s)

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

Cost & Schedule

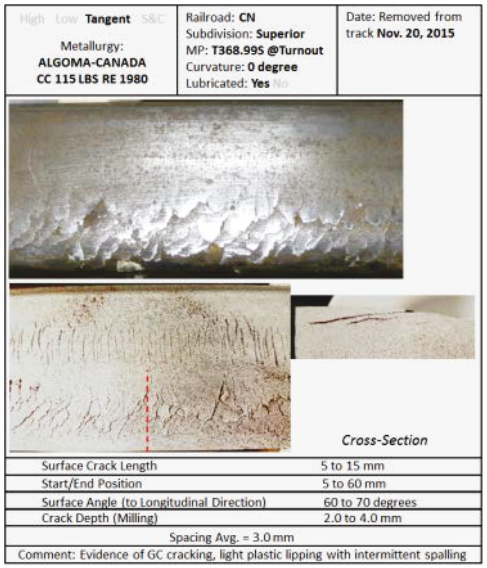
Coordinating ICRI

- Annual funding of 50k has been matched by funding from Canadian organizations (Transport Canada, CP Rail and NRC Canada).
- Deliverables: Review report submitted to FRA Nov 2016
- Roughly two workshops annually

FRA Project Manager

- Ali Tajaddini, PE, (202) 493-6438, Ali.Tajaddini@dot.gov

Atlas of Rail Surface Fatigue



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
- Extend rail life and reliability

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.

Project Partner(s)

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

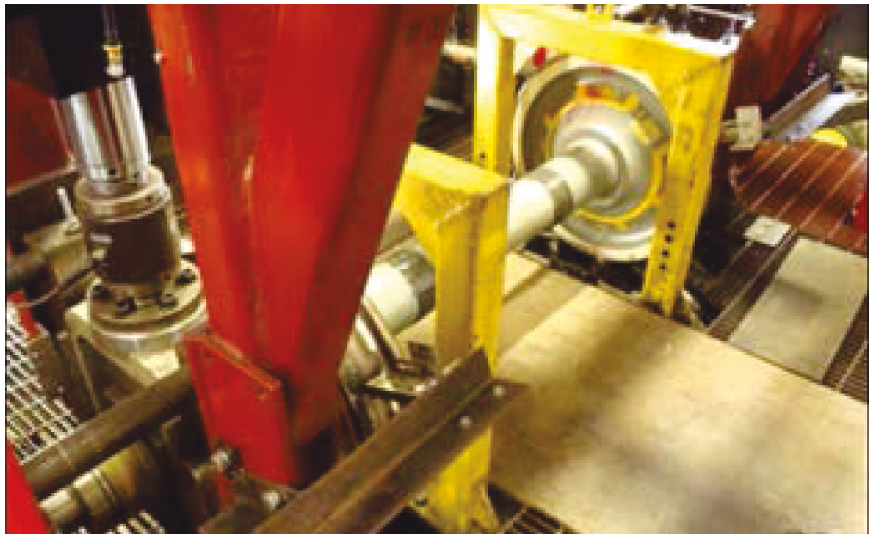
Cost & Schedule

- Years 1 and 2: Field work to validate electromagnetic crack measuring systems. Measure/monitor RCF development on the CP Paynesville subdivision. Simulate damage using MBD.
- Year 3: Include Sperry in the measurement program. Extensive field monitoring moved to CSX railroad. Assemble data into document. Undertake preliminary correlations.
- Delivered FRA technical report re: validation.
- Draft of Atlas due by end 2016.
- Total cost of $450k

FRA Project Manager

- Ali Tajaddini, PE, (202) 493-6438, Ali.Tajaddini@dot.gov

Friction Characterization



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 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.

Project Partner(s)

- National Research Council, Canada

Cost & Schedule

- Experimental work and data analysis completed
- Technical report on the findings submitted to FRA at end of December 2016
- Technical paper submitted end of December 2016.
- Total Cost over 3 years: 200K

FRA Project Manager

- Ali Tajaddini, PE, (202) 493-6438, Ali.Tajaddini@dot.gov

International Collaborative Research Initiative on Wear and Fatigue of Rails and Wheels (2017-2020)

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 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

Project Partner(s)

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

Cost & Schedule

Coordinating ICRI

- Annual funding of 70K will be supplemented by funding from Transport Canada (25K), and NRC Canada (40K) and 10K in-kind from Advanced Rail Management.
- Two workshops will be held annually - one internationally and one in North America

FRA Project Manager

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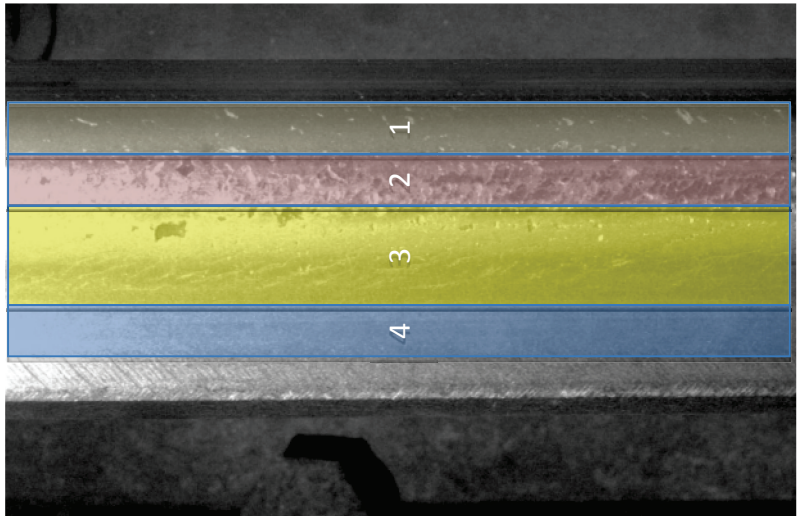
Quantifying rail surface damage



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 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.

Project Partner(s)

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

Cost & Schedule

- Two field trips each year to collect pre-grind rail condition data and friction measurements.
- Receive field data from collaborators, include eddy current measurements, profiles and surface condition photographs.
- Rail sectioning as required to support crack depth measurement and technology validation.
- Duration: 32 months
- Cost: 100K annually for three years

FRA Project Manager

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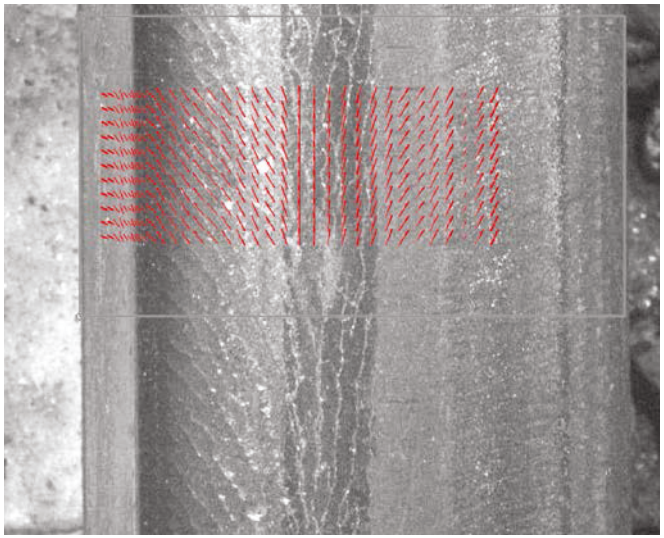
Vehicle-Track Interaction, RCF and Wear



Railroad Impact

- This project leverages ongoing “Quantify Surface Damage”, vehicle-track economics and risk assessment projects.
- A credible damage model will be developed for use in risk and economic assessments of RCF and wear.
- The resulting damage model will be invaluable to railroads and suppliers looking to make decisions regarding rail grinding, implementation of friction management, rail profiles, cant deficiency, etc.

Project Description

- Computer modeling is an increasingly viable approach for predicting rail damage, and thus to support risk and economic analysis.
- Damage monitoring on CSX, CN and NYCTA is already underway – modeling will be applied on one or more railroads to simulate the observed damage.
- A credible damage model will be developed.

Project Partner(s)

- National Research Council, Canada,
- Virtual Vehicle (Austria) and University of Huddersfield (UK) to support damage modeling

Cost & Schedule

- 4 months: Collection and management of track and vehicle data
- 4 months: Develop and run pummelling simulations to determine representative loading conditions on test locations.
- 12 months: Coordinate collaborative efforts with project partners, simulation, compare results
- 4 months: reporting, develop technical paper.
- Cost: 110K annually for two years

FRA Project Manager

- Ali Tajaddini, PE, (202) 493-6438, Ali.Tajaddini@dot.gov

RCF, Wear and Rail Integrity

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 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 the CSX railroad is already underway and data related to rail safety (defects, breaks, derailments) will be correlated with detailed rail condition, wear and VTI data.

Project Partner(s)

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

Cost & Schedule

- 24 months
  - 2 field trips to CSX
  - Collection and management of wear, surface condition, VTI and defect data
  - Establishing base lines for wear, wear rates and surface damage changes.
- 8 months: Correlation analysis, reporting, technical paper.
- Cost: 70K annually for three years

FRA Project Manager

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Adjustable Precision Track Anomaly Test 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 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.

Project Partner(s)

- Transportation Technology Center, Inc.

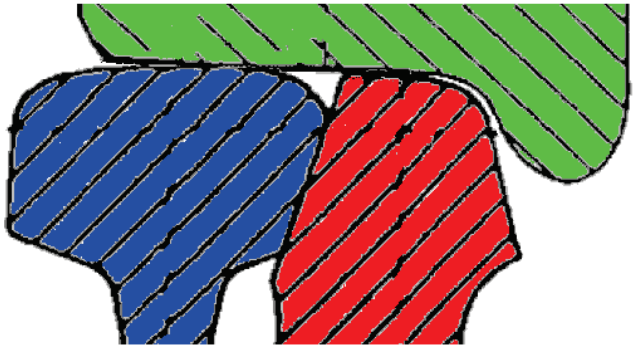
Cost & Schedule

- Design and build the track section
- Commissioning of the track
- Total cost of the project $1.0M

FRA Project Manager

- Ali Tajaddini, PE, (202) 493-6438, 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 ridy body or deformable body cases
- Implement rigid body and deformable body solutions in stand-alone wheel/rail interaction code
- .

Project Partner(s)

- Vehicle Dynamics LLC

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

Cost & Schedule

- Representation of measured and design profiles −
- Efficient search for contact locations, rigid body and deformable body cases
- Implementation in wheel/rail interaction code, rigid body and deformable body cases
- Total cost − $95,000
- One-year schedule

FRA Project Manager

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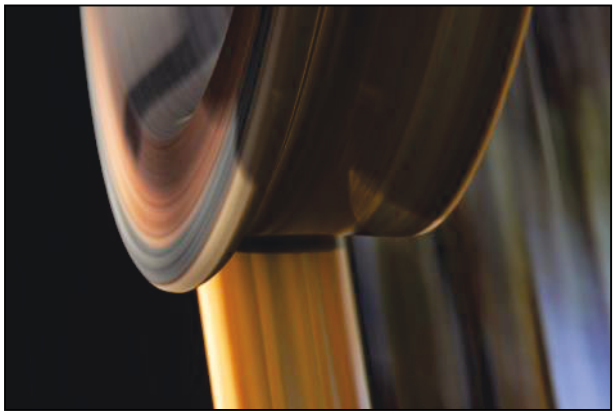
Three-Dimensional Wheel/Rail Contact Geometry



Project Description

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

Project Partner(s)

- Vehicle Dynamics LLC

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

Cost & Schedule

- Representation of measured and design profiles
- Efficient search for contact locations, rigid body and deformable body cases
- Implementation in wheel/rail interaction code, rigid body and deformable body cases Total cost
- One-year schedule

FRA Project Manager

- Ali Tajaddini, PE, (202) 493-6438, 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.

Project Partner(s)

- ENSCO Inc.

Cost & Schedule

- April 2015 – April 2017 – $380K
  DOTX 216 TTC Testing, Summer 2015, 2016

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.

FRA Project Manager

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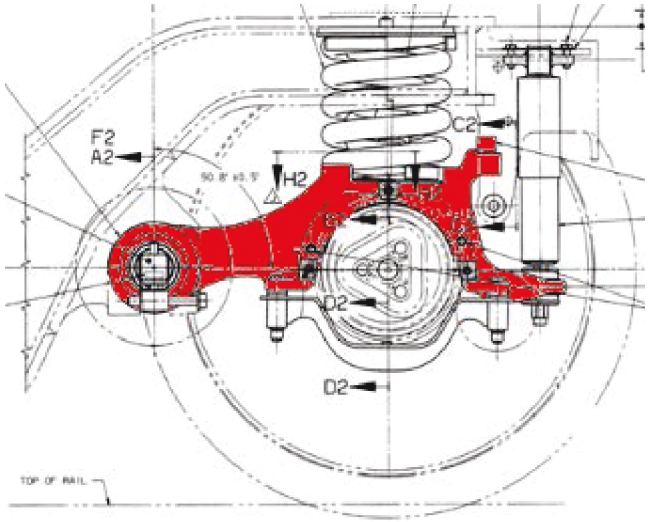
Coil Spring Characterization and Modeling



Railroad Impact

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

Project Description

- Procure a multiaxial test machine to test suspension springs under various loading conditions
- First phase is to procure the test machine then,
- 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

Project Partner(s)

- Volpe Center, Zwick

Cost & Schedule

- Phase I: Procure the test machine: $500k
- Phase II: Perform testing to characterize springs: $200k

FRA Project Manager

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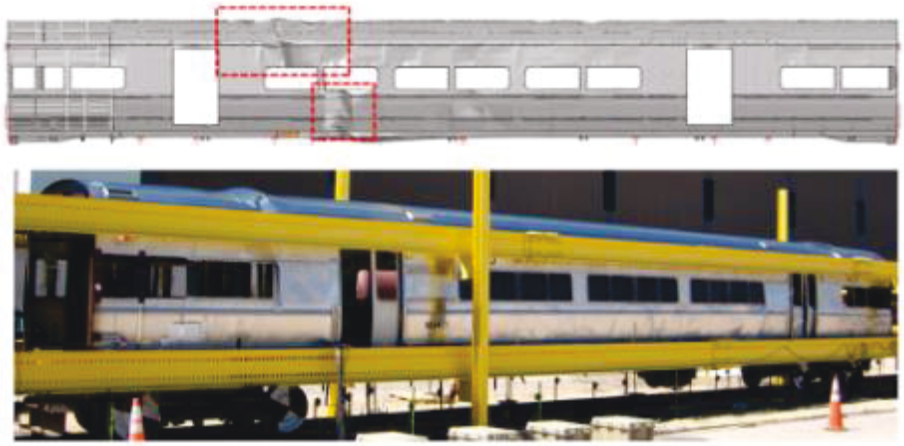
Section 2

Rolling Stock

Passenger Equipment Structural Crashworthiness



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 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

Project Partner(s)

- Volpe Center

Cost & Schedule

- 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
- **Funding level:** $25k

FRA Project Manager

- Jeff Gordon, (617) 494-2303, jeffrey.gordon@dot.gov

RAIL

U.S. Department of Transportation
Federal Railroad Administration

Locomotive Structural Crashworthiness

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

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

Project Partner(s)

- Volpe Center, TTCI, TIAX, Canarail

Cost & Schedule

- FRA Report on Component Re-designs, December 2014
- ASME Paper on Component Re-designs, April 2015
- Summary Report on Coupling Tests, July 2015
- Funding level: $480k

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 ATD 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

Project Partner(s)

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

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)

Cost & Schedule

- Develop test requirements for parametric impact tests to evaluate the
- H3RS abdominal instrumentation, September 30, 2014.
- MADYMO model of H3RS ATD, validated with 2012 sled test data, November 19, 2014.
- MADYMO model of H3RS ATD, validated with parametric test data (and 2015 sled test data, if conducted), March 12, 2015.
- Test Report on parametric testing (and 2015 sled tests, if conducted), March 12, 2015.
- Funding level: $160k

FRA Project Manager

- Jeff Gordon, (617) 494-2303, jeffrey.gordon@dot.gov

Field Investigations

Project Description

- Accident investigations are conducted at the request for 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 produced from the preliminary findings
- A technical report or paper is written from the technical presentation and reconstruction of the field investigations

Project Partner(s)

- Volpe Center

Railroad Impact

- Passenger equipment safety research program areas of focus cannot be developed absent information derived from real-world conditions
- Field investigations of actual incidents 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

Cost & Schedule

- 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 Dec 2013.
- Funding level: $50k

FRA Project Manager

- Jeff Gordon, (617) 494-2303, jeffrey.gordon@dot.gov

Regulatory Development, Waiver Support and Technology Transfer

Project Description

- The overall program goal is to advance and enhance technologies for rail equipment safety and facilitate their implementation in the railroad industry
- This work applies the research results from all program activities to increase safety, efficiency and effectiveness of federal regulations, help drive down life-cycle costs, and create consistent safety standards world-wide, so that foreign train designs require minimal adaptation for domestic use
- Focus is on identification of safety concerns, safety strategies for mitigating the concerns, and the information needed to explain and apply new technology:
  - 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 R&D 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.
- FRA Research and Development 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

Project Partner(s)

- Volpe Center

Cost & Schedule

- Editing and commenting on Notice of Proposed Rulemaking for High Speed Passenger train crashworthiness: September 1, 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 1, 2014
- Draft regulations for alternatively designed single locomotives and single cab cars for use in Tier I service: August 1, 2014
- Draft regulations for alternatively designed single coach cars for use in Tier I service: August 1, 2014
- Funding level: $100k

FRA Project Manager

- Jeff Gordon, (617) 494-2303, jeffrey.gordon@dot.gov

RAIL
Moving America Forward

U.S. Department of Transportation
Federal Railroad Administration

Vehicle-Track Interaction Research

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 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

Project Partner(s)

- Volpe Center

Cost & Schedule

- 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
- Funding level: $100k

FRA Project Manager

- Jeff Gordon, (617) 494-2303, jeffrey.gordon@dot.gov

Impact Tests of Passenger/DMU Locomotive 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 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

Project Partner(s)

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

Cost & Schedule

- Period of Performance - 12/6/2012 – 12/31/2015 - completed
- Extended to perform tests on new DMU fuel tanks 12/31/2015 - 2/28/2017 (extended on DMU fuel tanks)
- $530k project cost

FRA Project Manager

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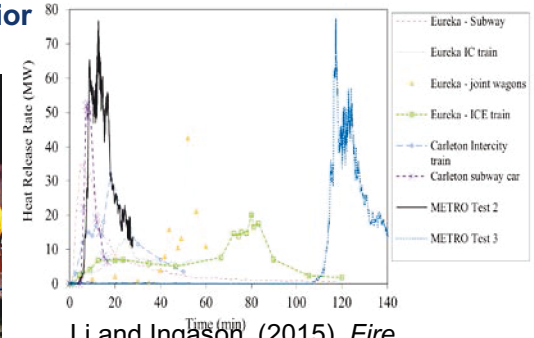
Fire Safety Research - Heat Release Rate

Old Interior

New Interior

Photo Courtesy of Tomas Karlsson.



Li and Ingason, (2015), *Fire Technology*

Railroad Impact

- Provide objective minimum criteria for meeting FRA regulations and industry fire safety standards for new and refurbished passenger equipment using Heat Release Rate criteria.
- Continue to improve upon fire safety standards and provide alternative methods to test new designs and materials.
- Provide cost-effective fire tests and modeling alternatives based on Heat Release Rate to flammability and smoke emissions requirements.

Project Description

- Heat Release Rate (HRR) Performance Measures:
- Supports rulemaking activities associated with Fire Safety on passenger rail cars.
- Investigate and evaluate alternative strategies and technologies relating to evaluating passenger rail car fire safety performance.
  - Research and testing to determine alternative fire safety tests based on the HRR of the various materials used in design of passenger rail cars.
  - Advance previous research funded by and conducted with FRA/Volpe/NIST.
  - Conduct additional fire testing of interior assemblies and materials.
  - Advance fire safety models and validate against predicted outcomes of various fire tests.
  - Consider toxicity impacts of materials
- Provide sound scientific and technical basis for revising the content of FRA passenger train fire safety requirements.
- Consult with subject matter experts, test experts, industry and designers/engineers.

Project Partner(s)

- Volpe National Transportation Systems Center
- Systems Safety and Engineering V-334
- Jensen Hughes, Baltimore, MD

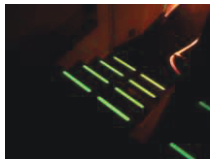
Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Emergency Preparedness Research



Railroad Impact

- Provides objective minimum criteria for meeting FRA regulations and industry standards for new and existing passenger equipment
- Use 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 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

Project Partner(s)

- Volpe Center

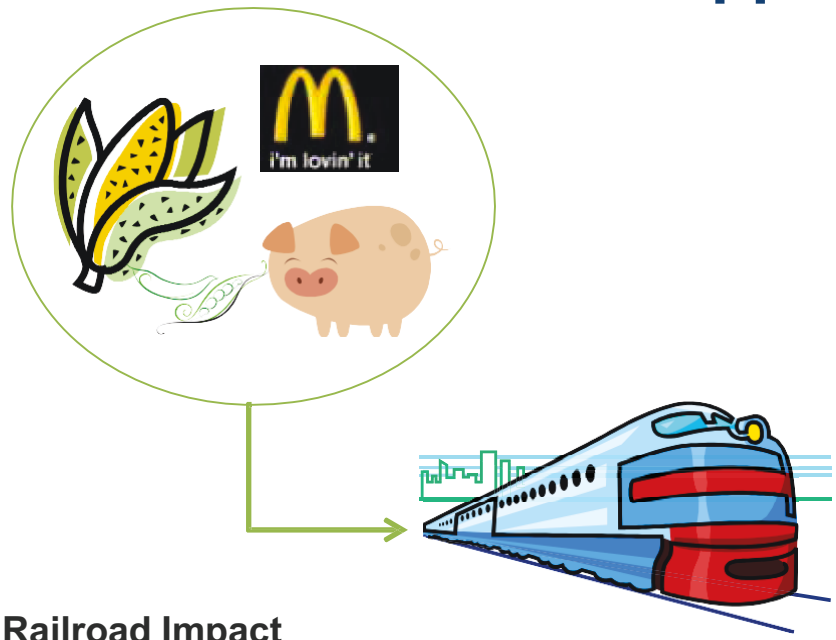
Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Biodiesel In Railroad Applications



Railroad Impact

- Newly proposed US EPA regulation will require railroad to reduce the amount of greenhouse gases emitted from locomotive engines: Nitrogen Oxides (NOx), Carbon Monoxide (CO), Hydrocarbons (HC) and Particle Matter (PM)
- The railroad industry is interested in alternative fuel and its capabilities
- Provides guidelines for the sustainable use of a renewable fuel
- source

Project Description

- This project focuses on determining the long term effects of using biodiesel in railroad equipment.
- The research is separated into the following subtasks:
  - Emissions testing of B5 and B20 biodiesel fuel in various models of locomotive engines
  - Engine Durability Assessment of B5 and B20 biodiesel in various models of locomotive engines
  - Railroad diesel fuel survey to assess homogeneity in fuel composition

Project Partner(s)

- Southwest Research, Inc., LMOA Fuel, Lube and Environmental Committee

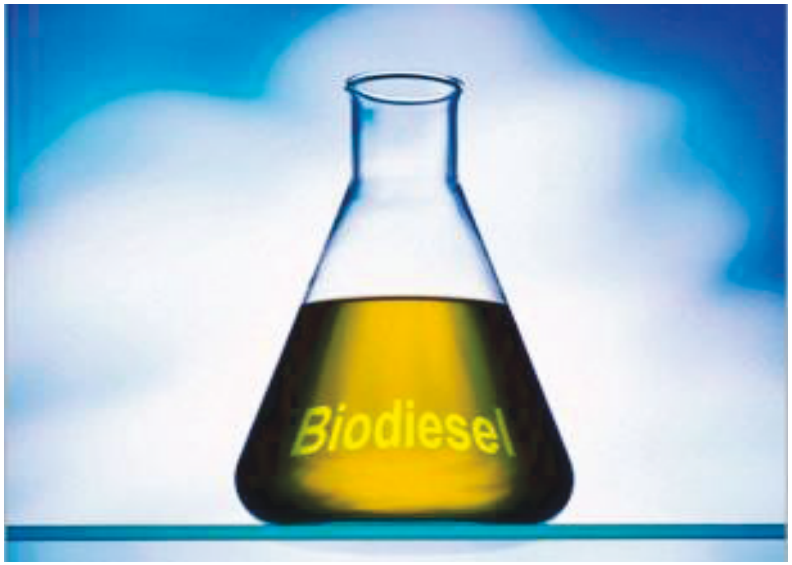
Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Locomotive Biofuel Study



Railroad Impact

- Newly proposed US EPA regulation will require railroad to reduce the amount of greenhouse gases emitted from locomotive engines: Nitrogen Oxides (NOx), Carbon Monoxide (CO), Hydrocarbons (HC) and Particle Matter (PM)
- The railroad industry is interested in alternative fuel and their capabilities
- Provides guidelines for the sustainable use of a renewable fuel source

Project Description

- This project intends to determine the extent to which freights railroads, Amtrak, and other passenger rail operators could use biofuel blends to power locomotives and other vehicles that currently operate on diesel fuel. Further, it aims to determine a “premium” blend of biofuel for rail vehicles. Focusing on comparing biofuels and diesel fuel for:
  - Energy intensity Environmental effects Emissions
  - Cost Availability
  - Public benefits from biofuel use Engine durability
  - Warranty specifications.

Project Partner(s)

- North Carolina State University

Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Study of the Use of Bio-based Lubricant Technology

Railroad Impact

- Lubricants and greases that are used in rail equipment can come from biodegradable sources that are considered:
  - Renewable
  - Cost effective
  - Environmentally benign.

Project Description

- This project tests the feasibility of using readily biodegradable lubricants and greases in locomotive, rolling stock and other equipment by conducting a comparative study of bio-based and conventional greases. Specifically, it analyzes the following factors:
  - Lubricant Performance in a railroad environment
  - Health and safety
  - Environmental impact
  - Equipment performance

Project Partner(s)

- University of Northern Iowa, National Agriculture-based Lubricant Center

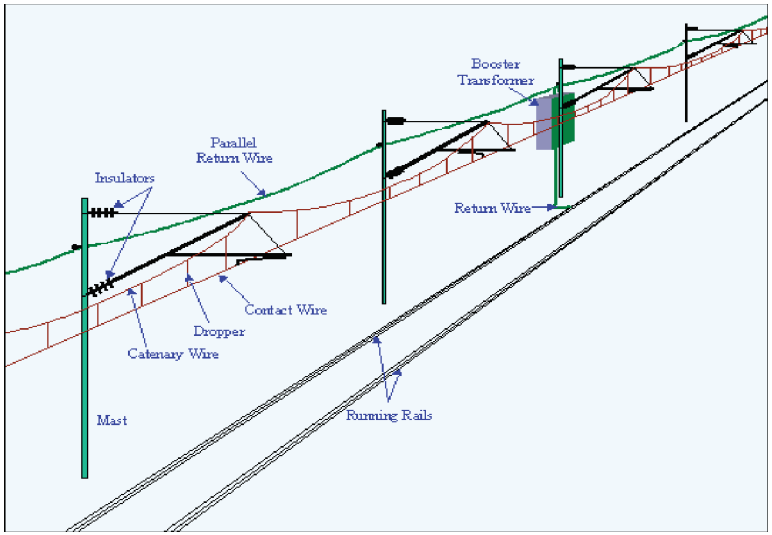
Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Cost-Benefit Analyses of Electrification for Next Generation Freight and Passenger Rail Transportation



Project Description

- Electrification study to assess the costs and benefits of electrifying nation's rail transportation system
  - Investigate the costs, benefits, barriers, and mitigation strategies of electrification
  - Determine efficiency impact
  - Assess the emissions reduction of electrification.
  - Identify innovative technology that can reduce costs and improve performance

Project Partner(s)

- Booz Allen Hamilton

Railroad Impact

- Identification of innovative electrification technologies that would:
  - Improve railroad efficiency
  - Reduce emissions
  - Reduce costs

Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Evaluation of the Displacement between Locomotive and Trailing Rail Vehicle (Simulated Natural Gas Tender)

Railroad Impact

- Improves the safety of rail transportation with the introduction of natural gas as a locomotive fuel
- Develops design specifications for interconnecting piping, hoses, and cables for natural gas locomotives

Project Description

- To assist in the safe design and testing of gas/liquid/electrical interconnections by analyzing the dynamic loading of interconnection between locomotive and natural gas tender.
  - Determine the tri-axial displacement, acceleration, and jerk environment between the locomotive and trailing (simulated tender) vehicle
  - Support development of equipment performance standard specification/test with railroad industry
  - Understanding the displacement environment between these two vehicles should enhance the effort to design and test the interconnecting equipment and result in improved performance and safety of those components

Project Partner(s)

- TTCI
- Sharma & Associates

Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Review of Codes, Standards, and Regulations for Natural Gas Locomotives

Railroad Impact

- Identifies existing standards, design codes, and regulations that can apply to new, natural gas locomotive systems
- Pinpoints gaps in current regulations relating to natural gas use
- in railroad environment

Project Description

- Review of codes, standards, and regulations for natural gas locomotive systems and components with the goal of identifying compliance with FRA regulations.
  - Develop a high level map of major natural gas fueling sub-systems between the incoming gas pipeline and the natural gas locomotive.
  - Identify, collect, and summarize relevant global codes, standards, and regulations for natural gas rail applications
  - Create a summary matrix that relates identified codes, standards, and regulations to the selected sub-system categories
  - Identify gaps in the global codes, standards and regulations which will need to be addressed for implementation of natural gas as a fuel for rail

Project Partner(s)

- Ricardo, Inc.

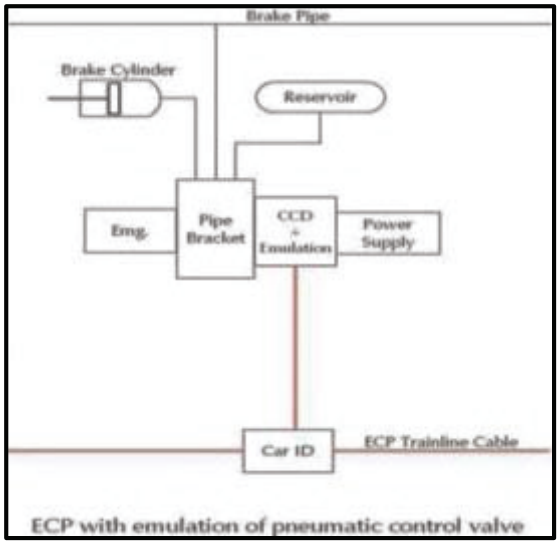
Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Accelerating Implementation of ECP Brake Technology



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

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

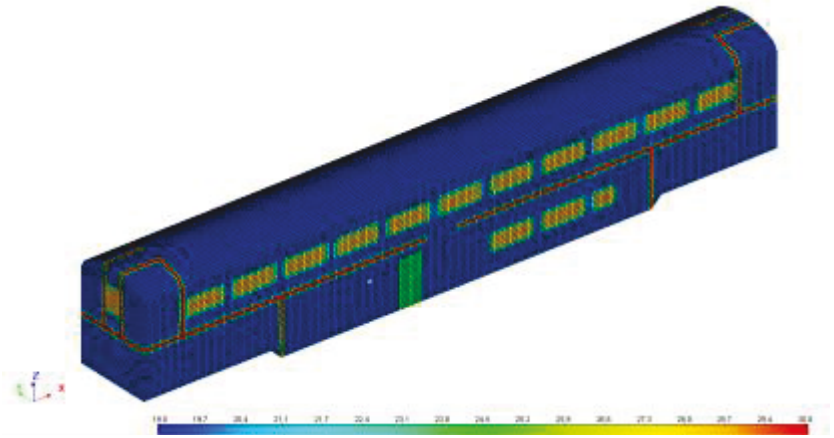
Cost & Schedule

- N/A

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



Railroad Impact

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

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
- Finally, it will determine barriers to implementation and how should they be overcome.

Project Partner(s)

- Sharma & Associates

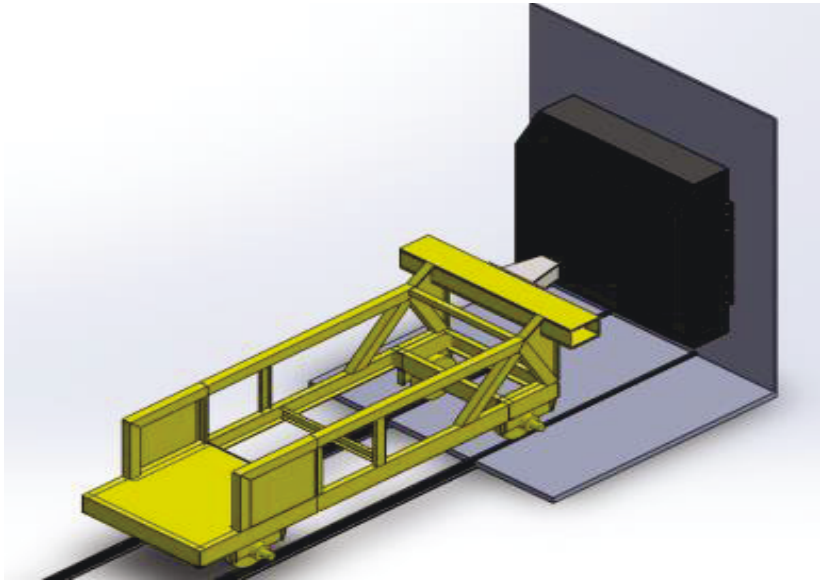
Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Fuel Tank Impact Test



Railroad Impact

- Identification dynamic performance of passenger locomotive fuel tank
- Understand performance of DMU fuel tank
- Support development of guidance for alternatively designed passenger equipment fuel tank

Project Description

- This research focuses on evaluating dynamic impact conditions for passenger fuel tanks and investigating how fuel tank design features (such as baffle placement) affect the collision performance of the tank. Research activities include :
  - Analytical modeling of fuel tanks under dynamic loading conditions
  - Dynamic impact testing of fuel tank articles
  - Recommendations for improved fuel tank protection strategies

Project Partner(s)

- Transportation Technology Center Inc.
- Volpe Center

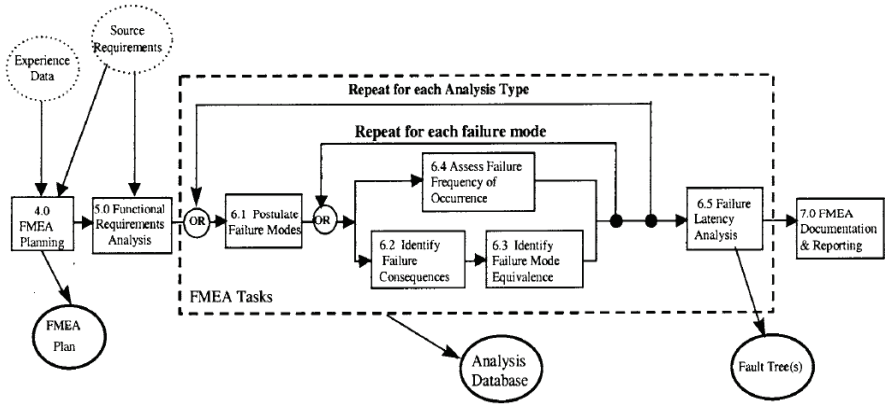
Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Safety Assessment of Natural Gas Fueled Locomotives



Project Description

- Support to the Federal Railroad Administration in review of industry submitted Failure Modes, Effects Analysis (FMEA) Identify methodology for evaluation of industry submitted
- FMEA and other safety assessment
- Development of informational brochure on natural gas fueled
- locomotives
- Aims to understand the safety of natural gas locomotive systems through:
- Identification of types of failures of natural gas system with potential for significant impact

Railroad Impact

- Identify standard industry accepted methodology for safety assessment of natural gas locomotive systems Identification of the risks associated with natural gas
- locomotive systems
- Improve design and safety of next generation natural gas locomotive systems

Project Partner(s)

- Sandia National Laboratories

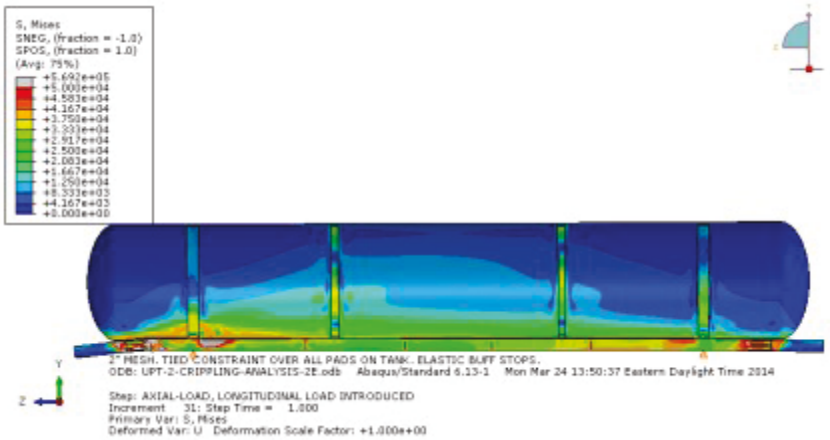
Cost & Schedule

- N/A

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



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
- Development 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 Description

- Develop Crashworthiness Standards for LNG 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

Project Partner(s)

- Volpe Center

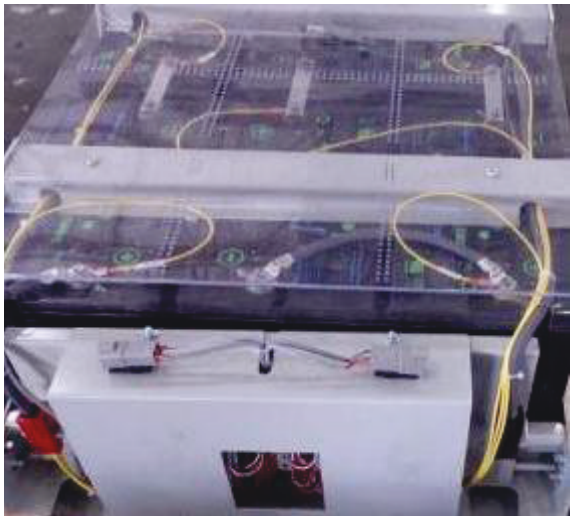
Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Review of Battery Energy Storage Systems for Railroad Application



Railroad Impact

- Provide RR operators with easy to understand comparison of batteries
  - RR's will be able to compare benefits and risks advanced battery chemistries based on Class I and Commuter load profiles
  - Enable better decision making regarding near and long term capital investments
  - Support next phase development of ruggedized container for hybrid locomotive battery for testing and validation
  - Enable longer-term adoption of hybrid technology

Project Description

- Evaluate performance and safety of battery chemistries for locomotive use
  - Paper report with summary table to be made available to RR's to identify optimal battery system for hybrid locomotives
  - Model and evaluate battery chemistries for performance and safety vs. load profile for Class I and Commuter locomotives; and identify requirements for ruggedized battery system
  - Lead Acid, Pb-C, Ni-Cad, Ni Capacitor, NiMH, Li-ion

Project Partner(s)

- Saft, Inc.

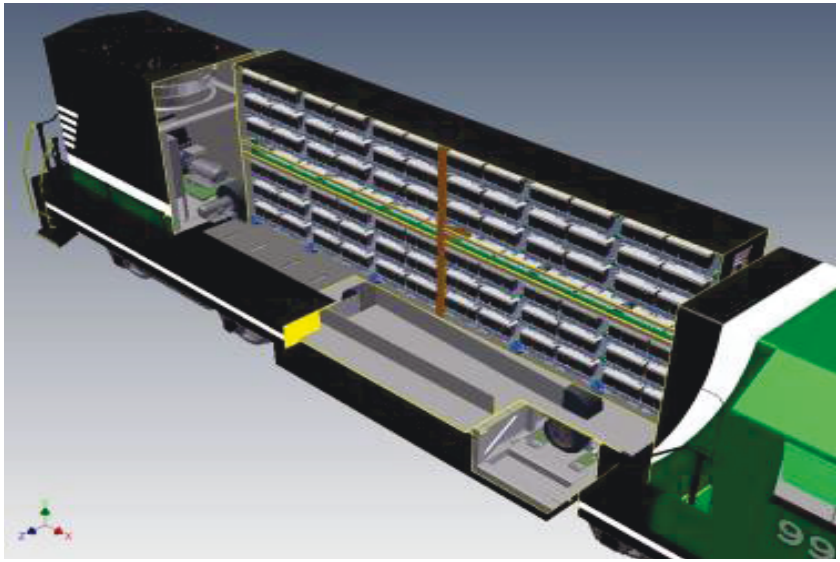
Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Hybrid (Battery Energy Storage System) Locomotive



Railroad Impact

- Zero-emissions solution for rail transportation
  - Evaluations of battery energy storage systems to reduce emissions associated with rail transportation
- Identify deficiencies and solutions for various battery technologies for rail transportation

Project Description

- Norfolk Southern Railroad S is developing a prototype electric switching locomotive (NS 999) powered by a lead-carbon battery based Energy Storage System (ESS).
- The ESS batteries, arranged in strings of 54 12 V batteries (~ 650 VDC), will be charged via wayside power and through onboard regenerative braking energy. A battery management system (BMS) monitors battery temperature, voltage, and current. The BMS system provides for active equalization of individual batteries across the strings with the ability to isolate batteries if parameters exceed preset safety thresholds. The electric switcher is the first step toward developing a locomotive energy storage system capable of recovering dynamic braking energy from line-of-road freight operations. Work under this grant focuses on addressing several short- comings identified from the initial NS 999 field trials including redesign of the Battery Management System, exploration of alternative battery technologies and repackaging of the energy storage system to improve battery maintenance practices.

Project Partner(s)

- Norfolk Southern Corporation

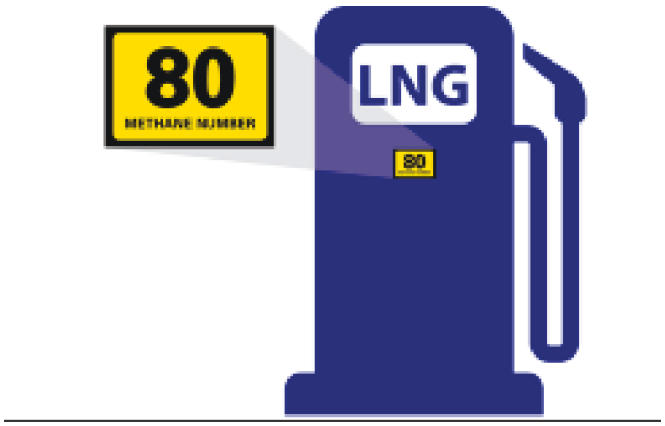
Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Investigation of an Anti-knock Index and Hydrocarbon Emissions of Natural Gas Blends



Project Description

- Fuel specification to limit the variation in knock index, hydrocarbon emissions and heating value is needed for natural gas-fueled locomotives
- Development of a non-proprietary natural gas anti-knock index through modeling and regression analysis of fuel test data to determine knock index curve
- Determination of hydrocarbon emissions effects of various blend of natural gas

Project Partner(s)

- Caterpillar, Southwest Research Inc.

Railroad Impact

- Facilitation of a robust solution for understanding fuel specification needs for natural gas-fueled locomotives by providing clarity for the fuel suppliers, engine developers, railroads and regulators
- Understanding the efficiency and emissions performance of natural gas-fueled locomotives based on the various fuel blends

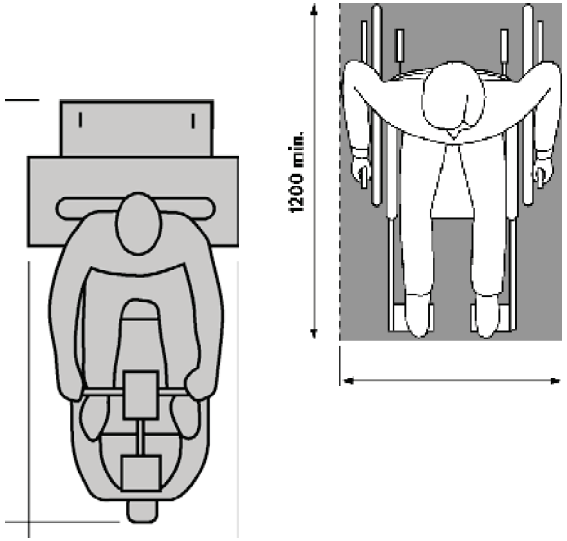
Cost & Schedule

- N/A

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

- Development of 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

Project Partner(s)

- Oregon State University, PRIIA Next Generation Equipment Committee

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

Cost & Schedule

- N/A

FRA Project Manager

- Melissa Shurland, (202) 493-1316, melissa.shurland@dot.gov

Evaluate Displacement for Locomotive-Tender Interconnections

Project Description

- The objective is to 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.
- The 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.

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.
- The 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..

Project Partner(s)

- TTCI
- Sharma & Associates, Inc.

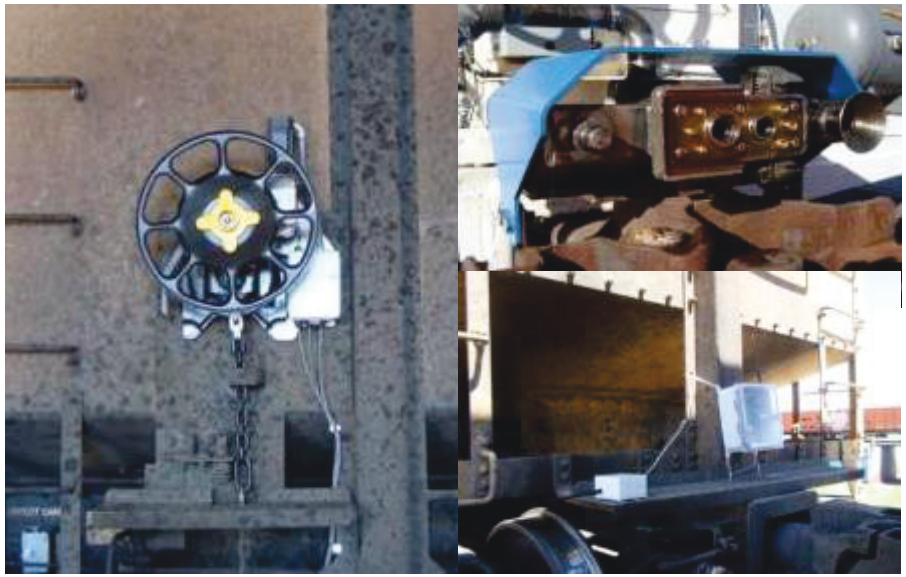
Cost & Schedule

- Period of Performance: 9/23/2013 – 10/31/2015
- Total cost: $185,796

FRA Project Manager

- Melissa Shurland, (202) 253-6539, 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)

- TTCI
- Sharma & Associates

Cost & Schedule

- N/A

FRA Project Manager

- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

Advanced Devices Train & Test Bed (ADT&TB)

Project Description

- Enable the creation of an Advanced Devices Train and Test Bed (ADT&TB) to test advanced devices for functionality and ergonomics
- Devices include Electrically Driven Hand Brake (EDHB), Tri-Couplers (air, electrical, and mechanical coupling systems), remote controlled angle cocks, and remote controlled cut- levers.
- Evaluations and demonstrations of advanced devices operated via advanced wireless network

Project Partner(s)

- TTCI
- Sharma & Associates, Inc
- QinetiQ North America
- Univ. of Nebraska

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

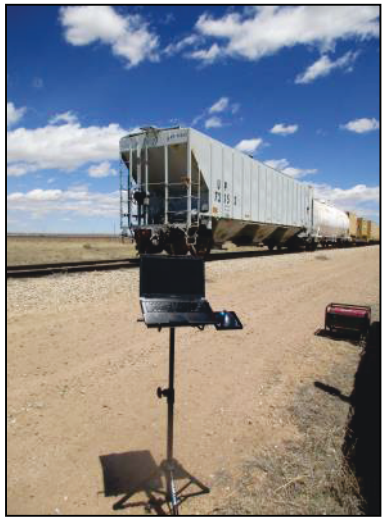
Cost & Schedule

- Period of Performance: 7/16/2014 – 10/16/2016
- Total cost: $381,755

FRA Project Manager

- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

Advanced Devices Train & Test Bed (ADT&TB)



Project Description

- Enable the creation of an Advanced Devices Train and Test Bed (ADT&TB) to test advanced devices for functionality and ergonomics
- Devices include Electrically Driven Hand Brake (EDHB), Electrical Power Supply System (EPSS), Tri-Couplers (air, electrical, and mechanical coupling systems), remote controlled angle cocks, and remote controlled cut-levers.
- Evaluations and demonstrations of advanced devices operated via advanced wireless network

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, IONX, Univ. of Nebraska

Cost & Schedule

- FRA funding: $381,755
- In 2014 & 2015, EPSS and Tri-coupler were installed and tested
- In 2016, a wireless EDHB setup and testing

FRA Project Manager

- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

Improved Truck Castings Phase II

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 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

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)

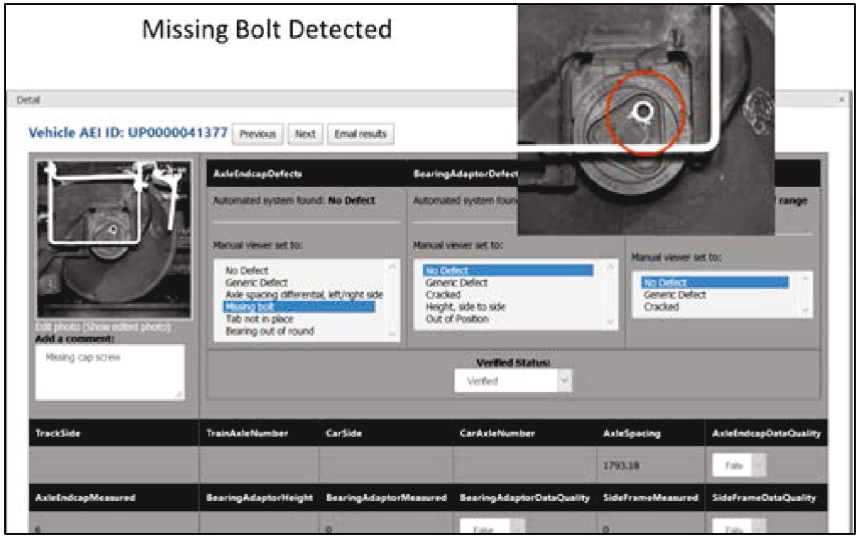
Cost & Schedule

- Budget of $189k
- 16 months for Phase II

FRA Project Manager

- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

Advanced Machine Vision of Truck Components



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 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.

Project Partner(s)

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

Cost & Schedule

- FRA funding: $425,000
- Revenue service testing of the KLD Truck Component Inspection system is set to begin in 2017
- Manual viewer software to be completed by end of 2016

FRA Project Manager

- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

Bearing Grease Degradation Related to Water and Roller Bluing

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 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.

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)

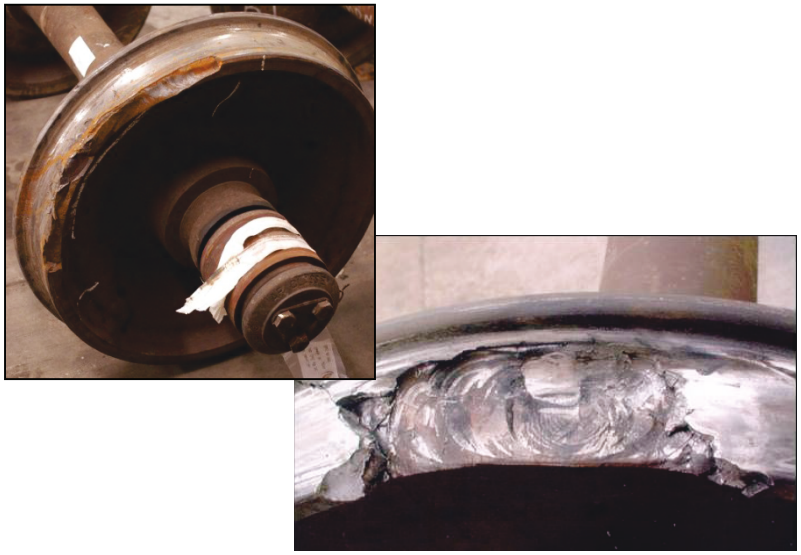
Cost & Schedule

- $245,000 overall cost
- Scheduled to complete by October 2017

FRA Project Manager

- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

Wheel Failure Research and Development Program



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 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.

Project Partner(s)

- ENSCO
- AAR, Wheel Suppliers

Cost & Schedule

- Phase I:
  Feb 2016 – Feb 2017, $195K

FRA Project Manager

- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

Wireless Digital Train Line for Passenger Trains

Railroad Impact

- This project 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 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.
- We will 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.

Project Partner(s)

- This project is conducted at **University of Nebraska-Lincoln**'s Advanced Telecommunications Engineering Laboratory (TEL)
- Contact: Hamid Sharif, hsharif@unl.edu, 402-554-3628

Cost & Schedule

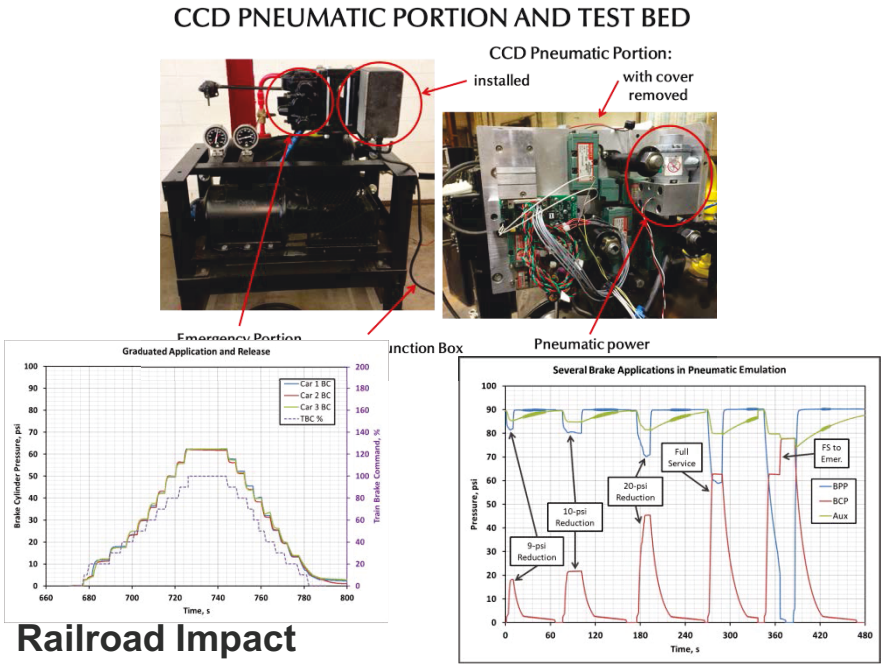
- Schedule: August 2015 – July 2017
- Cost: $199,972

FRA Project Manager

- Tarek Omar, (202) 4936189, tarek.omar@dot.gov
- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

RAIL
Moving America Forward

Accelerating Electronically Controlled Pneumatic (ECP) Brakes



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

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

- $ 668,856
- August 7, 2013 - October 6, 2016

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.

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

Project Partner(s)

- Sharma & Associates

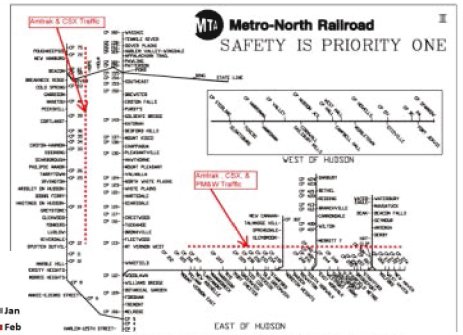
Cost & Schedule

- Phase I $199,338 Phase II $254,767 Phase III $ 245,856
- September 11, 2015 – September 10, 2020

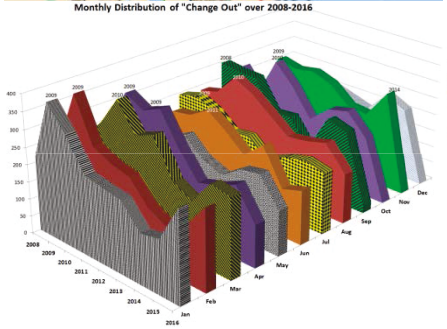
FRA Project Manager

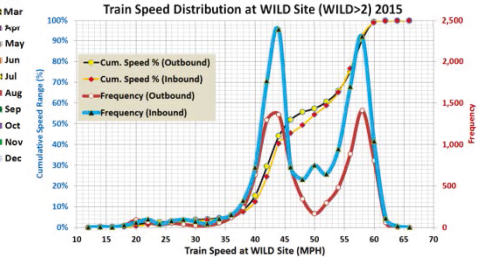
- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

Wayside Advanced Technology Systems (WATS) Pilot Demonstrations



Monthly Distribution of "Change Out" over 2008-2016





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.

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

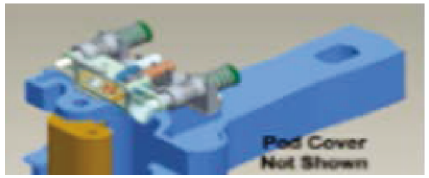
Cost & Schedule

- Phase II $ 190,000
- February 2, 2016 – February 1, 2018

FRA Project Manager

- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

Advanced Tri-Coupler



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).

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.

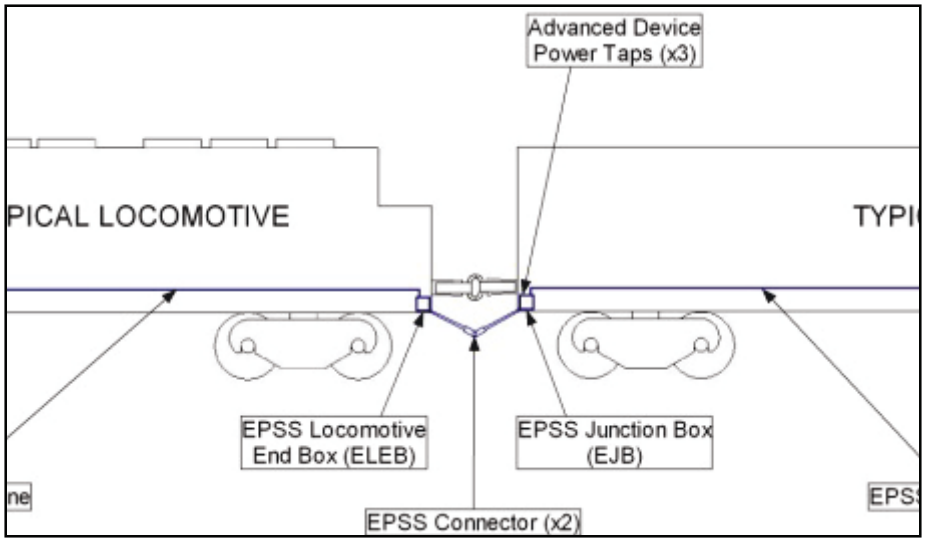
Cost & Schedule

- Not currently funded in FY17

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..

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

Project Partner(s)

- Sharma & Associates, Inc.

Cost & Schedule

- Budget: Funded $424,986
- Schedule: Ends November 2018

FRA Project Manager

- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

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

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.

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

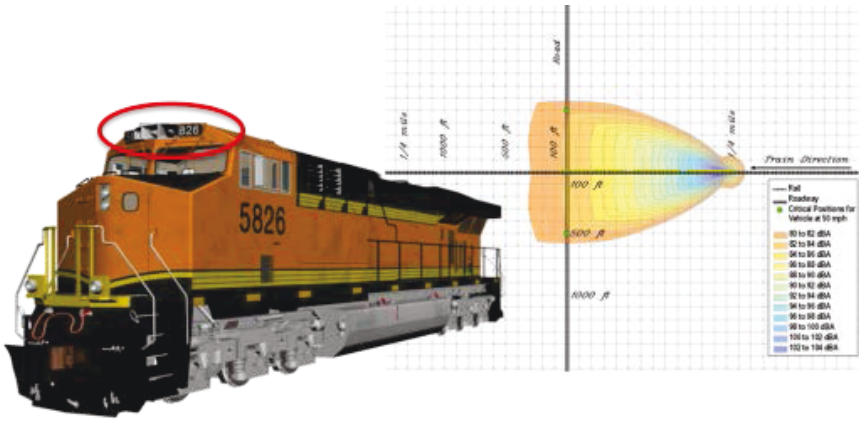
- Funded $404,103; Ends October 2017

FRA Project Manager

- Monique Stewart, (202) 493-6358, monique.stewart@dot.gov

Optimized Acoustical Warning Device (AWD) as a Train Horn

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

Project Description

- Implement AWD in a Pilot Implementation Program at the Maryland Transit Authority.
- 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.

Project Partner(s)

QinetiQ North America – Tom Campbell

Cost & Schedule

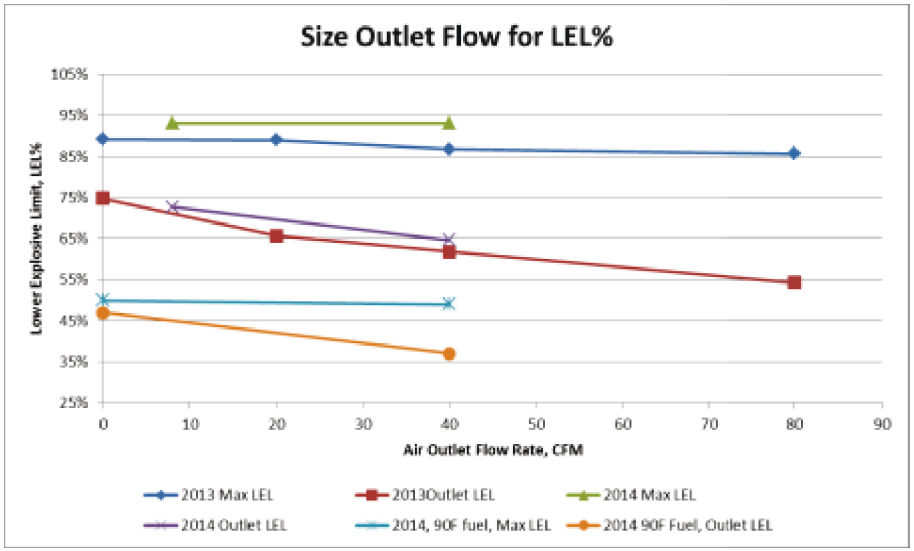
- FY2010/FY2011 – Feasibility study of using LRAD as train audible warning device - $400k
- FY2012 – Prototype developed and tested – $300k
- FY2013 – AWD prototype optimized and dynamically tested at TTCI – $400k
- FY2014 – Tests will be conducted in transit at MTA and freight lines in cooperation with BNSF and other railroads – $300K
- FY15 Est. – Continue demonstration to evaluate community noise reduction - $250k

FRA Project Manager

- Tarek Omar, (202) 493-6189, Tarek.Omar@dot.gov

Benefits of Fuel Vapor Reclamation System

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



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

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.

Project Partner(s)

QinetiQ North America – Tom Campbell

Cost & Schedule

- FY2010/FY2011 – Literature search and laboratory-scale proof-of-concept demonstration – $750k
- FY2012 – Vapor reclamation unit design, integration, and testing with locomotive – $300k
- FY2013 – Optimization of vapor reclamation unit, installation and monitoring - $350k
- FY2014 – Bench top and environmental validation tests, field evaluations - $400k
- FY2016 Est. – Continue field evaluations and develop a cost benefit analysis - $200k

FRA Project Manager

- Tarek Omar, (202) 493-6189, Tarek.Omar@dot.gov

Locomotive Emergency Response Training

Shown here: Locomotive Emergency Egress Experiments

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.

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.
- We are working with operation Lifesaver to disseminate course information.

Project Partner(s)

QinetiQ North America – Mike Willis

Cost & Schedule

- FY2010/FY2011 – Developed and conducted pilot training for firefighters to learn how to respond to a locomotive accident – $450k
- FY2013 – Tested various firefighting tools and techniques in extricating, obtained and added video of extraction in training , developed train-the-trainer course - $350k
- FY2014 – Develop training for dispatcher response to a locomotive emergency - $400k
- FY15 Est. – Develop crew emergency survival training for locomotive emergencies - $200k

FRA Project Manager

- Tarek Omar, (202) 493-6189, Tarek.Omar@dot.gov

Advanced Devices Train & Test Bed (ADT&TB)

Project Description

- Enable the creation of an Advanced Devices Train and Test Bed (ADT&TB) to test advanced devices for functionality and ergonomics
- Devices include Electrically Driven Hand Brake (EDHB), Tri-Couplers (air, electrical, and mechanical coupling systems), remote controlled angle cocks, and remote controlled cut-levers.
- Evaluations and demonstrations of advanced devices operated via advanced wireless network

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)

- TTCI, Sharma & Associates, Inc, QinetiQ North America, Univ. of Nebraska

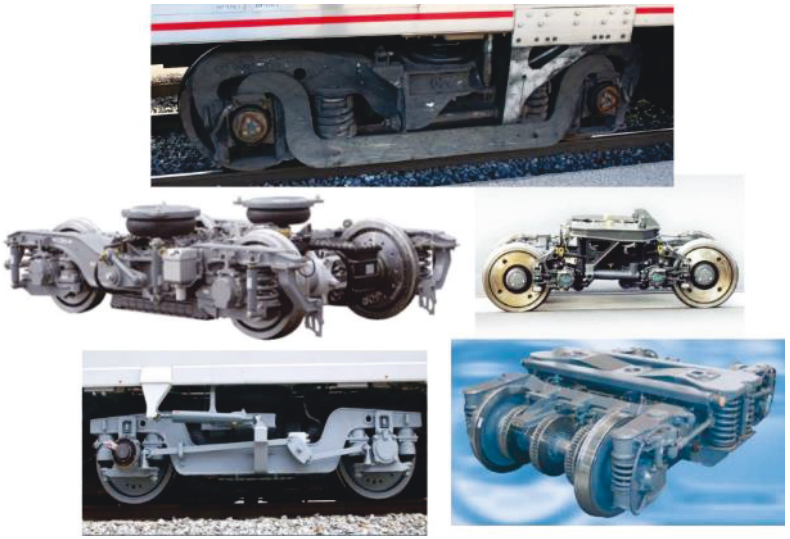
Cost & Schedule

- Period of Performance: 7/16/2014 – 10/16/2016
- Total cost: $380K

FRA Project Manager

- Tarek Omar, (202) 493-6189, Tarek.Omar@dot.gov

Design Considerations for High-Speed Passenger Trucks



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).
- Help to establish a sensible low-speed evaluation criteria for high speed trains

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.

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)

Cost & Schedule

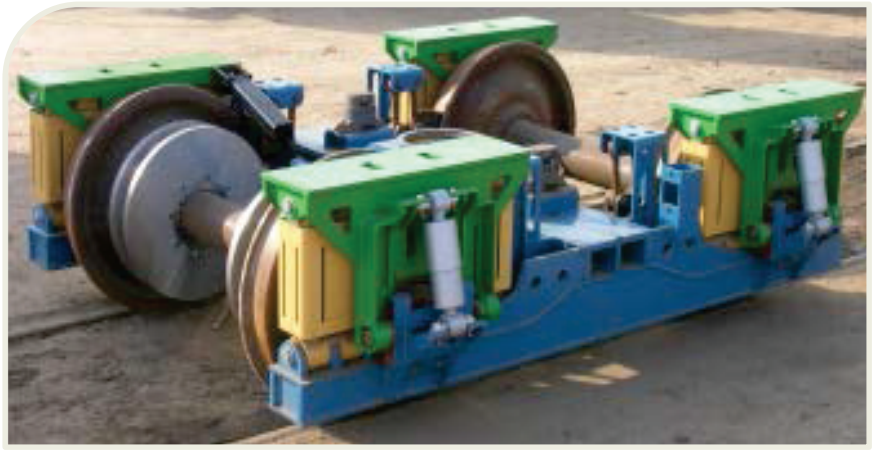
- 2012-2015
- Total Cost: $530K

FRA Project Manager

Tarek Omar, (202) 493-6189, Tarek.Omar@dot.gov

Higher Speed Freight Truck (HST)

Shown here: HST Prototype



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 GRL cars.

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
- Further, 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)

- TTCI
- Sharma & Associates

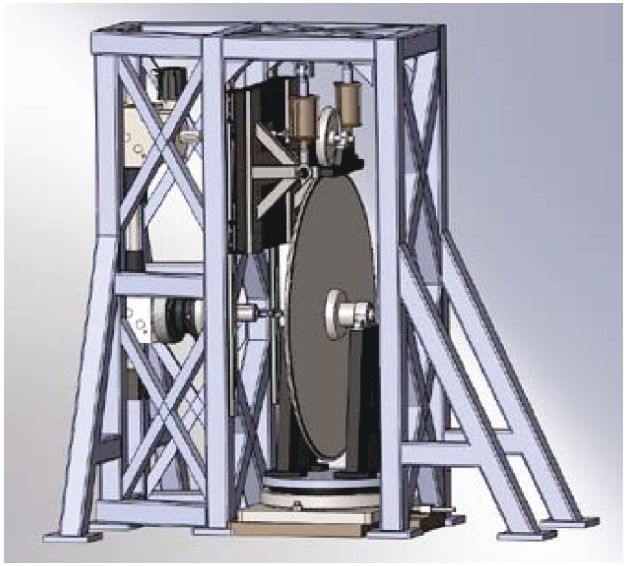
Cost & Schedule

- FY2013/FY2014 – Modifying refrigerated container car for higher speed freight - $400k
- FY2015 – Extend design to 110-ton and design brake arrangement for the truck. – $300k

FRA Project Manager

Tarek Omar, (202) 493-6189, Tarek.Omar@dot.gov

Effects of Temperature on Wheel Shelling



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 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.

Project Partner(s)

- TTCI

Cost & Schedule

- 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 Wheel Failure Mode

Railroad Impact

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

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

Project Partner(s)

- TTCI, AAR, and Texas A&M University
- Jointly funded by FRA and AAR

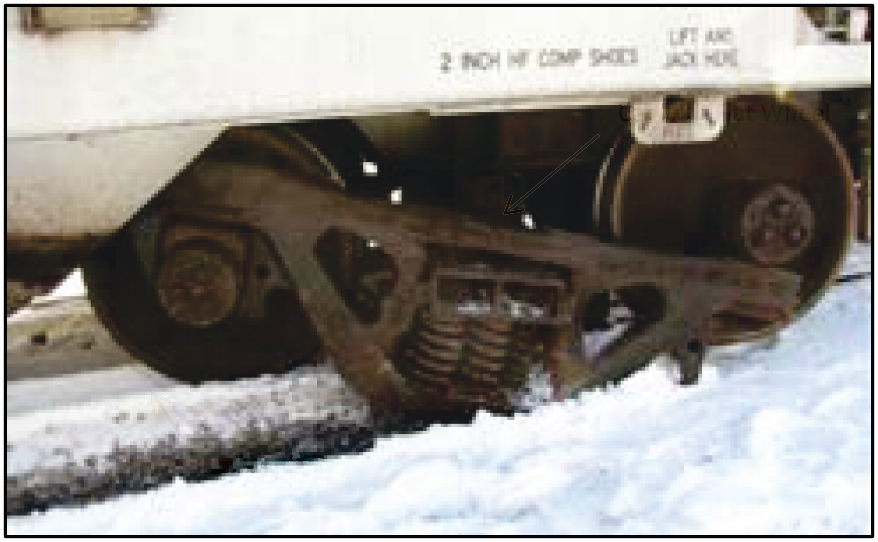
Cost & Schedule

- 2013 Machined 'crack' in wheel ; began rolling load test to propagate crack
- 2014 Finite element modeling and residual stress testing
- 2014 Reporting and project conclusion
- Total FRA cost $200k

FRA Project Manager

- Tarek Omar, (202) 493-6189, Tarek.Omar@dot.gov

Improved Truck Castings



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 Description

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

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)

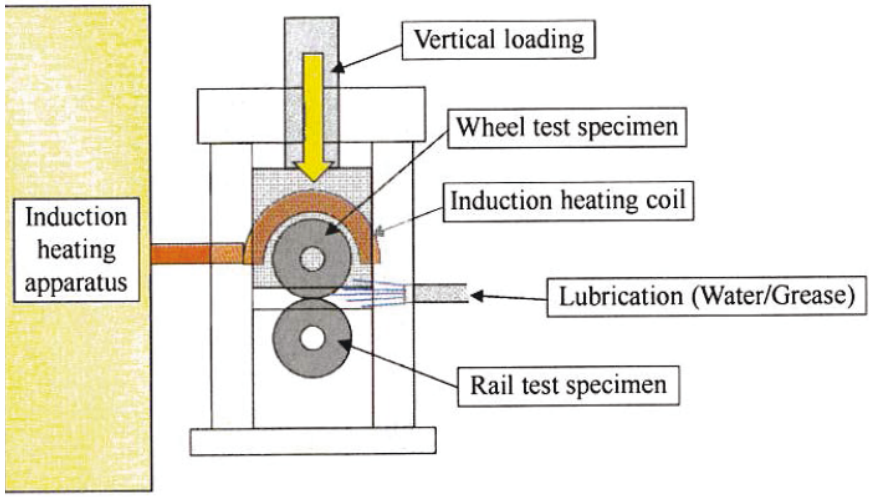
Cost & Schedule

- Budget of $164k
- 12 Month Project (Phase I)

FRA Project Manager

- Tarek Omar, (703) 407-1504, 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)

- TTCI, NSSMC

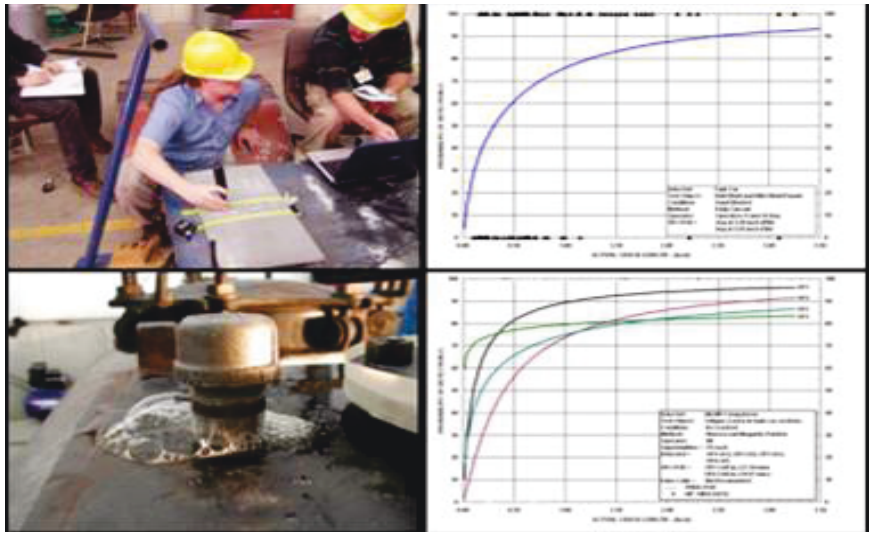
Cost & Schedule

- 2013 – Initial research and literature review
- 2104 – Visit to NSSMC laboratory, initial report
- 2015 – Meetings with NSSMC and test design and scheduling
- Total FRA cost $98K

FRA Project Manager

- Tarek Omar, (703) 407-1504, 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.

Project Partner(s)

- TTCI

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

Cost & Schedule

- Small Tank car shop NDT testing 2015 - $100k

FRA Project Manager

- Francisco Gonzalez, (202) 493-6076, francisco.gonzalez@dot.gov

Nondestructive Testing of Tank Cars and Probability of Detection (POD)

Project Description

- The rulemaking issued by the DOT 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.
  - Acceptable NDT methods include PT, MT, RT, UT, and VT for assurance of structural integrity of a tank car.
  - POD evaluations of these NDT methods by industry technicians and company procedures.

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.

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)

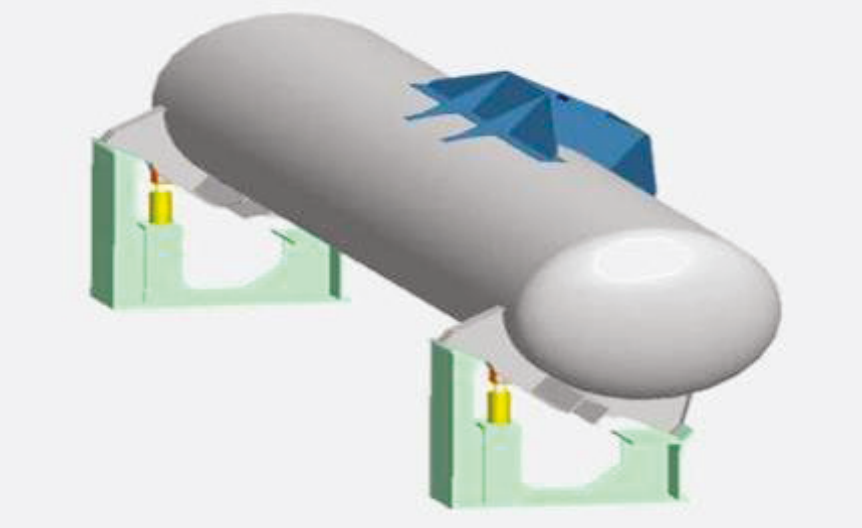
Cost & Schedule

- 2013-2015
- $300,000 Projected Costs

FRA Project Manager

- Francisco Gonzalez, (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, and reinforced protective housing.
- Calibrate analytical models to test results.
- Develop criteria and protocols for future industry research.

Project Partner(s)

- Sharma and Associates

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.

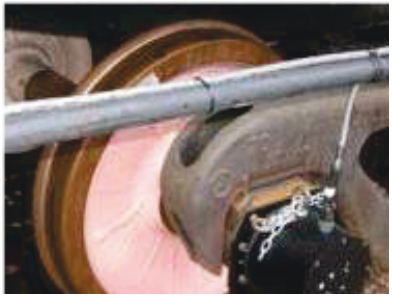
Cost & Schedule

- Evaluate retrofit techniques for DOT 111 – 2015 - $150k

FRA Project Manager

- Francisco Gonzalez, (202) 493-6076, francisco.gonzalez@dot.gov

Instrumented Tank Car



Project Description

- To determine the cause of fractures in the stub sills of tank cars.
- Instrument tank car with strain gauges, accelerometers, instrumented couplers, instrumented wheelsets, etc., Measure speeds as well as distance to couple for all track,
- specially Yard.
- Using similar instrumentation, add remote monitor equipment for autonomous data collection.

Project Partner(s)

- ENSCO Inc., GE Rail

Railroad Impact

- Creates better understanding of the operational environment and forces exerted on tank cars when fracture occurs.
- Confirms the industry's current understanding of fracture initiation and propagation.
- Potentially reveals additional factors that are critical to the understanding of the phenomena.

Cost & Schedule

- Yard impact testing – 2015 - $75k
- Over the road test-crude oil route - $100k

FRA Project Manager

- Francisco Gonzalez, (202) 493-6076, francisco.gonzalez@dot.gov

Renewable Fuels Non-Accident Releases Research

Railroad Impact

- Reduces the Non-Accident releases.
- Reduces the exposure of railroad employees to chemical releases.

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

Project Partner(s)

- Renewals Fuels Foundation

Cost & Schedule

- Best practices guideline 2015 - 50k

FRA Project Manager

- Francisco Gonzalez, (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.

Project Partner(s)

- Sharma & Associate, ARA, Transport Canada, The Chlorine Institute, BAM

Railroad Impact

- DOT requires that these tank car safety systems are designed so that they 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.

Cost & Schedule

- 1/3 scale test report 2015 - $100k

FRA Project Manager

- Francisco Gonzalez, (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.

Project Partner(s)

- Volpe Center

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.

Cost & Schedule

- Full scale testing and modeling - 2015 $150k

FRA Project Manager

- Francisco Gonzalez, (202) 493-6076, francisco.gonzalez@dot.gov

Tank Car Impact Tests

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

Project Partner(s)

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

Railroad Impact

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

Cost & Schedule

- Period of Performance - 8/6/2013 – 12/31/2015
- $1,079k project cost

FRA Project Manager

- Francisco Gonzalez,, (202) 493-6076, francisco.Gonzalez@dot.gov

Hazmat Risk Assessment

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 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.

Project Partner(s)

- Dr. Alan Bing, Private Consultant

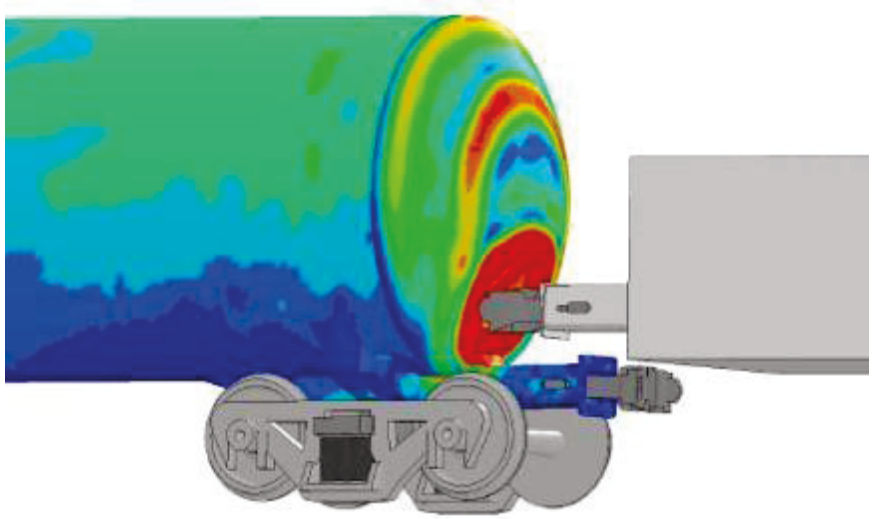
Cost & Schedule

- Final report 2015 - $50k

FRA Project Manager

- Francisco Gonzalez, (202) 493-6076, francisco.gonzalez@dot.gov

Collaboration with Industry



Railroad Impact

- This research is in cooperation with Advance Tank Car Collaborative Research Program (ATCCRP)
- 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 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.

Project Partner(s)

- AAR, Tank car manufacturers, Chemical Industries, PHMSA

Cost & Schedule

- Full scale test of pressure tank cars 2015 - $150k
- Develop testing procedures for new designs 2015 - $150k

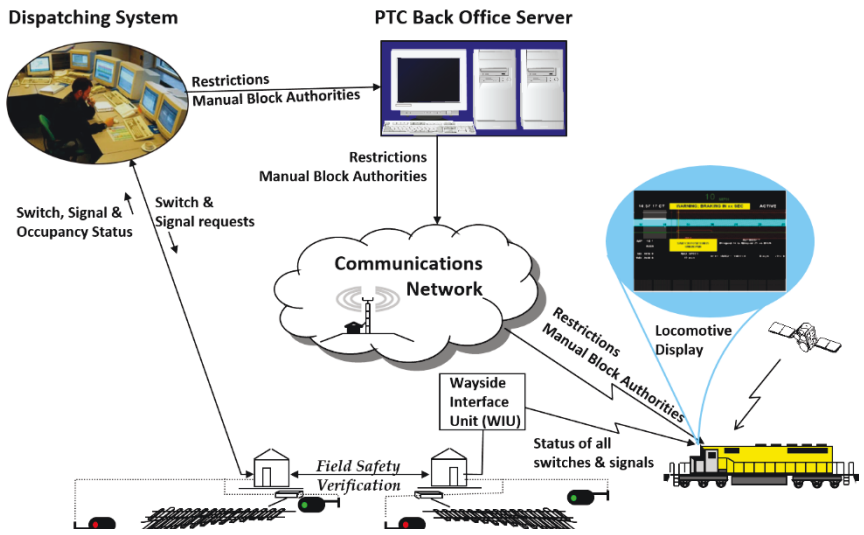
FRA Project Manager

- Francisco Gonzalez, (202) 493-6076, francisco.gonzalez@dot.gov

Section 3

Train Control and Communications

PTC Monitoring and Analysis of the Integrated Network (MAIN) Phase 1



Railroad Impact

- Work directly with the railroads to understand current monitoring and troubleshooting of PTC
- Document best practices for data collection and storage, analytic methods, and issue mitigation
- Develop a concept of operations for a standard tool that will assist railroads in deploying, integrating, testing, and operating PTC

Project Description

- Determine what information and methods are used by railroads and suppliers to diagnose PTC system problems and to assess status, performance and trends
- Identify what additional data would enable more complete situational assessment and more efficient diagnostics
- PTC troubleshooting tools and methods, with maximal automation, will be proposed for development of MAIN

Project Partner(s)

- Transportation Technology Center, Inc.

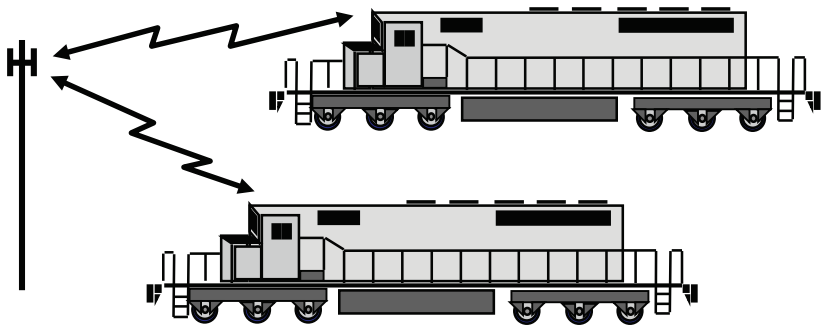
Cost & Schedule

- 2016 - Visit railroads to discuss current monitoring and analysis of their PTC systems
- 2017 - Continue to work with railroads to setup best practices for data collection and storage and analysis. Develop a concept of operations for the standard tool MAIN.
- 2018 - Submit phase 1 report and recommendations on future phases
- Project end date is 2/16/2018 –
- Total FRA cost $722,500

FRA Project Manager

- Richard Orcutt, (719) 584-0507, richard.orcutt@dot.gov

Railroad Wireless Communications Roadmap



Project Description

- 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

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)

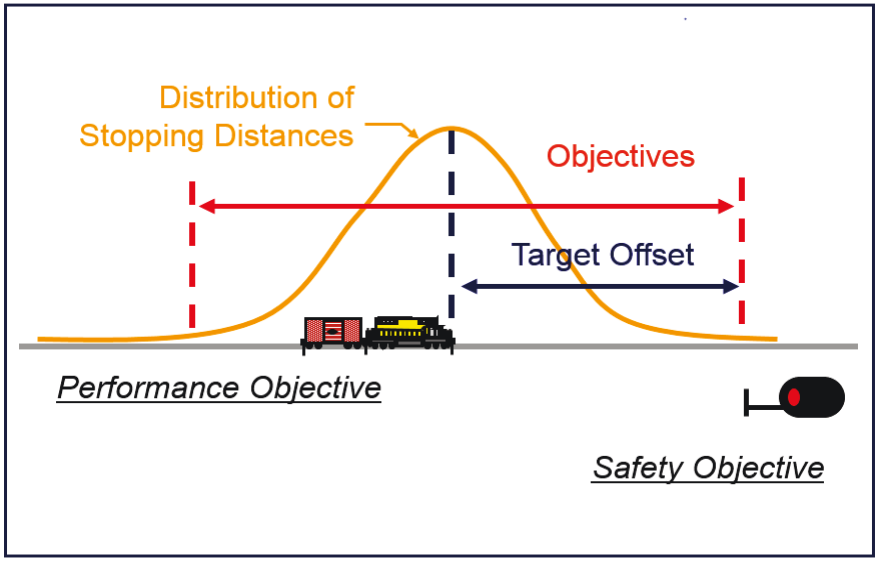
Cost & Schedule

- $338k overall cost
- Planned project completion in December 2016

FRA Project Manager

- Jared Withers, (202) 493-6362, Email: jared.withers@dot.gov

Passenger-Commuter PTC Braking Enforcement Algorithm Research



Railroad Impact

- Evaluate performance of PTC enforcement algorithms with reduced time and cost associated with revenue service testing
- Improve accuracy of braking distance prediction in PTC implementation for passenger/commuter trains.
- As funding permits, support passenger and commuter agencies by providing and presenting data and analysis to help in gaining enforcement algorithm approval from FRA Office of Safety

Project Description

- Perform simulation testing of the current I-ETMS and ACSES enforcement algorithms and identify potential areas of concern
- Develop a passenger/commuter train enforcement algorithm test application
- Identify potential methods for improvement of enforcement algorithm performance
- Field testing of the improved passenger/commuter train enforcement algorithm

Project Partner(s)

- Transportation Technology Center, Inc.

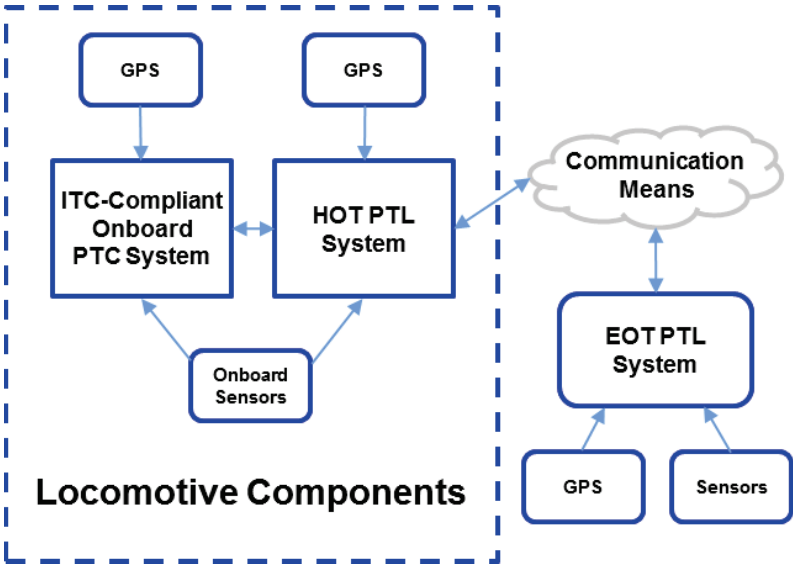
Cost & Schedule

- 2016 Q4 I-ETMS and ACSES performance simulations
- 2016 Q4 Develop and evaluate base passenger brake algorithm
- 2017 Q1 Investigate algorithm enhancements
- 2017 Q3 Field test algorithm enhancements
- 2017 Q4 Report
- Total FRA cost $1,067,039

FRA Project Manager

- Richard Orcutt, 719) 584 – 0507, richard.orcutt@dot.gov

Positive Train Location



Railroad Impact

- Accurate train length and train location data at both train initialization and during train operation
- Reliable automatic track discrimination
- Determination of train clearing switch with no track circuit
- Enabling technology for moving block or virtual block operations

Project Description

- Develop, integrate, and test a high-accuracy, augmented GPS train location system
- For use on ITC-compliant PTC equipped trains

Project Partner(s)

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

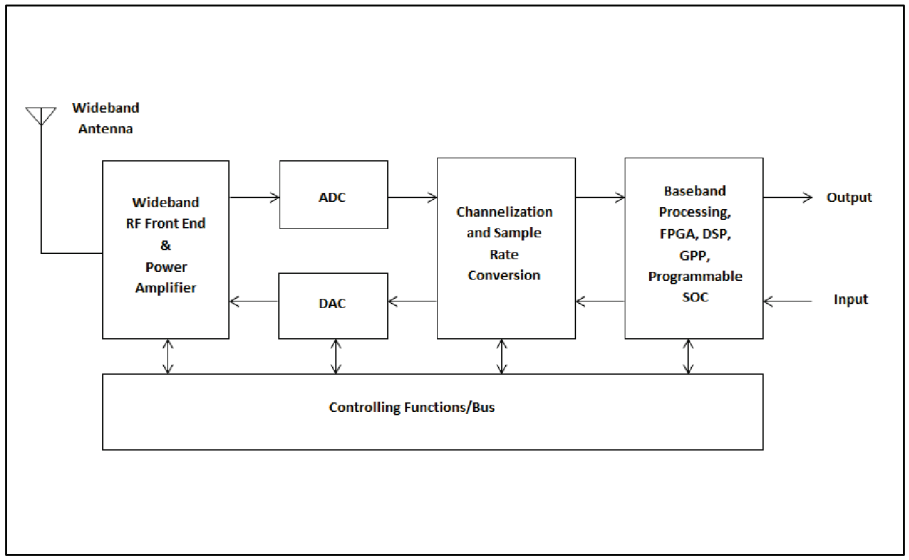
Cost & Schedule

- $5M overall cost for 2012-2016
- Planned project completion in December 2016

FRA Project Manager

- Jared Withers, (202) 493-6362, jared.withers@dot.gov

Rail Software-Defined Radio (SDR)



Project Description

- 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)

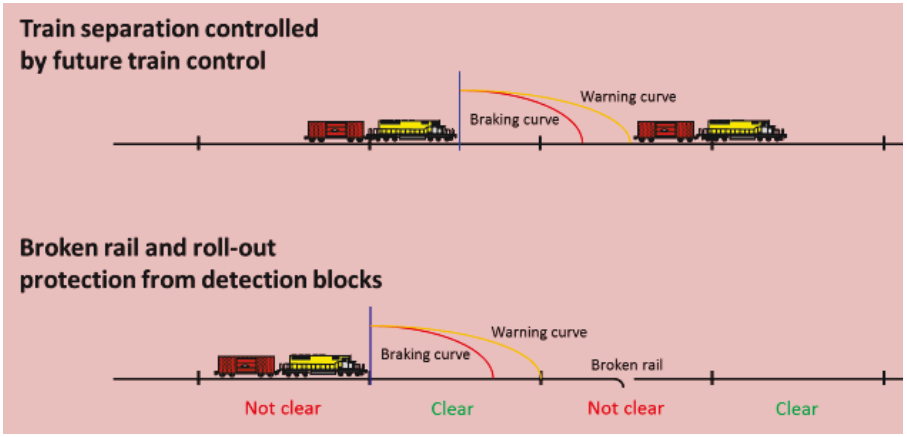
Cost & Schedule

- Period of Performance – 15 months
- $518,188

FRA Project Manager

- Jared Withers, (202) 493-6362, jared.withers@dot.gov

Next Generation Track Circuits



Project Description

- Develop Concept of Operations (Conops)
- Survey the current and emerging technologies that may support implementation of next generation track circuits
- Prepare and issue a Request for Information (RFI) to suppliers and developers
- Research the physical characteristics of rail as a sensing medium

Railroad Impact

- Next Generation Track Circuits provide broken rail and roll-out protection that will be utilized by a future train control system

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)

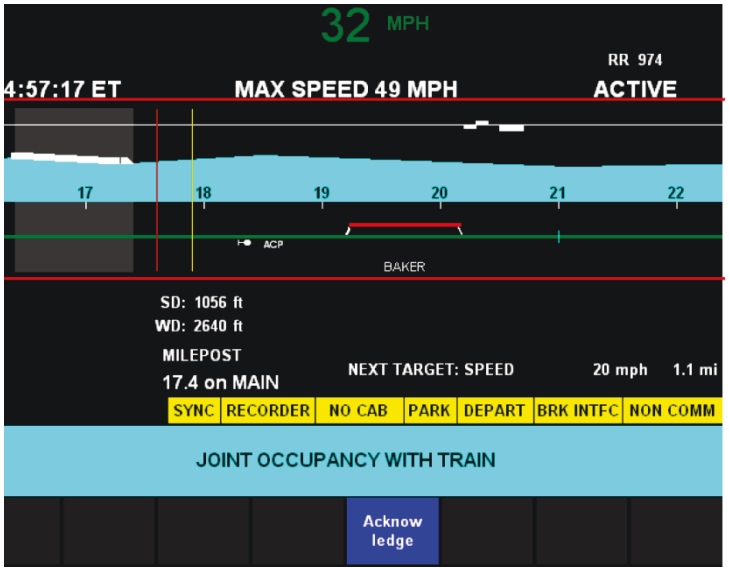
Cost & Schedule

- Period of Performance: 6/2015 – 6/2017
- $236k project overall cost

FRA Project Manager

- Richard Orcutt, (719) 584-0507, richard.orcutt@dot.gov

PTC Test Facility Analysis and Design



Railroad Impact

- An Interoperable Train Control (ITC) laboratory with simulators and ITC hardware-in-the-loop, combined with the on-track test capabilities at TTC can provide the desired test facilities to railroads for performing regression testing with new components and software releases
- Help ensure railroads are operating compatible and fully tested ITC releases

Project Description

- Conduct an assessment of railroad ITC test cases and facilities to perform a gap analysis to determine what is necessary to build an industry standard ITC Test Lab at Transportation Technology Center (TTC)
- Develop a way-forward for the design and development of a ITC Test Lab at TTC

Project Partner(s)

- Transportation Technology Center, Inc.

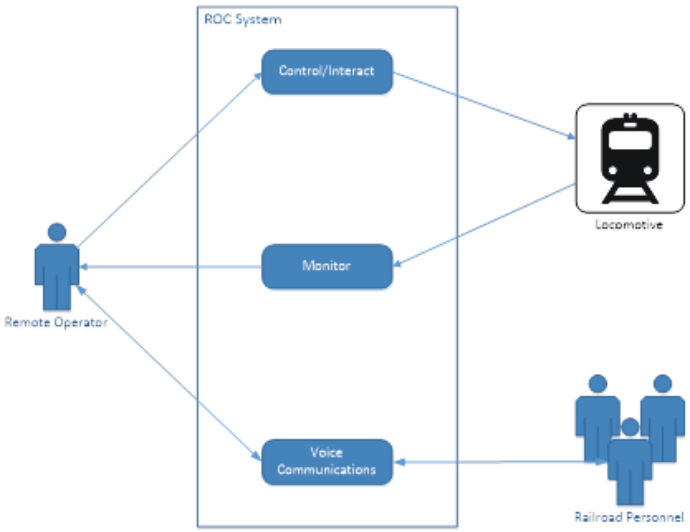
Cost & Schedule

- $41,816 – April 2016 to August 2016

FRA Project Manager

- Richard Orcutt, (719) 584-0507, richard.orcutt@dot.gov

Flexible Operator Location Feasibility Analysis



Railroad Impact

- Potential to improve operational efficiency and system capacity by reducing the number of hand brake applications and allowing railroads to change crews at any time, irrespective of train location
- Potential to improve safety by reducing overtime hours ensuring locomotive crews remain alert, preventing fatigue-related incidents

Project Description

- 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

Project Partner(s)

- Transportation Technology Center, Inc.

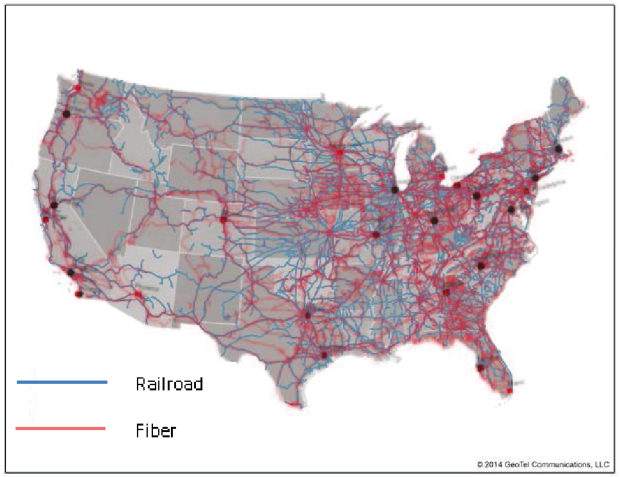
Cost & Schedule

- $400,013 – September 2015 to March 2017

FRA Project Manager

- Jared Withers, (202)493-6362, Email: jared.withers@dot.gov

Fiber Optic Availability and Opportunity Analysis for North American Railroads



Railroad Impact

- Identify priority applications of utilizing Fiber Optic Acoustic Detection (FOAD) technology in the railroad industry.
- Potential to enhance railroad safety by offering increased train tracking capabilities and potential for monitoring and detecting wayside events.
- Potential for cost savings benefits to the railroads as a single FOAD system may be utilized for multiple functions, thereby reducing the costs associated with several individual systems.

Project Description

- Collaborate with AAR FOAD Task Force to identify the priority railroad applications of FOAD technology.
- Determine, to the extent possible, the amount and typical characteristics of existing fiber optic cable installed along the North American rail network.
- Document the advantages and limitations for potential fiber optic-based railroad applications and the corresponding, existing non-fiber optic-based systems that perform similar functions.
- Provide a comparison of the cost drivers associated with FOAD technology to those of existing systems performing similar functions.

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)

Cost & Schedule

- $103,936 – January 2016 to November 2016

FRA Project Manager

- Richard Orcutt, (719) 584-0507, richard.orcutt@dot.gov

Support for Technical Training Standards Department

Railroad Impact

- Training facility and technical support for Federal and participating State railroad safety inspectors
- Incorporates hands on training into the class curriculum to enhance the design, development, and delivery of training classes

Project Description

- Technical support to the Technical Training Standards Department (TTSD) leadership and lead instructors under the six technical disciplines
- TTSD has begun transitioning its training program to TTC with the support from TTCI to incorporate hands on training into the class curriculum for FRA personal that regulate railroad safety

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)

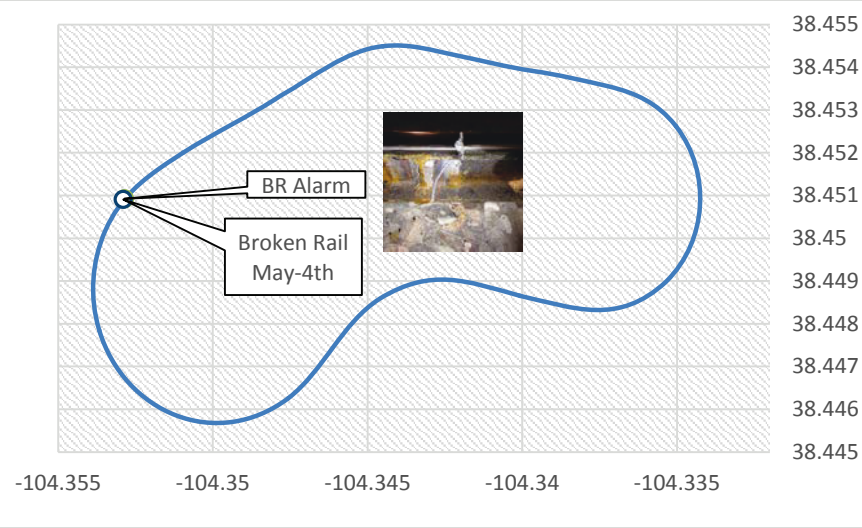
Cost & Schedule

- Period of Performance – 05/31/2016 – 05/30/2017
- Project Cost: $114K

FRA Project Manager

- Rick Orcutt, (719) 584-0507, richard.orcutt@dot.gov

Broken Rail Detection Evaluation of Fiber Optic Based Systems



Railroad Impact

- Gain an understanding of how current fiber optic based broken rail detection systems perform
- GAP analysis that shows what current fiber optic systems can and cannot do with regards to conventional track circuits
- Paths forward for fiber optic systems to fill in areas from GAP analysis
- Recommendation on future work for fiber optic based broken rail detection

Project Description

- Evaluate the broken rail detection capabilities of fiber optic based systems
- 20 weeks of testing during FAST operations will be used to characterize the false positives, false negatives, and true positives of broken rail detections
- Conduct a GAP analysis between current fiber optic technology and conventional track circuits and research how fiber optic systems can start filling gaps

Project Partner(s)

- Transportation Technology Center, Inc.

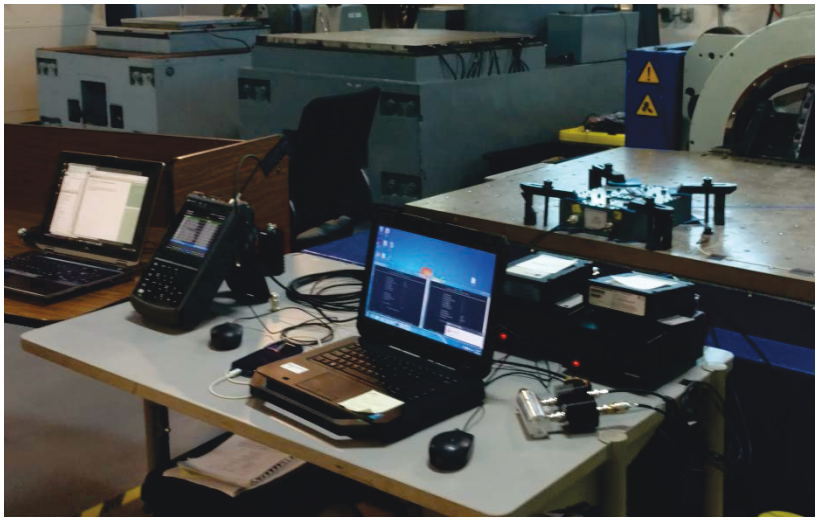
Cost & Schedule

- 2015 Worked with vendors to get interest in participating in evaluation
- 2016 Installed two systems for evaluation, worked on calibration of systems on HTL fiber test bed, and began evaluation
- 2017 Complete evaluation during FAST operations, document results, and conduct GAP analysis
- Project end date is 1/16/2018 – Total FRA cost $813,500

FRA Project Manager

- Richard Orcutt, (719) 584-0507, richard.orcutt@dot.gov

PTC Locomotive Filter Identification and Test



Railroad Impact

- Potential mitigation of PTC radio interference, that results in degraded PTC system performance and reliability, between ITC and ACSES deployments in the North East Corridor.
- Identification and test of potential industry wide solution to interference between ITC and ACSES systems.
- Environmental RF test results may be applicable to other railroad radio bands.

Project Description

- Develop requirements for radio frequency (RF) filters to protect ACSES and ITC 220 MHz locomotive radios from desense.
- Acquire sample 220 MHz RF filters of multiple technologies for test.
- Design performance and environmental test program for RF filters.
- Conduct environmental and performance tests on filters to determine feasibility of using RF filters on locomotives.

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)

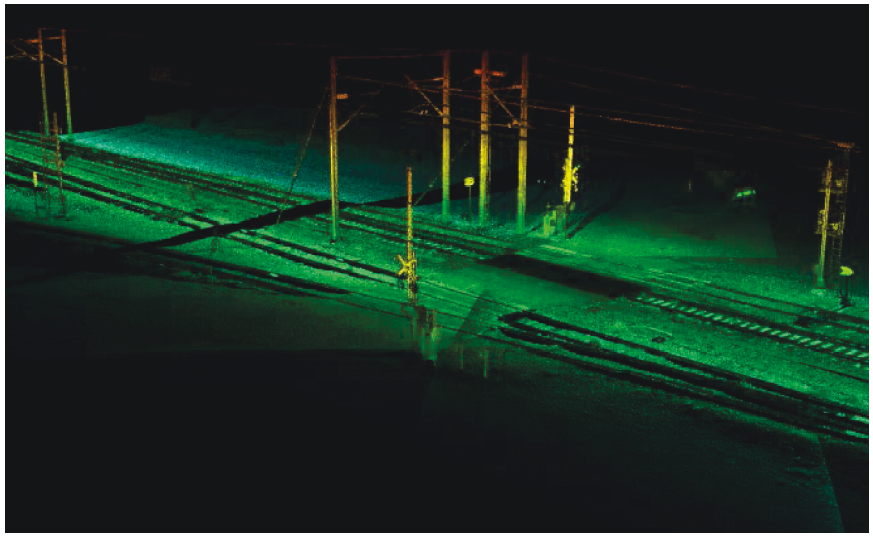
Cost & Schedule

- $510k overall cost
- Period of Performance: 10/2015 – 12/2016

FRA Project Manager

- Richard Orcutt, (719) 584-0507, richard.orcutt@dot.gov

PTC Critical Assets Machine Vision Track Map Auditing System Requirements



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 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

Project Partner(s)

- Transportation Technology Center, Inc. (TTCI)

Cost & Schedule

- Period of Performance – 9/21/2015 – 6/29/2017
- $317,206 project cost

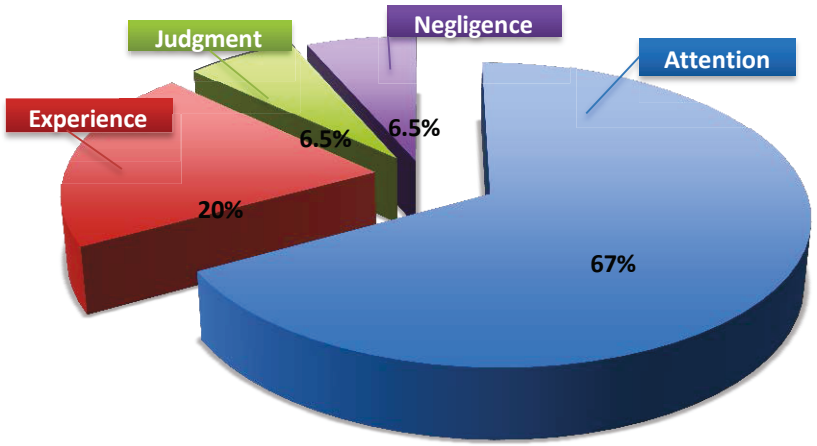
FRA Project Manager

- Jared Withers, (202) 493-6362, jared.withers@dot.gov

Section 4

Human Factors

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



Veolia Transportation Services Inc. Study

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 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

Project Partner(s)

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

Cost & Schedule

- Project was completed September, 2014, FRA Technical Report in editing
- Cost-share agreement, $250k, started May, 2011 Data collection completed mid-August, 2014 Analysis completed September, 2014
- Pilot training course on distraction developed.

FRA Project Manager

- Mike Jones, michael.e.jones@dot.gov

Experimental Crewstation Evaluation

Railroad Impact

- This crewstation 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 Description

- Volpe evaluated the effectiveness of the experimental crewstation. 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. Additionally, 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.

Project Partner(s)

- Volpe Transportation Research Center – Human Factors Div.

Cost & Schedule

- Volpe HF-IAA, Aug 2014 to Sept 2015
- $56,765
- $47K remaining

FRA Project Manager

- Michael Jones, FRA Program Manager Humans and Technology
  michael.e.jones@dot.gov

Computer-Based Training in Human Systems Integration

Project Description

- Conduct a pilot project to develop, implement and assess a computer-based training (CBT) suite to improve industry's awareness of, and use of Human Systems Integration (HSI), particularly human factors engineering methods in system development.

Railroad Impact

- Introduce and inform rail industry on HSI/HFE methods Encourage implementation of HSI/HFE methods to improve
- performance, safety, and reduce total life-cycle costs of new rail systems.

Project Partner(s)

- Applied Research Associates, Inc

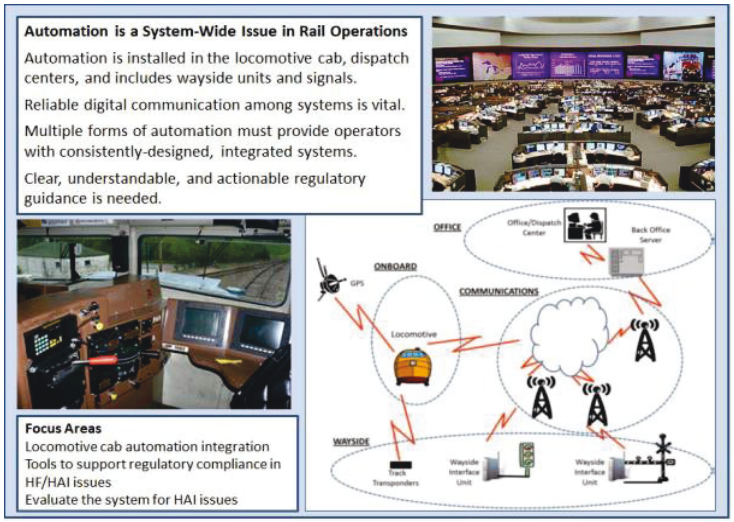
Cost & Schedule

- Project started December, 2013, $450k
- Phase 1 1st year, $250k, develop training requirements and learning objectives
- Phase 2 2nd year, $200k, develop CBT pilot suite

FRA Project Manager

- Mike Jones, RPD-34, michael.e.jones@dot.gov

Human-Automation Interaction Aviation Lessons Learned



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
- Improves 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 Description

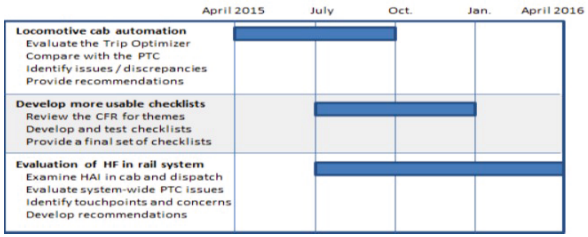
- Research implementation of automation in the aviation domain and provide lessons learned to the rail industry domain.

Project Partner(s)

- Alion Science and Technology, Boulder CO

Cost & Schedule

- Cost: $295K.



FRA Project Manager

- Mike Jones, RPD-34, michael.e.jones@dot.gov

Suicide Countermeasures

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

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 Center
- Various railroad carriers

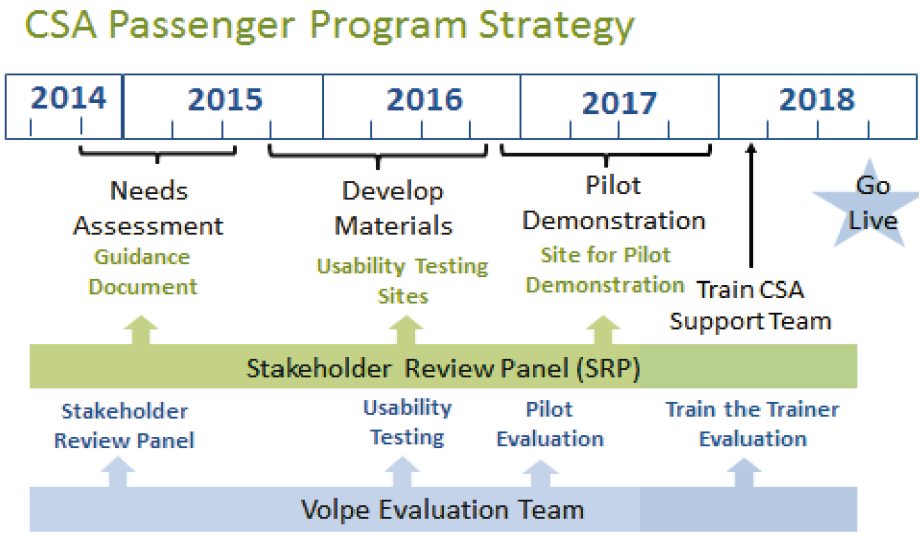
Cost & Schedule

- Period of Performance: through 6/30/2015

FRA Project Manager

- Starr Kidda, 202-493-1300, starr.kidda@dot.gov

Passenger Clear Signal for Action Materials Project



Railroad Impact

Pilot Programs	Dept	Outcomes
Rules Revision	All Operating	**51%** reduction in reportable injuries Drop in *liability claims*
EAGLES*	Station Services	**80%** drop in *injury rates* **76%** drop in reportable injuries
ISROP	Mechanical	**50%** drop in injury rates (all injuries)
CAB*	Road	**72%** drop in L.E. *decertification rates* **69%** drop in HF *derailment rates*
STEEL*	Switching	**62%** drop in yard derailment rates
C3RS	Road & Yard	Reduced accidents Improved safety culture
*** CSA Projects**		

Project Description

- CSA is a proactive joint labor-management method for improving safety and safety culture by changing practices, procedures, and policies. It integrates peer-to-peer feedback, continuous improvement, and safety leadership
- This project will provide no-cost, customizable CSA software and training materials and low-cost implementation support for passenger rail.
- This project will use a 20+ railroad Stakeholder Review Panel to ensure utilization. The SRP will review an Implementation Guidance Document for how to implement the program.
- The CSA contractor will train FRA personnel to help railroads implement the program.

Project Partner(s)

- Office of Railroad Safety Analysis Virginia Rail Express
- Metra Direct BLET
- SMART

Cost & Schedule

- Period of performance : 8/25/2011 – 9/30/19 *
- Total funding: $9M

FRA Project Manager

- Maryam Allahyar, 202-493-6356, maryam.allahyar@dot.gov

RAIL
Moving America Forward

New Jersey Transit Run Through Switch Project

Railroad Impact

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

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.

Project Partner(s)

- FRA sponsored research
- Volpe Transportation Research Center

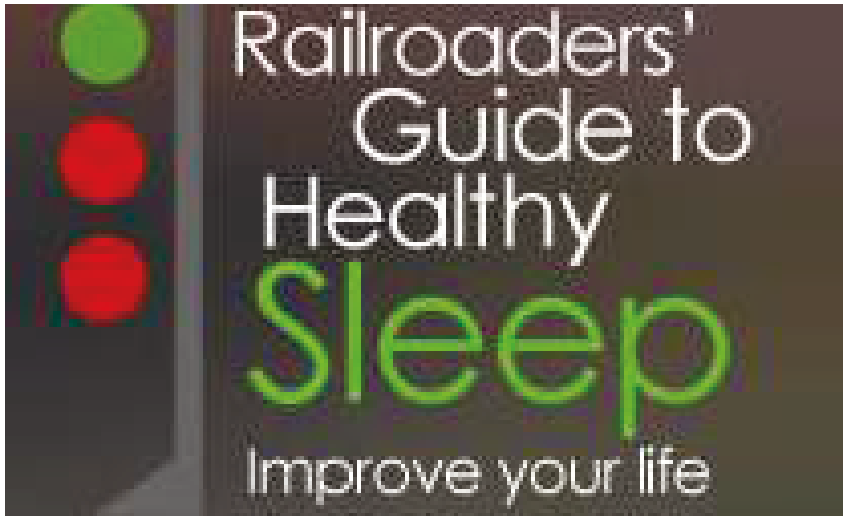
Cost & Schedule

- Approx. $200K
- October 2016 to September 2017

FRA Project Manager

- Rachel Grice, rachel.grice@dot.gov

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



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 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. The site re-launch is planned for the 2015 TRB conference, and will be accompanied by cross-industry promotion efforts and other outreach activities involving stakeholders.

Project Partner(s)

- Volpe, The National Transportation Center
- Harvard Medical School Division of Sleep Science
- AAR, ASLRRA, BLET, SMART-TD, and rail carriers

Cost & Schedule

- Estimated Period of Performance: 30 June, 2015
- Project Balance: $600k (including project evaluation effort)
- Received $310k in FY14

FRA Project Manager

- Maryam Allahyar 202-493-6356, maryam.allahyar@dot.gov

Maintenance-of-Way Worker Fatigue

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 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.

Project Partner(s)

- FRA-sponsored research, 10 major passenger railroads

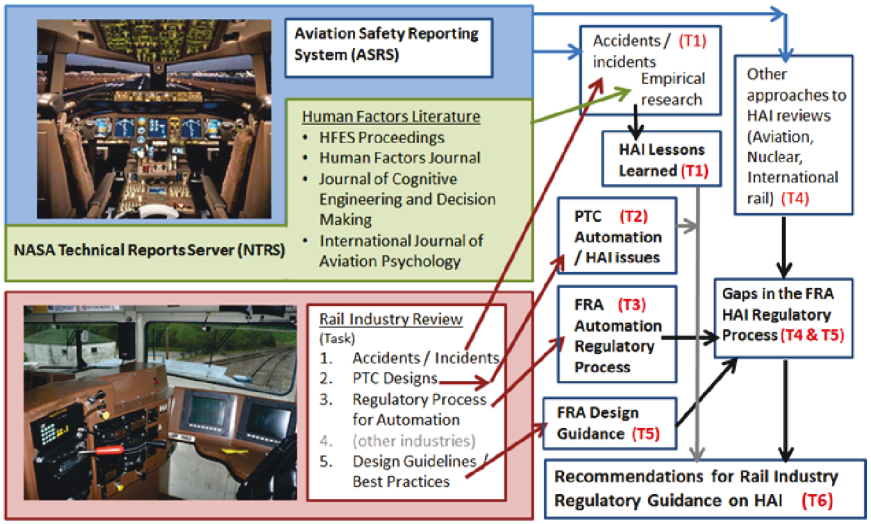
Cost & Schedule

- Approx. $150K
- May 2016 to November 2017

FRA Project Manager

- Rachel Grice-Project Manager, rachel.grice@dot.gov

Human-Automation Interaction (HAI) Guidance



Railroad Impact

- Guidance to human performance specialists for evaluating locomotive cab automation
- Identification of factors that affect engineer performance
- Provides technical bases for evaluating and comparing potential systems
- Improves 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 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**.
- We will 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.
- We will develop **recommendations for regulatory guidance** regarding HAI for the rail industry.

Project Partner(s)

- Alion Science & Technology

Cost & Schedule

- July, 2015 to August, 2016
- $288,619

FRA Project Manager

- Michael Jones, michael.e.jones@dot.gov

Wearable Technology Interface for Track Inspection

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 Description

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

Project Partner(s)

- Fulcrum Corporation
- Buckingham Branch Railroad

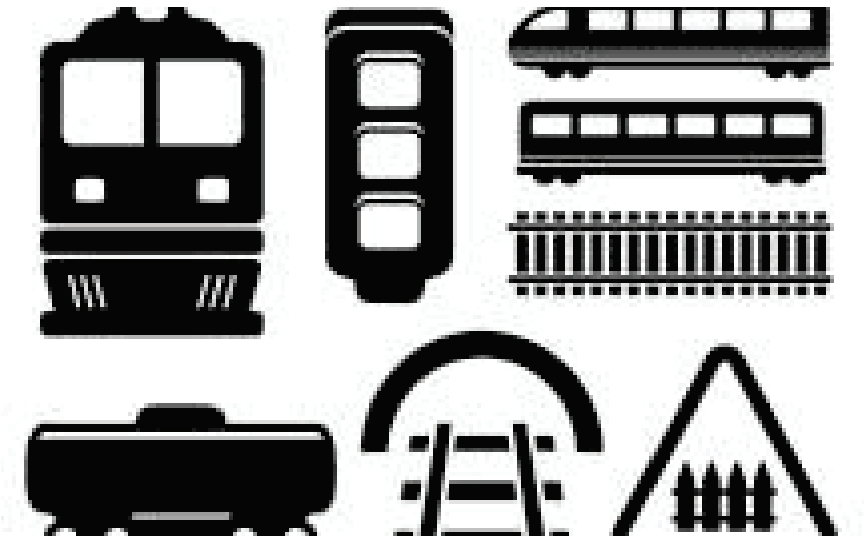
Cost & Schedule

- $149,280 April 01, 2016 to March 31, 2017

FRA Project Manager

- Michael Jones, michael.e.jones@dot.gov

Human System Integration E-Learning Website --Distraction



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 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

Project Partner(s)

- Applied Research Associates

Cost & Schedule

- Period of performance: December 2013 to August 2016
- Total cost: $ 455K

FRA Project Manager

- Michael Jones, michael.e.jones@dot.gov

A Head-up Display (HUD) Alternative for Locomotives

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 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.

Project Partner(s)

- FRA sponsored & led research, MIT Man-Vehicle Lab, Volpe Transportation Research Center

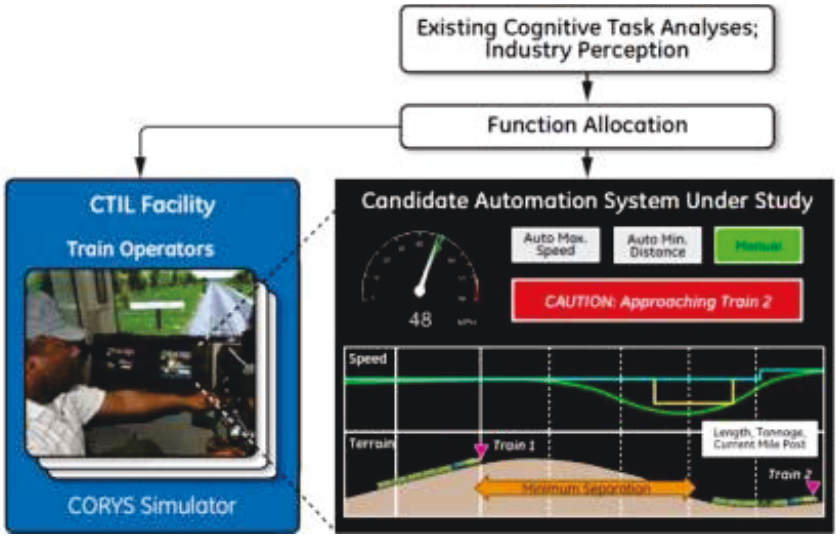
Cost & Schedule

- Approx. $150K ($48K for MIT production of HUD)
- June 2016 to June 2017

FRA Project Manager

- Michael Jones, michael.e.jones@dot.gov

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



Railroad Impact

- Framework for novel workflow and roles definition for, e.g., reduced workload & 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 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

Project Partner(s)

- GE-Global research, the MIT Man-Vehicle Lab, the Volpe Transportation Research Center

Cost & Schedule

- Phase 1 cost share $350K Analysis, Function allocation
- Phase 2 Cost Share $360K Research in FRA's CTIL
- Overall 2-year study, started May, 2014
- Extended data analysis thru January, 2017

FRA Project Manager

- Michael Jones, michael.e.jones@dot.gov

Human Systems Integration Acquisition Guidance Document

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 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.

Project Partner(s)

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

Cost & Schedule

- Volpe HF-IAA, Oct 2012 to Sept 2016
- $216,356
- $75,094 remaining

FRA Project Manager

- Michael Jones, michael.e.jones@dot.gov

Motorist Behavior at Grade Crossings

Railroad Impact

- Human behavior is a main cause of grade crossing accidents
- Purpose of project:
  - Collect and analyze data about why drivers violate grade crossings
  - Use characteristics associated with grade crossing accidents to prevent accidents and improve grade crossing design

Project Description

- Project Goals:
  - Determine whether technology (e.g., cameras) can help prevent and deter grade crossing violations
  - Analyze Naturalistic Driving Study data to determine how drivers react to active and passive grade crossings
  - Develop simulator scenarios to examine driver behavior under different conditions
  - Describe trends and correlations associated with grade crossing accidents
  - Incorporate trends and correlations into a predictive model of grade crossing accidents
  - Determine the relationship between train arrival time and motorists' compliance with grade crossing warning devices

Project Partner(s)

- Sharma & Associates
- Michigan Technological University
- Volpe
- City of Orlando, FL

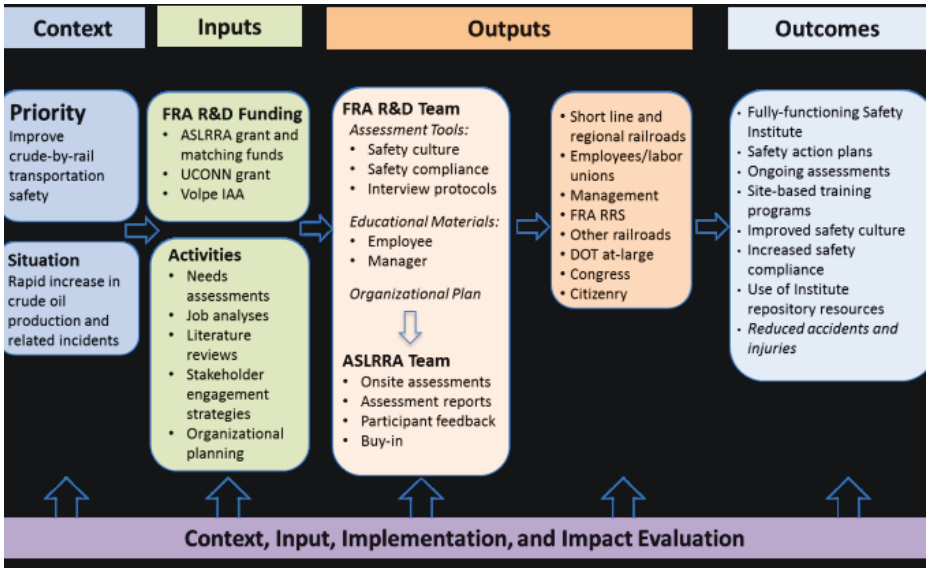
Cost & Schedule

- Grade Crossing Data Analysis and Predictive Modeling: $300,000
- Photo Enforcement at Grade Crossings: $180,000
- Driver Behavior at Highway-Rail Grade Crossings: $271,223
- Motorist Behavior Modeling: $150,000

FRA Project Manager

- Starr Kidda, 202-493-1300, starr.kidda@dot.gov

Short Line Safety Institute



Railroad Impact

- The Short Line Safety Institute (Institute) was formed to improve safety practices and safety training for Class II and Class III freight railroads that transport crude oil and other hazardous materials to build a stronger, sustainable safety culture
- The Institute:
  - Conducts **safety culture assessments** and provide recommendations on how to improve safety culture;
  - Provides **training and education** about safety culture;
  - Serves as a **research** center that compiles and disseminates information on safety needs and trends;
  - **Communicates** to stakeholders about safety culture improvement efforts

Project Description

- FRA is partnering with the Institute 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 Institute to develop and test safety culture assessment tools and provide on-going program improvement
  - The University of Connecticut (UConn) developed a safety culture survey, interview protocols, and procedures for assessing and measuring safety culture.
  - Volpe provides evaluative feedback to the Institute on its processes and procedures.
  - FRA RD&T's expertise in safety culture, organizational change, and industrial/organizational psychology provides support for the Institute's strategic direction.

Project Partner(s)

- Short Line Safety Institute, University of Connecticut (UConn), and Volpe

Cost & Schedule

- FY16:
  - $1.9 million grant to Short Line Safety Institute
  - $200,000 to Volpe

FRA Project Manager

- Starr Kidda, 202-493-1300, starr.kidda@dot.gov