# Federal Railroad Administration
# Office of Research, Development, and Technology

## Broad Agency Announcement – BAA 2015

## Appendix C – Research Topics

Note: Concept papers may be submitted at any time, through the closing date of the research topic.

| Track Research | | |
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| **Topic** | **Title** | **Closing Date for Concept Papers** |
| FRA-TR-001 | Field Assessment of Ballast Support Condition via Measurement of Tie Deflection Profile | May 4, 2015 |
| FRA-TR-002 | Abrasive Interaction between Concrete Ties and Ballast: Laboratory Characterization and Field Inspection | May 4, 2015 |
| FRA-TR-003 | Automated Rail Turnout Inspection Technology | May 4, 2015 |
| FRA-TR-004 | Mechanisms and Criteria for Ballast Performance | May 4, 2015 |
| FRA-TR-005 | Innovative Methods for Measuring Longitudinal Rail Stress | May 4, 2015 |
| FRA-TR-006 | Wheel/Rail Force Measurement | May 4, 2015 |
| FRA-TR-007 | High Speed Rail Noise Standards and Regulations | May 4, 2015 |
| FRA-TR-008 | Leveraging Satellite Data for Safety-Related Condition Monitoring | May 4, 2015 |

| Rolling Stock and Equipment | | |
|---|---|---|
| **Topic** | **Title** | **Closing Date for Concept Papers** |
| FRA-RS-001 | Big Data from Wayside and Onboard Detection Systems | May 4, 2015 |
| FRA-RS-002 | Safety at Passenger Rail Stations | May 4, 2015 |

| Train Control | | |
|---|---|---|
| **Topic** | **Title** | **Closing Date for Concept Papers** |
| FRA-TC-001 | Non-Track Circuit Train Detection for Advance Highway Intersection Preemption | May 4, 2015 |
| FRA-TC-002 | Automated Freight Train Technologies | May 4, 2015 |
| FRA-TC-003 | Drone/Unmanned Remote Sensing Vehicles for Railroads | May 4, 2015 |

| Human Factors | | |
|---|---|---|
| **Topic** | **Title** | **Closing Date for Concept Papers** |
| FRA-HF-001 | Human Performance Modeling and Simulation | May 4, 2015 |
| FRA-HF-002 | Evaluation of Industry Safety Culture | May 4, 2015 |

# Track Research

**Topic: FRA-TR-001**

**Title: Field Assessment of Ballast Support Condition via Measurement of Tie Deflection Profile**

The classical railroad engineering theory dictates that the tie deflection profile changes as the ballast support condition changes, e.g., from the newly tamped to the center binding conditions. Recent finite element (FE) modeling efforts have enabled the prediction of detailed concrete tie deflection profiles subjected to dynamic track loading and under varying ballast support conditions. This research seeks to (1) develop new or adapt existing technologies that provide accurate in-track measurement of tie deflection profiles, and (2) assess and classify ballast support conditions by processing the tie deflection measurement data. The measurement shall contrast fully loaded vs. reference (i.e., unloaded or lightly loaded) tie deflection profiles. This research shall leverage the detailed FE modeling work ongoing at the Volpe National Transportation Systems Center to analyze tie deflection profiles and assess ballast support conditions.

**Topic: FRA-TR-002**

**Title: Abrasive Interaction between Concrete Ties and Ballast: Laboratory Characterization and Field Inspection**

The abrasive interaction between concrete ties and ballast due to cyclic dynamic track loading can be detrimental to the integrity of railroad track structures. Field observations have indicated that such interactions can lead to worn concrete ties with reduced flexural capacity, in addition to deteriorated ballast from pulverization. The combined effects of abraded tie bottom and pulverized ballast can lead to voids or gaps along the tie-ballast interfaces. Uneven gaps toward the tie ends can give rise to unfavorable center binding support conditions for the concrete ties. The objectives of this research topic are to (1) develop a better understanding of the abrasive mechanism between concrete ties and ballast under cyclic dynamic loading in a laboratory setting, and (2) develop or apply novel technologies capable of detecting and measuring the deteriorations along the tie-ballast interfaces. The former shall lead to experimental methods that characterize the abrasion in the concrete tie-ballast interfaces and qualification tests that evaluate the abrasion resistance of concrete ties. The latter shall lead to in-track detection and measurement of reduced concrete tie cross sections and/or gaps between the concrete tie and ballast components. Research projects addressing one or both objectives are acceptable.

**Topic: FRA-TR-003**

**Title: Automated Rail Turnout Inspection Technology**

This topic seeks to develop automated turnout inspection technology that can inspect all sizes and types of switches in common use in the US rail system to FRA safety standards. The objective of this research is to augment traditional human inspection techniques with advanced technology that can make the inspection process more accurate and efficient. To date there has been limited progress made towards this objective through the adaption of line scan imaging and laser-based geometry measurement systems. These systems are typically rail-vehicle-based and provide some quantitative data from of turnout conditions, but are technology-limited. The focus of this research is to study the applicability of other technologies such as optical scanning, machine vision, and associated comparative algorithms in an attempt to form the technical foundation of a more complete inspection system. The vision of a future system is one that can "scan" the turnout and automatically generate a comprehensive condition report. Ideally, the system should be human-portable.

**Topic: FRA-TR-004**

**Title: Mechanisms and Criteria for Ballast Performance**

The performance of ballast is critical to the safe and economic performance of track. Testing to demonstrate ballast failure modes and mechanisms are sought as they relate to the practical development of inspection criteria, measurement systems, and performance measures for track. Development of systems targeting known failure mechanisms, problem conditions, or safety concerns will be considered for funding under this task. In addition, methods to remediate problem ballast conditions to provide more reliable and effective ballast maintenance will also be considered. These areas must all be linked to alleviating problem ballast performance that can affect track performance or improve the safety and reliability of rail transportation, especially considering oil train routes and other high risk corridors or commodities.

**Topic: FRA-TR-005**

**Title: Innovative Methods for Measuring Longitudinal Rail Stress**

The stress state of rail is a key parameter that drives rail safety. Effective management of thermal stresses in rail is critical to preventing rail buckles and pull-a-parts. The objective of this research topic is to develop technologies that can accurately measure the absolute stress state of rail without disturbing the track structure and without prior knowledge of the zero stress state (neutral temperature) of the rail.

**Topic: FRA-TR-006**

**Title: Wheel/Rail Force Measurement**

This topic seeks to develop innovative techniques to measure wheel /rail forces. Direct measurement of wheel/rail forces is typically accomplished through the use of strain gage arrays mounted directly to the wheel plate. Signals are transmitted through slip rings or other devices that accommodate the rolling motion of the wheel. These techniques are accurate, but costly and time consuming to execute. The FRA is interested in developing new technologies to directly measure lateral, vertical and longitudinal forces at the wheel/rail interface at speeds up to 200 mph. Systems shall be mounted to moving railcars, as opposed to stationary wayside installations.

**Topic: FRA-TR-007**

**Title: High Speed Rail Noise Standards and Regulations**

Research is needed to determine the most appropriate standards and regulations for managing noise in high speed passenger rail environments. FRA seeks new or revised noise standards for passenger rail operating at speeds greater than 160 mph. These new or revised standards shall be based on empirical data and analysis of industry best practices. In addition to standards, FRA seeks guidance on effective strategies and techniques to regulate noise environments in high speed rail territories to eliminate or limit exposure to harmful noise levels.

**Topic: FRA-TR-008**

**Title: Leveraging Satellite Data for Safety-Related Condition Monitoring**

FRA is interested in cooperative projects with railroads and researchers to investigate and/or demonstrate the feasibility of using commercially available satellite data for condition monitoring of safety critical elements of railroad infrastructure. Successful projects will include condition monitoring for landslides, track shift, track structure movement, or other related conditions. All projects shall include significant levels of railroad participation to ensure that the developed technology is immediately useful for railroad safety condition monitoring.

# Rolling Stock and Equipment Research

**Topic: FRA-RS-001**

**Title: Big Data from Wayside and Onboard Detection Systems**

The rail industry is collecting large volumes of equipment performance data from Wayside and Onboard Detection Systems. While the data is being analyzed within individual systems to a certain degree, there is significant future scope to develop protocols and algorithms to collectively analyze the large volumes of data from these multiple systems in order to effectively use/analyze the data, and thereby extend the safety and performance of rail equipment/operations. The FRA is interested in research ideas and potential pilot projects that attempt to combine data from multiple detector systems and data from multiple cars of similar construction across the fleet, into a more cohesive data analysis platform, that can improve safety and performance of the rail network, through better prediction of safety and performance indicators.

**Topic: FRA-RS-002**

**Title: Safety and Passenger Rail Stations**

Employee and passenger safety at stations and platforms has not been studied in detail in North America. FRA is looking for research ideas that might help study and quantify passenger safety and risk at train stations, as well as, research ideas for development or implementation that might help improve employee/passenger safety in train stations and train platforms. Including the risks associated with passengers crossing the tracks at level crossings.

# Train Control

**Topic: FRA-TC-001**

**Title: Non-Track Circuit Train Detection for Advance Highway Intersection Preemption**

A Non-Track Circuit detection system is required to assess train presence, speed and direction in multi-track corridors. This detection system should properly communicate with sensors at the highway-rail grade crossing and the adjacent traffic intersection controller. With proper selection of the proposed detection system, its location, and its effective communication approach, accurate advance preemption could be provided to the adjacent highway traffic signal system. The research objective is to develop and establish optimal safety advance preemption approach at the adjacent signalized highway intersection without the financial impact or technical challenges associated with lengthening crossing approach track circuits beyond that required for crossing activation. The proposed system must be cost-effective, viable and requires minimal maintenance.

**Topic: FRA-TC-002**

**Title: Automated Freight Train Technologies**

It is currently thought that increases in freight rail capacity and safety could be achieved by implementing automated or remote controlled train operation, especially on some long haul cross county routes. Potential benefits include greatly reduced train delay due to required crew changes, increased efficiency through advanced power management, and a lowered risk of human error. Automated operation will require technologies which provide cab situational awareness, train performance profiling, and communication of real time information to the railroad operations center. Automating or remotely controlling certain freight train operations has the potential to safely increase rail capacity; however there are significant technology gaps and operational challenges to realizing this. Research is needed to determine technical feasibility and sound approach.

This research topic is seeking projects for systems or technologies which have the ability to enable freight trains to operate autonomously or by remote control. This includes locomotive-based sensors, locomotive control systems, secure communications systems, and train handling algorithms. Objectives are to advance an enabling technology for automated or remote train operation and/or produce a feasibility analysis, operational concept, system requirements, and a demonstration of system capability.

**Topic: FRA-TC-003**

**Title: Drone/Unmanned Remote Sensing Vehicles for Railroads**

Recent advances in drone technologies in other sectors are demonstrating capabilities which may be applicable to freight and/or passenger rail operations. FRA is interested in evaluating concepts which leverage these technologies to address rail safety or efficiency issues. Examples include right-of-way trespasser detection, obstruction detection at grade crossings, broken rail/buckled rail detection, landslide detection, etc. It is envisioned that the vehicle would travel ahead of the train and provide advanced warning to the operator with enough time for the train to slow down or stop. Projects shall be limited to feasibility analyses, cost analyses, operational concepts, and modeled demonstrations of system capabilities.

# Human Factors

**Topic: FRA-HF-001**

**Title: Human Performance Modeling and Simulation**

Perform system modeling to examine the impact of new technology on human performance. Develop systems models to better understand how new technology might impact tasks, workload, and procedures of operating personnel under certain operational settings. The potential outcome of this modeling will be useful to address interactive effects of automation on railroad operating personnel, make process and procedures recommendations, as well as address and make recommendations for the optimal manning of systems in terms of numbers of personnel and quality of skills needed for safe operation of the system.

**Topic: FRA-HF-002**

**Title: Evaluation of Industry Safety Culture**

Develop innovative evaluation models, frameworks, or approaches for implementing, assessing, monitoring and/or measuring safety culture and safety culture change initiatives in the U.S. rail industry. The overall purpose is to reduce significant safety risks, improve safety, and strengthen safety culture by applying systematic, principled evaluation approaches aimed at institutionalizing key organizational processes for long-term sustainability in safety improvements and risk reduction. Innovative models, frameworks, or approaches should foster and assist safety program improvement through continuous, proactive, decision-oriented assessments and evaluations.

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