April 7, 2014

# Federal Railroad Administration
# Office of Research and Development

## Broad Agency Announcement – BAA 2014-2

## Appendix C – Research Topics

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

| Track Research | | |
|---|---|---|
| **Topic** | **Title** | **Closing Date for Concept Papers** |
| FRA-TR-001 | Automated Rail Turnout Inspection Technology | May 30, 2014 |
| FRA-TR-002 | Rail Seat Deterioration Detection and Measurement | May 30, 2014 |
| FRA-TR-003 | Human/Machine Methods to Improve Safety Inspections | May 30, 2014 |
| FRA-TR-004 | Track Structure Failure Research | May 30, 2014 |
| FRA-TR-005 | Mobile Methods for Measuring Longitudinal Rail Stress | May 30, 2014 |
| FRA-TR-006 | Wheel/Rail Force Measurement | May 30, 2014 |
| FRA-TR-007 | Position Control of Rail Sensor Box Assembly | May 30, 2014 |
| FRA-TR-008 | Mixed Freight and Higher Speed Passenger Trains: Guidance for Operators and Inspectors | May 30, 2014 |
| FRA-TR-009 | Rail Surface Damage - Feature Extraction From Digital Images | May 30, 2014 |

| Rolling Stock and Equipment | | |
|---|---|---|
| **Topic** | **Title** | **Closing Date for Concept Papers** |
| FRA-RS-001 | Natural Gas Locomotive Research | May 30, 2014 |
| FRA-RS-002 | Safety Research – Steam Locomotives | May 30, 2014 |
| FRA-RS-003 | Monitoring Vapor Properties in Tank Cars | May 30, 2014 |

| Train Control | | |
|---|---|---|
| **Topic** | **Title** | **Closing Date for Concept Papers** |
| FRA-TC-001 | Secure Positive Train Control Wireless Communication in a Limited Bandwidth Environment | May 30, 2014 |

| Human Factors | | |
|---|---|---|
| **Topic** | **Title** | **Closing Date for Concept Papers** |
| | No topics at this time | |

# Track Research

**Topic: FRA-TR-001**

**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. The FRA is not interested in Unmanned Aerial Vehicle research.

**Topic: FRA-TR-002**

**Title: Rail Seat Deterioration Detection and Measurement**

Concrete crossties are in widespread use on passenger, freight, and mixed-use track throughout the US. In some installations, there is significant wear under the rail seat. This rail seat deterioration (RSD) can pose a serious safety risk to trains and, in some cases, has been the root cause of train derailments. Identifying RSD on ties is complicated due to the presence of the rail, fasteners, and pads. Thorough inspections require the disassembly of components and hand-held measurement techniques. This topic seeks to develop technology to detect RSD on concrete ties in an automated manner from a moving railcar.

FRA also seeks research towards the development of automated machine tools that will measure the level of RSD on a crosstie without disturbing the track structure (rail, clips, pads, tie, etc.). Such devices could be hand held or mounted to a vehicle. The tools shall not require a person to read a gage, or interpret an abstract image. The goal is to develop a system that can automatically provide the shape and depth of the rail seat deterioration.

Participants may elect to submit concept papers for either the detection or measurement research, or both.

**Topic: FRA-TR-003**

**Title: Human/Machine Methods to Improve Safety Inspections**

This topic seeks innovative approaches to improve track inspection activities through the coupling of humans with advanced machine technology. Research activities may include track video inspection, data integration, and development projects, and machine vision technology development for detailed condition assessments.

**Topic: FRA-TR-004**

**Title: Track Structure Failure Research**

This topic seeks research projects that develop advanced technologies and techniques for measuring track conditions and predicting the progressive and/or sudden failure of track structures. This is a general research requirement that covers all aspects of track and track support structures. FRA is searching for novel, technology-based, techniques for improving rail safety through improved understanding of system and component failure modes, drivers, and timing. Novel applications of existing technology to provide measurements of various aspects of track failure are sought including innovative applications of new materials to provide new or unique measurements.

In addition to technology development, this topic also seeks innovative approaches to using data obtained from one or more existing track inspection technologies to determine the potential for track failure or the development of track defects under a range of operating and track conditions. The focus is to make better use of the data obtained from existing and emerging inspection techniques. This includes merging of multiple inspection technologies to provide better information about development of track defects and/or failure of the track structure

**Topic: FRA-TR-005**

**Title: Mobile 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. FRA has recently developed new technologies that non-destructively measure the longitudinal stress state of rail at a fixed location. The objective of this research topic is to develop technology that can accurately measure rail longitudinal stress from a moving platform.

**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: Position Control of Rail Sensor Box Assembly**

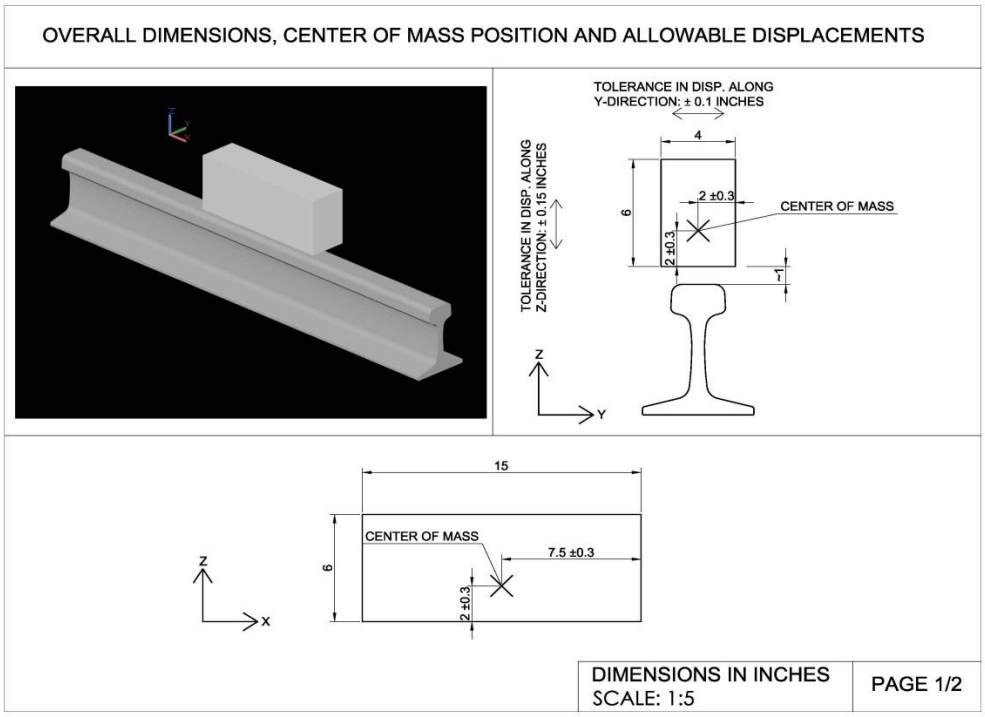
This topic seeks to develop a system to precisely control the position of a specialized rail sensor box over the railhead. This research is particularly challenging given the mass of the sensor box, the speed of testing, and the need for precise, active control of the box position while compensating for high and low frequency vibrations and forces encountered in the rail environment and variations in rail position. To be successful, Offerers must have documented experience designing, building, and operating similar high accuracy motion control systems in hostile environments. A general specification follows:

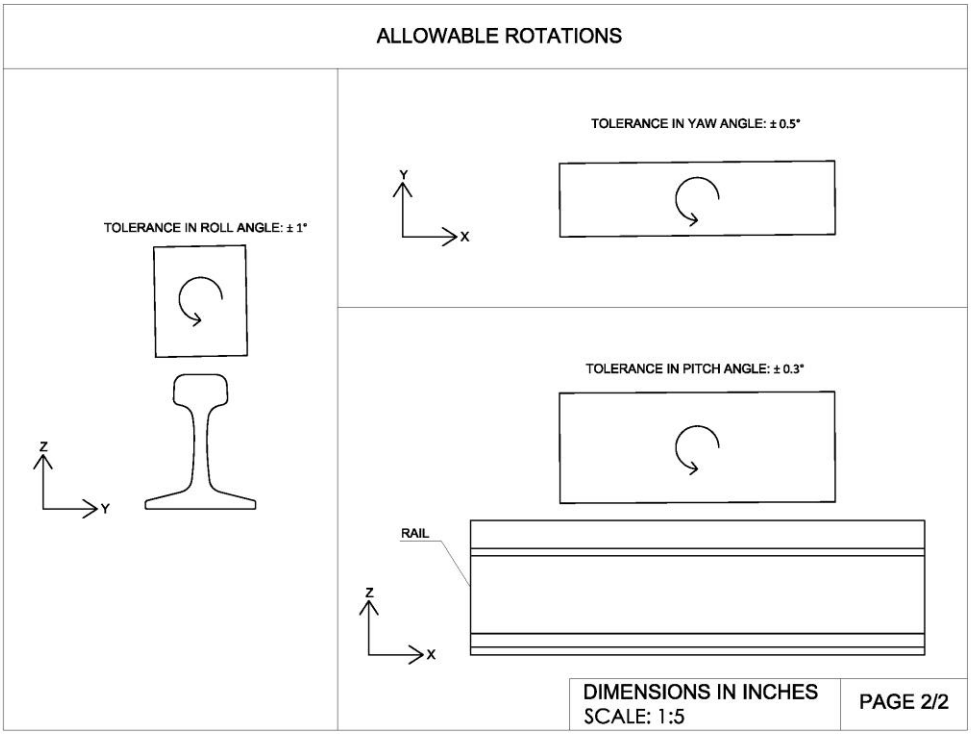
Environment Conditions:

- Exterior mounting on full-size railcar – truck or car body. FRA is not interested in rolling carts, trolleys, or other rail bound solutions.
- Maximum operating speed – 79 miles per hour
- Track Variations – within FRA class of track tolerances (49-CFR Part 213). Maximum curvature is 12 degrees.
- Vibration environment – variable depending on track conditions, speed of operation, and location of control system. Transient vibrations up to 10 g's can be seen if the system is mounted on the car body above the suspension system, and 100 g's if the system is mounted on the truck below the suspension system.

Rail Sensor Box Position Requirements

- Rail sensor box mass = 15 pounds



**Topic: FRA-TR-008**

**Title: Mixed Freight and Higher Speed Passenger Trains: Guidance for Operators and Inspectors (respond to one or more subtopics)**

Part A: Guidance manual for Owners/operators planning system upgrades – Superelevation

The choice of superelevation on curves that are shared by heavy axle load, low speed freight trains and higher speed passenger trains is not straightforward. FRA would like to provide rail corridor planners with guidance on choosing the optimum superelevation in curves. A guidance document is required that lists the issues that need to be considered and identifies tools and methods for analyzing those issues. The issues should cover safety, comfort, maintenance and inspection. FRA recently published a guidance document for noise and vibration - http://www.fra.dot.gov/eLib/details/L04090 - that can be used as a model for the guidance document on superelevation.

Part B: Guidance manual for quality control and inspection activities

FRA published a new Track Safety Standards for operation of trains at high speed or/and high cant deficiency. Under this new rule, equipment can go be qualified to run at speeds that create more than 3" or 4" cant deficiencies on curves for freight and passenger service respectively. A guidance document is required that lists the issues that the track inspectors need to be aware of when inspecting curves with high cant deficiency operation. Issues should include inspection frequencies, inspection scope, and track and/or track component degradation signals.

Part C: Mixed-Use Track Studies: Empirical Data to Improve the State of Knowledge

This research shall develop test plans to measure track and vehicle parameters that have specific influence on the safe and efficient operation of mixed freight and higher speed passenger territories. The objective is to identify specific track locations and service conditions that may provide information as to the in-service performance of the vehicle/track system, and to create executable test plans to gather the required data. Parameters of interest include track curve performance with higher cant deficiency operation, track turnouts that include design elements for mixed service, vehicle condition variables that may impact track/train interaction, and rail wear. Participants may choose these or others parameters to test. In all cases, the participant shall include rationale for parameter selection.

**Topic: FRA-TR-009**

**Title: Rail Surface Damage - Feature Extraction From Digital Images**

This research topic seeks to develop and test imaging software algorithms to identify, characterize, and categorize rail head defects. Machine vision systems that collect photographs of the rail surface are becoming more common, but the resulting data is voluminous and difficult to process. A software tool is needed to automate the feature extraction process and report rail condition and location information for sections of track that exceed thresholds. A software system to interrogate and extract information from the image data should be able to automatically identify the following features:

- Checking/cracking (orientation, position, density, severity).
- Pitting, spalling, shelling (position, size, morphology, density)
- Plastic flow (welds, field side, gage side)
- Surface running band, looking especially for oscillation in width such as corrugation and sudden Shifts that might occur for example at bad welds or mismatched rails

Early development efforts should focus on identifying abnormalities on the rail head and classifying the rail damage according to severity [none, light, moderate, heavy, severe] and position on railhead of greatest intensity [gage corner, mid-gauge, middle/crown of rail, field side]. More advanced systems should categorize the type of damage.

FRA seeks organizations with proven methodologies and/or previously developed software, and demonstrated experience in machine vision data reduction in railroad or other fields.

# Rolling Stock and Equipment Research

**Topic: FRA-RS-001**

**Title: Natural Gas Locomotive Research**

This topic seeks to advance the state of knowledge with regard to the safe use of natural gas as a locomotive fuel. Research shall investigate crashworthiness and survivability of LNG/CNG tanks, inspection and maintenance practices (routine, and after incidents/accidents), post-derailment inspection and handling, and fire suppression systems in the context of current FRA safety regulations. Results shall identify regulatory changes needed for wider implementation of natural gas fuels in the rail environment. Additional research areas include understanding the training required for railroad employees and first responders to safely interact with natural gas fuels and equipment, interoperability and standards for safety control systems, fuel distribution systems and emergency shut-off systems.

**Topic: FRA-RS-002**

**Title: Safety Research – Steam Locomotives**

The FRA is interested in performing research that will ensure safe operations of historic steam locomotives. The research efforts will focus on investigating technologies and processes that will improve safety and potentially reduce maintenance of the equipment. (1) Boiler Water Treatment Testing – The National Transportation Safety Board recommended that steam-locomotive operators have a documented water-treatment program. This research effort will investigate a modern water treatment system for boilers with the goal of reducing maintenance requirements of historic boilers in operation across the US, thereby improving safety and performance, (2) Stress Analysis of boiler staybolts and Fluid Flow Through Fireboxes and Tubes – This research effort will investigate the stresses of the staybolts, tubes and sheets and how those stresses are influenced by the flow of super-heated water past those bolt

**Topic: FRA-RS-003**

**Title: Monitoring Vapor Properties in Tank Cars**

Technologies exist for monitoring the vapor properties of hazardous materials. FRA is interested in the feasibility, costs and benefits of using these technologies on tank cars carrying crude oil and other hazardous materials. The monitoring might take place during loading to ensure the vapor properties are as expected; during transportation to ensure no material changes have occurred; and during unloading to ensure the delivered material is as

expected. Information on vapor properties could also be useful after an accident or some other unplanned event that necessitated the product to be unloaded.

# Train Control

**Topic: FRA-TC-001**

**Title: Secure Positive Train Control Wireless Communication in a Limited Bandwidth Environment**

The Rail Safety Improvement Act of 2008 mandated the development and deployment of Positive Train Control (PTC) to improve train movement safety. The PTC system uses RF networks to convey movement authorities to locomotives, wayside equipment, and train status information using Software Defined Radios (SDRs). SDRs provide additional level of security resulting from the extensive configuration management focused on preventing software and RF based attacks. However, this added security requires additional bandwidth, which is very limited. Therefore, the FRA seeks research to advance communication security management technologies. The research objective is to increase the security of wireless message transmissions between control centers, trains, and wayside locations while maintaining reliability without increasing bandwidth use or incurring any latency in message delivery.

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