Federal Railroad Administration
Office of Research, Development, and Technology

Broad Agency Announcement – BAA 2016

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	Innovative Methods for Measuring Longitudinal Rail Stress	May 6, 2016
FRA-TR-002	Advanced Internal Rail Flaw Detection	May 6, 2016
FRA-TR-003	Track Structure Failure Research	May 6, 2016
FRA-TR-004	Automated Track Condition Change Detection	May 6, 2016
FRA-TR-005	Track Risk Assessment and Data Analysis	May 6, 2016
FRA-TR-006	Modeling Wheel-Rail Friction Modifier	May 6, 2016
FRA-TR-007	Modeling 3-Dimensional Wheel-Rail Contact Geometry	May 6, 2016
FRA-TR-008	Modeling Changes in Rail Profile	May 6, 2016
FRA-TR-009	Improved Air Spring Model	May 6, 2016

Rolling Stock and Equipment		
Topic	**Title**	**Closing Date for Concept Papers**
FRA-RS-001	Protecting Hazardous Material Tank Cars from Punctures and Heat	May 6, 2016
FRA-RS-002	Quantity of Lading Loss under Breach Conditions	May 6, 2016
FRA-RS-003	Fire Performance of Alternate Fuel Tenders	May 6, 2016

Train Control		
Topic	**Title**	**Closing Date for Concept Papers**
FRA-TC-001	Vital Back Office Server for PTC Systems	May 6, 2016
FRA-TC-002	PTC Communication System Management Enhancement	May 6, 2016
FRA-TC-003	Restricted Speed Enforcement for PTC Systems	May 6, 2016

Human Factors		
Topic	**Title**	**Closing Date for Concept Papers**
FRA-HF-001	Highway-Rail Grade Crossing Safety	May 6, 2016
FRA-HF-002	Human Factors Research in Vehicle and Rail Systems	May 6, 2016
FRA-HF-003	R&D Safety Culture Strategic Roadmap and Implementation Plan	May 6, 2016

Track Research

Topic: FRA-TR-001

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 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. Offerors shall demonstrate knowledge of the past research in this area and an understanding of the scientific and other technical challenges encountered in these past efforts.

Topic: FRA-TR-002

Title: Advanced Internal Rail Flaw Detection

This topic seeks research projects to advance the state-of-the-art in continuous rail flaw detection technology. The objective is to develop systems that improve detection accuracy, increase test speed, reduce false alarm rates, and improve data processing and analysis efficiency. Ideally, such an advanced rail flaw detection system will be autonomous, non-contact and operate at track speed to permit use on revenue service equipment, including locomotives. Offerors may propose development and/or demonstration projects that respond to some or all of these objectives.

Topic: FRA-TR-003

Title: Track Structure Failure Research

This topic seeks research projects that develop technologies and techniques for 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.

Topic: FRA-TR-004

Title: Automated Track Condition Change Detection

The objective of this research is to develop and demonstrate methods to detect and report changes in the track structure that may be a safety concern for operators. Preference will be given to technologies that “scan” the track structure from a moving platform, perform

comparative analyses from multiple surveys, and report areas of change with sufficient resolution to allow an experienced operator to make decisions regarding the need for detailed inspection of these areas. There are no limitations with regard to the type of technology that may be proposed, and, at least in the early development stages, these systems are not required to perform discrete measurements of track parameters.

Topic: FRA-TR-005

Title: Track Risk Assessment and Data Analysis

The objective of this research is intended to provide new knowledge, managerial insights, and implementation tools to assist FRA and the railroad industry in optimizing rail and track inspection frequencies through risk analysis and optimization models. This research can also result in track safety performance metrics that can be used to assess safety risks and appropriate remedial action timeframes. This research can evolve into a larger, integrated risk management framework for rail transportation providing safety improvement strategies.

Topic: FRA-TR-006

Title: Modeling Wheel-Rail Friction Modifier

Currently available Vehicle-Track Interaction software packages do not generally account for friction effects such as falling friction at high creepage values and other effects that occur in third body layers such as when modeling friction modifiers. The FRA seeks to obtain a detailed wheel-rail contact model that includes these friction effects. The contractor must provide a detailed physical explanation and solution approach that is portable and non-code specific so that it is capable of being integrated into any of the available commercial packages.

Topic: FRA-TR-007

Title: Modeling 3-Dimensional Wheel-Rail Contact Geometry

Vehicle-Track Interaction software packages typically represent a wheel as a 2-dimensional profile. In some limited cases, the wheel has been represented as a uniform revolution of a 2-dimensional profile. In either case, 3-dimensional wheel-rail contact geometry is not accurately modeled. The FRA seeks to obtain a true 3-dimensional wheel representation, allowing for profile changes along the wheel radially and capable of predicting contact at any location along the wheel's surface. The contractor must provide a detailed physical explanation and solution approach that is portable and non-code specific so that it is capable of being integrated into any of the available commercial packages.

Topic: FRA-TR-008

Title: Modeling Changes in Rail Profile

Currently available Vehicle-Track Interaction software packages typically model longitudinal variations in rail profile as a series of discrete 2-dimensional profiles that often create discontinuities at their transitions. The FRA seeks a rail model that is capable of representing longitudinal variations in rail profile, treats the rail as a continuous surface, and allows for prediction of wheel-rail contact at any location along the rail's surface. The contractor must provide a detailed physical explanation and solution approach that is portable and non-code specific so that it is capable of being integrated into any of the available commercial packages.

Topic: FRA-TR-009

Title: Improved Air Spring Model

Current software packages do not have a standard suspension element that can be used to model air springs. The FRA seeks a standard suspension element model that is capable of accurately representing air springs used in rail cars. The contractor must provide a detailed physical explanation and solution approach that is portable and non-code specific so that it is capable of being integrated into any of the available commercial packages.

Rolling Stock and Equipment Research

Topic: FRA-RS-001

Title: Protecting Hazardous Material Tank Cars from Punctures and Heat

Increased volumes of hazardous material transport by rail (especially crude oil & ethanol), observed consequences of corresponding derailment events, and current research on the ability of these tanks to survive post-derailment fire conditions have raised concerns about the thermal protection levels needed to transport hazardous materials by rail. FRA is interested in research that can help address such concerns, including research on the performance of tank cars involved in a fire, improvements in thermal protection and thermal protection systems, improved techniques for modeling thermal behavior and/or puncture behavior, performance of safety valve under fire conditions, or other related research that can enhance the safety of hazardous material transport.

Topic: FRA-RS-002

Title: Quantity of Lading Loss under Breach Conditions

When a train derailment occurred and tank cars carrying flammable liquids loses their contents under fire conditions, the resulting loss ends up further feeding the fire. FRA wants to conduct research to study this phenomenon so that we better understand the volume and quantity of lading loss when tank cars are suddenly breached under fire conditions.

Topic: FRA-RS-003

Title: Fire Performance of Alternate Fuel Tenders

The railroad industry is actively working on alternative fuels to diesel, including LNG and CNG. The safety performance of these alternate fuel tank cars under derailment induced fire conditions has not been verified and is a cause for concern. The FRA is interested in methods and approaches, both analytical and test, which can evaluate the thermal safety performance of LNG/CNG means of containment (tanks, ISO tanks, etc.) under fire conditions. Proposals can cover the evaluation of components, systems, or the entire container. The FRA is particularly interested in proposals from entities that can conduct medium and full- scale fire test(s) of a tank car and ISO tank.

Train Control

Topic: FRA-TC-001

Title: Vital Back Office Server for PTC Systems

Background: Due to the complexities of train dispatching systems and PTC communications requirements, North American railroads are deploying Positive Train Control (PTC) systems with non-vital Back Office Servers (BOS). Experts have voiced concern over the potential safety risks of this design, as well as increased train delay and rail capacity reduction due to BOS failure. FRA is interested in researching the safety and operational costs and benefits to implementing a vital BOS. This includes analyzing the complexities of interfacing with disparate railroad dispatch systems, of which there are many flavors. Analysis of current BOS-to-dispatch system communication protocols and identification of standardization schemes is desirable.

Objectives: Produce a detailed technology survey, feasibility analysis, cost/benefit analysis, business case analysis, and operational concept for a Vital BOS for Advanced Civil Speed Enforcement System (ACSES) and/or Interoperable Train Control (ITC) positive train control systems. Partnership with a major railroad is desirable.

Topic: FRA-TC-002

Title: PTC Communication System Management Enhancement

Background: The freight/passenger railroad industry has established PTC messaging structures and protocols which govern the communication between various components of a PTC system. So far, focus has been on defining messages essential to PTC operation as mandated by the Rail Safety Improvement Act (2008). FRA is interested in researching the ability of the messaging structure to support additional messages related to PTC system functionality enhancements such as communicating track condition ahead including obstructions and grade crossing status. It is envisioned that the communication system would enable notification to the train crew of track condition ahead of the train, giving the train crew enough time to take appropriate measures to slow or stop.

Objectives: Produce a detailed feasibility analysis, cost analysis, and operational concept.

Description of Research Need: Enhance the PTC system functionality by adding additional messaging capability within the existing PTC message structure. Research is needed to determine if technologies can be implemented in a cost effective and timely manner.

Topic: FRA-TC-003

Title: Restricted Speed Enforcement for PTC Systems

Background: The required functionalities of Positive Train Control (PTC) systems currently being deployed on North American railroads are to:

- Enforce train speed limits
- Prevent train-to-train collisions
- Prevent unauthorized incursion into an established work zone
- Prevent derailment by passing over a switch in the wrong position

Current regulation does not require PTC to perform these functions when a train is traveling slower than restricted speed, which is defined as a speed that will permit stopping within one half of the range of vision, not exceeding 20 mph. FRA is interested in researching the safety and operational costs to implementing restricted speed PTC. This includes evaluating current train positioning sensors, speed sensors, braking algorithms, etc. for suitability to enable low speed enforcement functionality.

Objectives: Produce a detailed safety case analysis based on historical accident data, cost analysis, operational impact assessment, and high level operational concept for modifying Advanced Civil Speed Enforcement System (ACSES) and/or Interoperable Train Control (ITC) positive train control systems to function below 5 mph.

Description of Research Need: FRA wishes to investigate the potential safety benefit and costs to incrementally update PTC systems to enforce speed limits, movement authorities, work zones, and switch misalignment at a speed range below 5 mph and to 20 mph.

Human Factors

Topic: FRA-HF-001

Title: Highway-Rail Grade Crossing Safety

Develop interventions or solutions that increase motorist, pedestrian, and/or bicyclist compliance at active and passive highway-rail grade crossings through human factors engineering. The overall purpose is to reduce significant safety risks and improve safety by incorporating human factors engineering into grade crossing design and operation. The FRA is interested in research ideas and potential pilot projects that attempt to address variables such as human perception, decision making, distraction and fatigue and identify practical applications to grade crossing safety. Research may address Positive Train Control and grade crossings with multiple railroad tracks.

Topic: FRA-HF-002

Title: Human Factors Research in Vehicle and Rail Systems

FRA seeks to improve system designs and integration of advanced technology equipment in locomotive cabs by including human capabilities and limitations in the design space for new solutions. The goal is to reduce risk of human error with the introduction of new control and display technologies in the locomotive cab and in rail operations. Research interests in the following areas include addressing rail systems design specifications for the human-machine interface, system design methodologies that include human factors, impacts of technology on human performance, and generally the impact of technology on safe and efficient vehicle and rail system operations where humans are involved:

1. The increasing technological complexity and system automation and the need for improved operational procedures to ensure safe and efficient human performance
2. The value of the use of simulators in a multi-simulator, integrated way that depicts the operational environment
3. The role of operational full-scale vehicle simulators in system design, forensics, and operational procedures development
4. Systems, processes and tools to improve rail operational decision-making
5. Defining human information requirements, communications methodologies and systems to ensure effective communication within the train and between the train and external interfaces, e.g. dispatching centers
6. Integration and interoperability of cab equipment and the effect of such system designs on human performance, operational efficiency and system safety

7. Assessment of the effects of operating cab automation, display integration, and information flows on human performance
8. Risk assessment and prediction of the unintended consequences of advanced technologies and automated technologies on human train control
9. Positive Train Control (PTC) technologies and their effect on in-cab human factors, including automated train control information requirements, display designs, real-time (and latent) and information flows, and the effect of operator experience on performance
10. Applicability of integrated, multi-function, synthetic, moving map, and heads-up displays to the locomotive cab and the effect of these systems on human performance, including the identification of critical system design requirements
11. Impact of train and rail system technology on training and selection of personnel- skill set and aptitude determination

Topic: FRA-HF-003

Title: R&D Safety Culture Strategic Roadmap and Implementation Plan

As background, the Office of Research, Development & Technology (RDT) has conducted numerous safety culture (SC) pilot demonstrations over the past decade, leading to significant improvements in safety outcomes at the pilot sites. As an expansion of these efforts, RDT recently undertook an initiative with the American Short Line and Regional Railroads Association (ASLRRA) to develop and implement a survey instrument and validated process for assessing safety culture in the short line and regional railroad industry. Simultaneously, RDT is developing and implementing non-proprietary training and educational materials that promote strong safety cultures in the passenger rail industry. As these pilots have evolved from successful pilot demonstration projects to company-wide and industry-wide initiatives a major challenge is scale up at the company level, the industry level, and the level of regulatory agency oversight. Major questions now needing to be addressed include the following, among others:

- What is the current of understanding of safety culture and its relationship with Safety Management Systems (SMS) among regulators and rail operators?
- What is the rail industry's highest priority needs to improve safety culture?
- What is the Regulatory Agency's role(s) in influencing safety culture?
- To what extent are safety culture assessment tools, approaches and interventions working for the rail operators and regulators? How effective are they at improving safety practices and culture? Are they usable, practical, flexible and adaptable?
- How can the design and implementation of safety culture interventions be improved to benefit operators and regulators?
- What are the most promising tools and approaches?

- What concerns do regulatory agency and rail operators have about conducting safety culture assessments (i.e., challenges, confidentiality, and practicality)?

Objectives: This topic will address two main objectives: 1) identify industry and regulatory oversight needs to better assess and improve safety culture of rail industry stakeholders, and 2) identify research and evaluation gaps that will support more effective implementations of safety culture initiatives in the rail industry.

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