United States Department of Transportation
Annual Modal Research Plans

Cover Page

Federal Railroad Administration
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Executive Summary

Federal Railroad Administration's (FRA) Research Development and Technology (RD&T) mission is to ensure the safe, efficient, and reliable movement of people and goods by rail through basic and applied research, and development of innovations and solutions. Safety is the Department of Transportation's (DOT's) primary strategic goal and thus, the principal driver of FRA's RD&T program. FRA's RD&T program also contributes to other DOT strategic goals because safety-focused projects typically yield solutions toward state of good repair, economic competitiveness, and environmental sustainability goals. The RD&T program also has an important role to play in workforce development.

FRA's RD&T program is founded on an understanding of safety risks in the industry. Hazard identification and risk analysis allows FRA to identify opportunities to reduce the likelihood of accidents and incidents, and to limit the consequences of hazardous events should they occur. Key strategies include stakeholder engagement and partnerships with other researchers such as the Association of American Railroads (AAR), prioritization of projects, and conducting research through cost-effective procurement.

FRA's RD&T consists of several critical program areas. These include Hazardous Material (HazMat) Transportation, Track and Structures, Rolling Stock, Highway-Rail Grade Crossing, Human Factors, Train Control, Train Occupant Protection, Track/Train Interaction, Testing Facilities and Equipment, and Railroad Systems Issues.

The hazardous materials research program includes fostering innovation throughout the industry, helping development of new regulations and design standards that improve the safety and integrity of tank cars and other packages carrying hazardous materials, and continuing growth of new research programs that satisfy the need of the industry and government.

Failure of track and infrastructure is the second leading cause of train derailments in the U.S. Incorrect interaction between moving vehicles and the track is a common cause of derailments. Strategic priorities for this program include: Developing track inspection technologies that detect defects before they become failures in service; developing computer modeling capabilities to improve understanding of vehicle-track interaction, wheel and rail profiles and contact conditions; expanding the use of autonomous recording methods to provide more frequent and cost-effective measurements of track condition; and developing new methods for monitoring difficult to detect safety issues such as longitudinal rail force, ballast lateral restraint and ballast condition.

Research efforts in the Rolling Stock Equipment and Components Program area focus on the development and improvement of equipment defect detection and control. Both

wayside and on-board detection and control systems offer diverse platforms for such research and demonstration.

Approximately 212,000 highway-rail grade crossings exist in the approximately 140,000 miles of track that make up the United States' railroad system. In 2015, 277 individuals died at railroad crossings. This figure is down from 294 in 2014 and 290 in 2013. The FRA issues and enforces regulations on grade crossing safety and sponsors research aimed at reducing grade crossing accidents and fatalities.

The objectives of FRA's Human Factors RD&T Program, consistent with Departmental strategic goals, are to improve the safety of rail transportation. Human Factors research is focused on conducting pilot trials to improve safety and organizational culture in railroad organizations; research on fatigue, distraction and ergonomics to address individual and team behavior; and developing technology, automation and systems design to minimize the potential for human errors.

Train control, which cuts across virtually all the RD&T program elements, includes the use of sensors, computers, and digital communications to collect, process, and disseminate information to improve the safety, security, and operational effectiveness of railroad. The FRA and the railroad industry are working on the development of Intelligent Railroad Systems that would incorporate the new sensor, computer, and digital communications technologies into train control, braking systems, grade crossings, and defect detection.

The Train Occupant Protection Program will carry out research on structural crashworthiness and interior safety of locomotives and in intercity and commuter rail cars, with the aim of improving the survivability of rail passengers and crewmembers in accidents. The goal of this research program is to promote and improve the safety of the national passenger rail transportation system.

The Track/Train Interaction Program addresses the safety implications arising from the dynamic interaction between track and train. This program will support the development of performance-based standards and guidelines for vehicle/track interaction safety and ride quality, and of safety standards and guidelines for transverse wheel and rail profiles.

The RD&T Facilities and Test Equipment Program addresses the acquisition, upgrading, and maintenance of FRA-owned facilities and equipment required to accomplish the whole spectrum of railroad research objectives and projects. The FRA owns the Transportation Technology Center (TTC) in Pueblo, Colorado. The facility is on 52 square miles of land leased from the State of Colorado. Since its dedication as the High-Speed Ground Test Center in 1971, it has played an important part in research, development, and testing of rail infrastructure and equipment.

Finally, the Railroad Systems Issues program area directs the entire RD&T program towards the DOT's goals and provides assurance that those goals are being met.

Section 1 – Program Descriptions, FY 2018

FY 2018 RD&T Program Funding Details

RD&T Program Name	FY 2018 Pres. Budget ($000)	FY 2018 Basic ($000)	FY 2018 Applied ($000)	FY 2018 Development ($000)	FY 2018 Technology ($000)
Track	11,279		8,777	2,502	
Rolling Stock	10,322		8,050	2,272	
Train Control & Communication	8,086		5,256	2,830	
Human Factors	5,542		4,322	1,220	
Railroad Systems Issues	3,871		3,290	581	
Totals	**39,100**		**29,695**	**9,405**	

FY 2018 RD&T Program Budget Request by Critical Transportation Topic Area

RD&T Program Name	FY 2018 Pres. Budget ($000)	PROMOTING SAFETY ($000)	IMPROVING MOBILITY ($000)	IMPROVING INFRASTRUCTURE ($000)	PRESERVING THE ENVIRONMENT ($000)
Track	11,279	11,279			
Rolling Stock	10,322	10,322			
Train Control & Communication	8,086	8,086			
Human Factors	5,542	5,542			
Railroad Systems Issues	3,871	3,871			
Totals	**39,100**	**39,100**			

Track Research Program

$11,279,000

Program Description:
The Track Research program addresses:

Track and structure inspection techniques, material and component reliability, design, and performance, including automated and autonomous inspection system design, development, testing and deployment, and Unmanned Aerial System (UAS) technology.

Track and train interaction, derailment mechanisms, and vehicle-track performance.

Rail integrity related derailments and rail inspection systems.

Track safety standards for freight and passenger operations, including support for FRA Office of Safety.

RD&T facilities at FRA's TTC.

Program Objectives:
FRA's Track Research program is aimed at reducing train derailments due to track related causes. The main causes are broken rails, track geometry defects and track buckles in hot weather.

Anticipated Program Activities:
Complete a joint research program with the industry studying ballast degradation and safety limits under heavy axle service loads.

Implement safety and performance metrics for vertical track deflection measurements.

Initiate engineering studies on broken rails related to rolling contact fatigue.

Continued testing and evaluation of vehicle responses to multiple track geometry conditions.

Continued evaluation, validation and improvement of track geometry measuring systems, including the Autonomous Track Geometry Measurement System (ATGMS).

Continue to develop Passive Air-coupled Rail Defect Detection approach to rail flaw detection.

Prototype development of an autonomous rail flaw defect detection system for use in revenue service.

Development of engineering guidelines for track inspection parameters based on correlations between measured data and track degradation.

Evaluation and implementation of concrete tie bending measurement methods to assess ballast support conditions.

Development and evaluation of a machine vision-based track condition assessment system.

Evaluation of unmanned aircraft systems payloads for hazard warning and railroad safety inspections.

Complete the investigation of rail fatigue properties of modern rail steels.

Continued development of facilities and test equipment at FRA's TTC.

Expected Program Outcomes:
Fewer train derailments due to poor track conditions, broken rails, track buckles, landslides and washouts. Improved facilities for conducting track research.

Collaboration Partners:
Volpe National Transportation Systems Center – Engineers and scientists at the Volpe Center will continue to conduct RD&T for FRA on topics such as rail integrity and vehicle-track interaction.

Research partners include Class 1, commuter railroads, short line and regional railroads.

Cross modal collaboration partners include Federal Aviation Administration (FAA) and Federal Transit Administration (FTA).

How Program meets Statutory Requirements:
The program meets the annual funding appropriation act's requirement to conduct track research.

Describe how public and stakeholder input have been utilized in the development of this research program:
The Track Research program will be evaluated periodically by a special committee of the Transportation Research Board (TRB).

The program will be coordinated with the AAR research program through the AAR's Heavy Axle Load Engineering Research Committee and Technology Outreach Program Committee.

Program staff will be members of industry working groups such as the American Railway Engineering and Maintenance-of-Way Association (AREMA) committees.

Program staff will participate in the FRA's Railway Safety Advisory Committee meetings.

Program staff will present research results for peer review at various conferences and in technical journals.

Rolling Stock Research Program

$10,322,000

Program Description:
The Rolling Stock Research program addresses:

Rolling stock and components, onboard and wayside monitoring systems, material and design improvements.

Hazardous materials transportation risk reduction, tank car damage assessment, inspection, and integrity.

Safety and clean energy benefits of Electronically Controlled Pneumatic brakes and other rolling stock technologies.

Train occupant protection, locomotive and passenger car safety and performance.

Program Objectives:
FRA's Rolling Stock Research program is aimed at enabling the safe introduction of high speed rail, reducing derailments due to equipment failures, minimizing the consequences of derailments, and minimizing hazardous material releases.

Anticipated Program Activities:
Continue to provide technical support to the FRA Office of Safety in assessing the performance and safety of new passenger rolling stock. Including the Acela replacement trainsets, for both high speed and conventional speed operations.

Continued research to gain a better understanding of current wheel failure modes and mechanisms, develop and evaluate potential solutions.

Collaboration with the railroad industry to develop and apply best practices in the introduction of automated rolling stock inspection systems. Primary focus will be on supporting the Union Pacific waiver for the use of Wheel Temperature Detectors to replace mandated manual brake system inspections (Class 1-A inspections).

Conduct full scale grade crossing crash tests for Liquefied Natural Gas (LNG) tender/tank car to support industry and Office of Safety assessment of the effectiveness of potential LNG tender and tank car design alternatives.

Continued research in support of potential rulemaking related to passenger equipment fuel tanks under dynamic loading scenarios.

Continuation of research to comprehensively describe the engineering requirements placed on glazing systems, develop effective strategies for balancing all of the safety demands and provide recommendations for glazing strategies which offer maximized occupant containment in accidents.

Continuation of analysis and full scale testing of passenger locomotives retrofitted with crashworthy components to improve performance and operator protection during train collisions.

Collaboration with other modes on alternative fuels, such as natural gas, for improved emissions and assured safety.

Complete research and support rulemaking in collaboration with Pipelines and Hazardous Materials Safety Administration, Maritime Administration (PHMSA) to assure the safety of containers and railcars intended to transport LNG.

Assess the safety of new tank cars intended for the transport of hazardous materials.

Expected Program Outcomes:
Fewer train derailments due to rolling stock equipment failures, better protection for passengers and train crews in accidents, and reduced release of hazardous materials.

Collaboration Partners:
AAR – The FRA Office of Rolling Stock Research and Development works closely with the AAR on a continuing basis to address research needs of mutual interest, including LNG use as a locomotive fuel, LNG transportation as a commodity, the safe introduction of Light Emitting Diode (LED) headlights for Locomotives, improved designs for hazmat tank cars, the introduction of new designs and features to better assure the safety of freight cars and continuing research to prevent wheel failures, such as vertical split rims.

Volpe National Transportation Systems Center – Engineers and scientists at the Volpe Center will continue to conduct RD&T for FRA on topics such as train occupant protection, crashworthiness of rolling stock, the safety of new railcar designs, and accident investigation.

PHMSA, Maritime Administration (MARAD)– FRA, PHMSA and MARAD will continue to collaborate on RD&T leading to new and improved regulations for LNG and other hazardous materials currently shipped or likely to be shipped in tank cars.

TRB – Works with the Federal Railroad to administer the FRA Safety Innovations Deserving Exploratory Analysis (IDEA) program which seeks new technologies and techniques to improve the safety and effectiveness of rail transportation.

The American Public Transit Association (APTA) – The FRA has long supported the development and maintenance of APTA standards and recommended practices as part of the APTA PRESS (Passenger Railroad Equipment Safety Standards) program. APTA's role in safety assurance is essential to the travelling public. The FRA Division of Rolling Stock R&D provides analysis, testing and technical support for the APTA PRESS Committees.

Other collaboration partners include Universities with rail programs (such as University of Illinois, Michigan Tech, and Virginia Tech.), State DOT's regarding passenger rail including California, Illinois, Washington State and New York State through the Next Generation Equipment Committee (NGEC).

How Program meets Statutory Requirements:
The program meets the annual funding appropriation act's requirement to conduct rolling stock research.

Describe how public and stakeholder input have been utilized in the development of this research program:
The Rolling Stock Research program will be evaluated periodically by a special committee of the TRB.

The program will be coordinated with the AAR research program through the AAR's Locomotive Committee and Equipment Engineering Committee.

Program staff will be members of industry working groups such as the APTA committees.

Program staff will participate in the FRA's Railway Safety Advisory Committee meetings.

Program staff will present research results for peer review at various conferences and in technical journals.

Train Control and Communications Research Program

$8,086,000

Program Description:
The Train Control and Communications Research program addresses:

Development and testing of train control and communication systems, including intelligent software defined radios, drone, and fiber optics technologies.

Grade crossing safety technologies and pilot studies, including intelligent transportation systems, blocked crossings, in-vehicle crossing violation warning/crash prevention, and trespass prevention countermeasures.

Automation research, including studies on Positive Train Control (PTC) have been a fundamental part of the Train Control and Communication Research program for decades. Nearly eighty percent of the program's funding is dedicated to advancing automation and automated systems.

Program Objectives:
FRA's Train Control and Communications Research program is aimed at reducing train-to-train collisions and train collisions with objects and trespassers on the line and at grade crossings.

Anticipated Program Activities:
Development of enhanced PTC communication security and authentication scheme to prevent potential hacking.

Development of a national wireless communication roadmap.

Development of simulation and modeling tools to evaluate safety and risks associated with PTC systems deployment.

Testing and enhancing the passenger braking algorithm.

Deployment of the PTC integrated roadway worker protection system.

Developing more effective and less costly alternative sensing and detecting methods using fiber optic technology.

Enhancing the intelligent transportation system-based prototype to warn vehicle drivers of the status of railroad crossings and enforce compliance.

Testing mitigating technology to prevent anticipated radio communication problems on the Northeast Corridor and congested rail traffic around the country.

Testing locomotive-based technologies for long-range trespasser detection and warning systems.

Developing the next generation track circuits for future train control systems.

Testing of an advanced highway preemption system.

Developing standards for monitoring PTC performance for the national system.

Support human factor studies related to pedestrian and driver behavior around railroad tracks and grade crossing.

Expected Program Outcomes:
Fewer train-to-train collisions and train collisions with objects on the line and at grade crossings.

Collaboration Partners:
Volpe National Transportation Systems Center - Engineers and scientists at the Volpe Center will continue to conduct RD&T for FRA on grade crossing safety and trespass prevention.

Federal Highway Administration (FHWA), Federal Motor Carriers Safety Administration, Intelligent Transportation Systems – Joint Program Office (ITS-JPO) – FRA will continue to collaborate with these partners on intelligent transportation systems RD&T.

RD&T will work with FHWA on the Railroad Crossing Violation Warning system.

On the Vehicular Automation front, FRA RD&T is collaborating with FHWA on the Connected Vehicle initiative where grade crossing status (active, approaching train) is transmitted to vehicles approaching the crossing to warn the vehicle driver to take action.

How Program meets Statutory Requirements:
The program meets the annual funding appropriation act's requirement to conduct train control and communications research.

Describe how public and stakeholder input have been utilized in the development of this research program:
The Train Control and Communications Research program will be evaluated periodically by a special committee of the TRB.

The program will be coordinated with the AAR research program through the AAR's Train Control, Communications and Operations Committee.

Program staff will participate in the FRA's Railway Safety Advisory Committee meetings.

Program staff will present research results for peer review at various conferences and in technical journals.

Human Factors Research Program

$5,542,000

Program Description:
The Human Factors Research program addresses:

Usability studies of automation, new technology, and system design

Studies of motorist decision-making at grade crossings.

Railroad trespass and suicide prevention, including pilot projects of potential countermeasures, geographic information system (GIS) mapping, and collaboration with international experts in rail suicide prevention.

Organizational culture and safety performance, including support for the Short Line Safety Institute.

Research into railway worker and operator performance, including fatigue, distraction, attention and situation awareness (e.g., stop signal violation research).

Human Factors Research in the Human Systems Integration (HSI) area, and the role of operators in accessing information about vehicle performance, status of track operations, and other operational information provided through electronic.

Program Objectives:
FRA's Human Factors Research program is aimed at reducing accidents caused by human error.

Anticipated Program Activities:
Human reliability studies following implementation of PTC technology in the Cab Technology Integration Laboratory (CTIL) to understand the challenges of human computer interaction and integration of multiple interfaces.

Studies of new and innovative in-cab technologies, such as Head-Up displays found in other transportation modes, CTIL to understand the challenges of human computer interaction and the integration of multiple interfaces on human performance.

Nonregulatory provision of human factors related guidance to enhance and streamline performance of rail system operational procedures and maintenance activity as automation and other technology is implemented.

Complete development of grade crossing predictive mathematical model for identifying environmental and behavioral predictors of accidents at grade crossings.

Completion of the Maintenance of Way (MOW) fatigue study to support the FRA Office of Railroad Safety's needs for issuing safety advisories and rulemaking.

Technical support of voluntary stakeholder working groups such as the Switching Operations Fatality Analysis (SOFA) Working Group and the Fatality Analysis of Maintenance-of-way Employees and Signalmen (FAMES) Committee.

Completion of safety culture measurement tools for the Short Line Safety Institute. Continued support of the Short Line Safety Institute (SLSI) to help improve safety across the short line and regional railroad industry.

Continued study of drivers' behavior at grade crossings by introducing data from naturalistic settings and driving simulator.

Develop communication strategy to expand the use of "Railroaders' Guide to Healthy Sleep" website.

Expected Program Outcomes:
Fewer accidents and incidents caused by human error.

Collaboration Partners:
Volpe National Transportation Systems Center - engineers and scientists at the Volpe Center will continue to conduct RD&T for FRA on human factors topics.

AAR - The AAR collaborates with subject matter expertise for research projects particularly where PTC and other automation research is conducted by the FRA.

The American Short Line and Regional Railroad Association (ASLRRA) - The Human Factors RD&T Division meets with ASLRRA stakeholders to learn about the specific safety concerns of small railroads.

The Short Line Safety Institute (SLSI) - The Human Factors RD&T Division has partnered with the SLSI to help improve safety and safety culture in small railroads and provide education and training for small railroads that do not have the resources to do so on their own.

Duke University - Duke is conducting research to develop mathematical modeling of dispatcher operations to address the impact of automation on dispatcher workload and operational safety.

Massachusetts Institute of Technology (MIT) - MIT is instrumental in prototyping and integrating experimental displays into the FRA's locomotive simulator lab, the CTIL. These

prototypes are then tested against locomotive engineer train driving performance in relation to automation research.

Michigan Technological University - As a result of the 2016 BAA solicitation, the Human Factors Division contracted with Michigan Tech to conduct innovative research study related to driver behavior at grade crossings.

How Program meets Statutory Requirements:
The program meets the annual funding appropriation act's requirement to conduct human factors research.

Describe how public and stakeholder input have been utilized in the development of this research program:
The Human Factors Research program will be evaluated periodically by a special committee of the TRB.

Program staff will be members of industry working groups such as the TRB Human Factors sub-committees.

Program staff will work closely with labor unions, the ASLRRA, and members of the AAR.

Program staff will participate in the FRA's Railway Safety Advisory Committee meetings.

Program staff will present research results for peer review at various conferences and in technical journals.

Railroad Systems Issues Research Program

$3,871,000

Program Description:
The Railroad Systems Issues Research program addresses:

Safety risk analysis, performance-based regulations, railroad environmental issues, and locomotive efficiency research.

Program evaluation, including the TRB's independent review of FRA's RD&T programs.

RD&TR related travel and contractor support.

Program Objectives:

FRA's Railroad Systems Issues Research program is aimed at prioritizing RD&T projects on the basis of relevance to safety risk reduction and other DOT goals.

Anticipated Program Activities:
Updating the safety risk model for guiding future RD&T.

Support program managers in evaluation of projects conducted by the four RD&T divisions.

Supporting the Workforce Development Program covering: Council on Women and Girls, Transportation Career Pathway Model Development, Minority Serving Institutions Task Force, and the Youth Empowerment and Success (YES) Mentoring Program.

Conducting a railroad industry workforce assessment to gather data on trends, skill demands, training opportunities, industry best practices, cross-modal efforts, etc.

Supporting the IDEA Program in collaboration with TRB.

Providing evaluation support for the Short Line Safety Institute.

Expected Program Outcomes:
Improved allocation of RD&T funds and support to other programs in improving railroad safety.

Collaboration Partners:
Volpe National Transportation Systems Center - Engineers and scientists at the Volpe Center will continue to provide project evaluation services to FRA.

Office of the Assistant Secretary for Research and Technology (OST-R) Research, Development & Technology Planning Team – FRA will continue to participate in the RD&T Planning Team meetings.

AAR – The FRA Railroad Systems Issues Research Program works closely with the AAR on a continuing basis to address research needs of mutual interest.

TRB voluntary evaluation of the FRA RD&T program to identify gaps and areas for improvement. Additionally, FRA RD&T participates in the IDEA program through TRB to provide grants for new and innovative ideas in transportation research.

How Program meets Statutory Requirements:
The program meets the annual funding appropriation act's requirement to conduct railroad systems issues research.

Describe how public and stakeholder input have been utilized in the development of this research program:

The Railroad Systems Issues Research program will be evaluated periodically by a special committee of the TRB.

The program will be coordinated with the AAR research program through the AAR's Railway Technical Working Committee.

Program staff will participate in the FRA's Railway Safety Advisory Committee meetings.

Program staff will present research results for peer review at various conferences and in technical journals.

Section 2 - Program Descriptions, FY 2019

Track Research Program

Program Description:
The Track Research program addresses:

Track and structure inspection techniques, material and component reliability, design, and performance.

Track and train interaction, derailment mechanisms, and vehicle-track performance.

Rail integrity related derailments and rail inspection systems.

Track safety standards for freight and passenger operations.

RD&T facilities at FRA's TTC.

Program Objectives:
FRA's Track Research program is aimed at reducing train derailments due to track related causes. The main causes are broken rails, track geometry defects, and track buckles in hot weather.

Anticipated Program Activities:
Develop guidelines on ballast condition safety limits under heavy axle service loads.

Continue engineering studies on broken rails related to rolling contact fatigue development.

Continued testing and evaluation of vehicle responses to multiple track geometry conditions.

Continued evaluation, validation and improvement of track geometry measuring systems.

Continued development of innovative methods for measuring longitudinal rail stress for buckling prevention.

Complete the Passive Air-coupled Rail Defect Detection approach to rail flaw detection and install on FRA testing car for in service evaluation.

Continue prototype development of an autonomous rail flaw defect detection system for use in revenue service.

Development of engineering guidelines for track inspection parameters based on correlations between measured data and track degradation.

Installation of machine vision-based track condition assessment system on FRA testing car for in service evaluation.

Continued evaluation of unmanned aircraft payloads systems for hazard warning and railroad safety inspections.

Continued development of facilities and test equipment at FRA's TTC.

Expected Program Outcomes:
Fewer train derailments due to poor track conditions, broken rails, track buckles, landslides and washouts. Improved facilities for conducting track research.

Collaboration Partners:
Volpe National Transportation Systems Center – Engineers and scientists at the Volpe Center will continue to conduct RD&T for FRA on topics such as rail integrity, vehicle-track interaction, and track support conditions.

Research partners include Class 1, commuter railroads, short line and regional railroads.

Cross modal collaboration partners include Federal Aviation Administration (FAA) and Federal Transit Administration (FTA).

How Program meets statutory requirements:
The program meets the annual funding appropriation act's requirement to conduct track research.

Describe how public and stakeholder input have been, or will be, utilized in the development of this research program:
The Track Research program will be evaluated periodically by a special committee of the TRB.

The program will be coordinated with the AAR Research program through the AAR's Heavy Axle Load Engineering Research Committee and Technology Outreach Program Committee.

Program staff will be members of industry working groups such as the AREMA committees.

Program staff will participate in the FRA's Railway Safety Advisory Committee meetings.

Program staff will present research results for peer review at various conferences and in technical journals.

Rolling Stock Research Program

Program Description:
The Rolling Stock Research program addresses:

Rolling stock and components, onboard and wayside monitoring systems, material and design improvements.

Hazardous materials transportation risk reduction, tank car damage assessment, inspection, and integrity.

Safety and clean energy benefits of Electronically Controlled Pneumatic brakes and other rolling stock technologies.

Train occupant protection, locomotive and passenger car safety and performance.

Program Objectives:
FRA's Rolling Stock Research program is aimed at reducing derailments due to equipment failures, minimizing the consequences of derailments, and minimizing hazardous material releases.

Anticipated Program Activities:
Research to gain a better understanding of current wheel failure modes and mechanisms.

Completion of research to comprehensively describe the engineering requirements placed on glazing systems, develop effective strategies for balancing all of the safety demands and provide recommendations for glazing strategies which offer maximized occupant containment in accidents.

Continuation of analysis and full scale testing of passenger locomotives retrofitted with crashworthy components to improve performance and operator protection during train collisions.

Collaboration with other modes on alternative fuels, such as natural gas, for improved emissions and assured safety.

Continue research and support rulemaking in collaboration with PHMSA to assure the safety of containers and railcars intended to transport LNG.

Continue to assess the safety of new tank cars intended for the transport of hazardous materials.

Expected Program Outcomes:
Fewer train derailments due to rolling stock equipment failures, better protection for passengers and train crews in accidents, and reduced release of hazardous materials.

Collaboration Partners:
Volpe National Transportation Systems Center – Engineers and scientists at the Volpe Center will continue to conduct RD&T for FRA on topics such as train occupant protection and accident investigation.

Pipelines and Hazardous Materials Safety Administration, Maritime Administration – FRA, PHMSA and MARAD will continue to collaborate on RD&T leading to new and improved regulations for hazardous materials shipped in tank cars.

How Program meets statutory requirements:
The program meets the annual funding appropriation act's requirement to conduct rolling stock research.

Describe how public and stakeholder input have been, or will be, utilized in the development of this research program:
The Rolling Stock Research program will be evaluated periodically by a special committee of the TRB.

The program will be coordinated with the AAR research program through the AAR's Locomotive Committee and Equipment Engineering Committee.

Program staff will be members of industry working groups such as the APTA committees.

Program staff will participate in the FRA's Railway Safety Advisory Committee meetings.

Program staff will present research results for peer review at various conferences and in technical journals.

Train Control and Communications Research Program

Program Description:
The Train Control and Communications Research program addresses:

Development and testing of train control and communication systems, including intelligent software defined radios, drone, and fiber optics technologies.

Grade crossing safety technologies and pilot studies, including intelligent transportation systems, blocked crossings, in-vehicle crossing violation warning/crash prevention, and trespass prevention countermeasures.

Program Objectives:
FRA's Train Control and Communications Research program is aimed at reducing train-to-train collisions and train collisions with objects and trespassers on the line and at grade crossings.

Anticipated Program Activities:
Enhancing the capabilities of the PTC test lab at the test center in Pueblo to support the anticipated high speed testing.

Continue the research and development of enhanced PTC communication security and authentication scheme to prevent potential hacking.

Continue the development of a national wireless communication roadmap.

Development of simulation and modeling tools to help Office of Safety evaluate safety and risks associated with PTC systems deployment.

Deployment of the PTC integrated roadway worker protection system.

Developing more effective and less costly alternative sensing and detecting methods using fiber optic technology.

Enhancing the intelligent transportation system-based prototype to warn vehicle drivers of the status of railroad crossings and enforce compliance.

Testing mitigating technology to prevent anticipated radio communication problems on the Northeast Corridor and congested rail traffic around the country.

Testing locomotive-based technologies for long-range trespasser detection and warning systems.

Developing the next generation track circuits for future train control systems.

Testing of an advanced highway preemption system.

Developing standards for monitoring PTC performance for the national system.

Support human factor studies related to pedestrian and driver behavior around railroad tracks and grade crossing.

Expected Program Outcomes:
Fewer train-to-train collisions and train collisions with objects on the line and at grade crossings.

Collaboration Partners:
Volpe National Transportation Systems Center - Engineers and scientists at the Volpe Center will continue to conduct RD&T for FRA on grade crossing safety and trespass prevention.

Federal Highway Administration, Federal Motor Carriers Safety Administration, Intelligent Transportation Systems – Joint Program Office – FRA will continue to collaborate with these partners on intelligent transportation systems RD&T.

How Program meets Statutory Requirements:
The program meets the annual funding appropriation act's requirement to conduct train control and communications research.

Describe how public and stakeholder input have been utilized in the development of this research program:
The Train Control and Communications Research program will be evaluated periodically by a special committee of the TRB.

The program will be coordinated with the AAR research program through the AAR's Train Control, Communications and Operations Committee.

Program staff will participate in the FRA's Railway Safety Advisory Committee meetings.

Program staff will present research results for peer review at various conferences and in technical journals.

Human Factors Research Program

Program Description:
The Human Factors Research program addresses:

Safety culture pilot programs.

Research into fatigue distraction, attention and situational awareness, and ergonomics.

Job and cognitive task analyses.

Usability studies of automation and new technology.

Trespass and suicide prevention.

Stop signal violation research.

Guidance for implementing safety management systems.

Studies of motorist decision-making at grade crossings.

Short Line Safety Institute support.

Program Objectives:
FRA's Human Factors Research program is aimed at reducing accidents caused by human error.

Anticipated Program Activities:
Human error in using automation (e.g. PTC, Fuel Optimizer) studies to understand the challenges of human computer interaction and integration of multiple interfaces.

Continued human reliability studies in FRA's CTIL following implementation of PTC technology.

Modifying and improving safety culture and safety compliance measurement tools for the Short Line Safety Institute.

Continued support in standing up the Safety Institute to help improve safety across the short line and regional railroad industry.

Completion of a list of leading human factors causes in rail accidents from FRA and National Transportation Safety Board (NTSB) accident reports. The results will help align the focus of human factors research with the leading causes of accidents due to human error.

Complete study of drivers' behavior at grade crossings by introducing data from naturalistic settings and driving simulator.

Continue to develop communication strategies to expand the use of "Railroaders' Guide to Healthy Sleep" website.

Provide nonregulatory guidance for Human Systems Integration (HSI) to aid implementation of rail operating personnel safely with advanced technologies.

Expected Program Outcomes:
Fewer accidents and incidents caused by human error.

Collaboration Partners:
Volpe National Transportation Systems Center - engineers and scientists at the Volpe Center will continue to conduct RD&T for FRA on human factors topics.

How Program meets statutory requirements:
The program meets the annual funding appropriation act's requirement to conduct human factors research.

Describe how public and stakeholder input have been, or will be, utilized in the development of this research program:
The Human Factors Research program will be evaluated periodically by a special committee of the TRB.

Program staff will be members of industry working groups such as the TRB Human Factors sub-committees.

Program staff will work closely with labor unions and the ASLRRA.

Program staff will participate in the FRA's Railway Safety Advisory Committee meetings.

Program staff will present research results for peer review at various conferences and in technical journals.

Railroad Systems Issues Research Program

Program Description:
The Railroad Systems Issues Research program addresses:

Safety risk analysis, performance-based regulations, railroad environmental issues, and locomotive efficiency research.

Program evaluation, including the TRB's independent review of FRA's RD&T programs.

RD&T related travel and contractor support.

Program Objectives:
FRA's Railroad Systems Issues Research program is aimed at prioritizing RD&T projects on the basis of relevance to safety risk reduction and other DOT goals

Anticipated Program Activities:
Continue to update the safety risk model for guiding future RD&T

Support program managers in evaluation of projects conducted by the four RD&T divisions.

Supporting the Workforce Development Program covering: Ladders of Opportunity, Council on Women and Girls, Transportation Career Pathway Model Development, Minority Serving Institutions Task Force, and the YES Mentoring Program.

Conducting a railroad industry workforce assessment to gather data on trends, skill demands, training opportunities, industry best practices, cross-modal efforts, etc.

Supporting the IDEA Program in collaboration with TRB.

Providing evaluation support for the Short Line Safety Institute.

Expected Program Outcomes:
Improved allocation of RD&T funds and support to other programs in improving railroad safety.

Collaboration Partners:
Volpe National Transportation Systems Center - engineers and scientists at the Volpe Center will continue to provide project evaluation services to FRA.

OST-R Research, Development & Technology Planning Team – FRA will continue to participate in the RD&T Planning Team meetings.

AAR – The FRA Railroad Systems Issues Research Program works closely with the AAR on a continuing basis to address research needs of mutual interest.

TRB voluntary evaluation of the FRA RD&T program to identify gaps and areas for improvement. Additionally, FRA RD&T participates in the Innovations Deserving Exploratory Analysis (IDEA) program through TRB to provide grants for new and innovative ideas in transportation research.

How Program meets statutory requirements:

The program meets the annual funding appropriation act's requirement to conduct railroad systems issues research.

Describe how public and stakeholder input have been, or will be, utilized in the development of this research program:

The Railroad Systems Issues Research program will be evaluated periodically by a special committee of the TRB.

The program will be coordinated with the AAR research program through the AAR's Railway Technical Working Committee.

Program staff will participate in the FRA's Railway Safety Advisory Committee meetings.

Program staff will present research results for peer review at various conferences and in technical journals.