

**United States Department of Transportation
Annual Modal Research Plans**

Cover Page

Federal Motor Carrier Safety Administration

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Executive Summary

The Federal Motor Carrier Safety Administration (FMCSA) carries out a multiyear Motor Carrier Research & Technology (R&T) Program under the authority of 49 USC 31108. The R&T Program includes in-house, contract, congressionally mandated, and joint-funded initiatives with other U.S. Department of Transportation (USDOT) organizations, the private sector, and academia. FMCSA is authorized to carry out research, development, and technology transfer activities with respect to:

- The causes of crashes, injuries, and fatalities involving commercial motor vehicles (CMVs).
- Means of reducing the number and severity of crashes, injuries, and fatalities involving CMVs.
- Improving CMV safety and efficiency through technological innovation and improvement.
- Improving technology used by enforcement officers when conducting roadside inspections and investigations to increase efficiency and information transfers.
- Increasing the safety and security of hazardous materials transportation.

FMCSA's mission is to reduce crashes, injuries, and fatalities involving large trucks and buses. The R&T Program serves as the underpinning for empirically answering research questions in support of the Agency's safety mission and the overall Departmental goals of *Safety* and *Innovation*. Using research to better understand factors associated with crashes, FMCSA can streamline and prioritize its enforcement efforts, focusing on vital Federal safety oversight functions.

Collaboration Efforts

FMCSA collaborates closely with product end-users—including internal FMCSA program offices and other USDOT modes—to identify common research needs and streamline existing and planned research efforts. The Agency works closely with the National Highway Traffic Safety Administration (NHTSA), the Federal Highway Administration (FHWA), and the Intelligent Transportation Systems Joint Program Office (ITS JPO) to answer research questions related to automated and connected CMVs, heavy vehicle crash avoidance, and enterprise data, and to accelerate the deployment of CMV safety technologies.

FMCSA also collaborates with external stakeholders and partners. The Agency regularly receives, reviews, and responds to safety-related CMV driver, carrier, and vehicle research and policy recommendations from the National Transportation Safety Board (NTSB), the National Academy of Sciences (NAS), the Transportation Research Board (TRB), the Committee on National Statistics (CNSTAT), the Motor Carrier Safety Advisory Committee (MCSAC), and other organizations. FMCSA evaluates recommendations from these organizations and adjusts the R&T agenda as needed. Where appropriate, FMCSA partners with external organizations—such as the National Institute of Occupational Safety and Health (NIOSH), the Department of Energy, and the Commercial Vehicle Safety Alliance (CVSA)—to conduct relevant CMV driver, carrier, and vehicle safety research. FMCSA also maintains close contact with the motor carrier industry, collaborating with industry associations and motor carriers to advance safety improvement efforts.

Strategic Objectives and Critical Programs

FMCSA's R&T Program has established the following strategic objectives:

- **Produce Safer Drivers:** Develop driver-based safety countermeasures to reduce crashes.

- **Improve Safety of CMVs:** Improve truck and motorcoach safety through vehicle-based research and the deployment of CMV safety technologies.
- **Produce Safer Carriers:** Improve motor carrier safety by compiling and communicating best management practices to motor carriers and work with industry to accelerate adoption of safety-enhancing technology, such as automatic emergency braking (AEB) systems.
- **Advance Safety through Information-Based Initiatives:** Support Agency enforcement efforts by: 1) evaluating existing research to highlight areas for additional investigation, 2) investigating the overall business, economic, and technical trends in the CMV industry to understand and respond to their impact on safety, and 3) exploring the feasibility and utility of using multiple measures as a basis for calculating crash statistics and setting safety goals. This strategic objective encompasses automated commercial vehicle research and support for the Innovative Technology Deployment (ITD) Grant Program, the Agency’s key mechanism for transferring proven enforcement technologies into operational systems for the States.
- **Enable and Motivate Internal Excellence:** Ensure the relevance, quality, and performance of research and technology activities and develop efficient methods to respond quickly and flexibly to Departmental and Agency needs.

FMCSA’s FY 2019 R&T activities, which primarily align with the USDOT Strategic Goals of *Safety* and *Innovation*, have two key focus areas: 1) automated CMV research and development, and 2) research to support Agency efforts to produce safer commercial drivers, carriers, and vehicles.

Anticipated Outcomes

FMCSA’s R&T Program develops the knowledge, practices, and technologies needed to solve problems that arise in prioritizing Agency resources and improving the safety of commercial drivers, vehicles, and carriers. Crashes involving CMVs are extremely costly; in 2015, the estimated costs of all large truck and bus crashes was \$118 billion (see Table 1). In 2016, 4,564 fatalities involved large truck and bus crashes (FMCSA, Large Truck and Bus Crash Facts 2016). In general, research conducted by FMCSA contributes to the development of safety technologies (for use by enforcement and commercial carriers) and recommended best practices to improve driver performance and the safe operation of CMVs, thus contributing to a reduction in crashes. By completing targeted research, FMCSA will:

Table 1. Estimated Costs of Large Truck and Bus Crashes, 2012-2015 (2015 Dollars)

Year	Fatal Crashes	Injury Crashes	Property-Damage-Only (PDO) Crashes	All Large Truck and Bus Crashes
2012	\$43 Billion	\$40 Billion	\$21 Billion	\$104 Billion
2013	\$44 Billion	\$41 Billion	\$22 Billion	\$107 Billion
2014	\$42 Billion	\$44 Billion	\$28 Billion	\$114 Billion
2015	\$44 Billion	\$46 Billion	\$28 Billion	\$118 Billion

Source: 2017 Pocket Guide to Large Truck and Bus Statistics, Table 4-22.

- Better understand the causes and impacts of CMV crashes and inform efforts to develop safety countermeasures to reduce crashes.
- Better understand the safety impacts associated with the adoption of automated CMVs.
- See continued progress in the development and testing of CMV safety technologies.

Ultimately, FMCSA’s R&T efforts will contribute to the Agency’s mission of reducing the number and severity of CMV-involved crashes on the Nation’s highways, reducing costs to the American public and saving lives.

Treatment of USDOT Priority Issues

Every USDOT mode is required to address how its research program(s) will address the following issues, where applicable. FMCSA's plan for treating relevant issues is summarized below. Additional details are presented throughout the research plan, as noted.

- **Economic impact of regulatory reform (critical priority):** In FY 2019, FMCSA will be collecting data for the Military Under-21 CMV Driver Pilot Program. Findings from this research effort could identify economic efficiencies for the CMV industry. See pages 15 and 31 for more details.
- **Economic impact of permitting reform (critical priority):** The R&T Program will continue to support FMCSA's ITD Grant Program, which (among other things) provides funding for States to improve their oversize/overweight permitting programs. See page 15 to learn more about the R&T Program's support of the ITD Grant Program.
- **Performance-based regulations and safety:** In FY 2019, the R&T Program will stand by to support any ongoing or planned FMCSA rulemaking efforts.
- **Potential impact of asset recycling:** While FMCSA will not be conducting research in this area, the Agency is committed to recycling existing Government assets. For example, in FY 2018, FMCSA acquired three Class 8 tractors previously used by NHTSA in the Connected Vehicle Safety Pilot. FMCSA will use these three tractors in FY 2019 as test vehicles in a series of truck platoon and automated CMV-related evaluations at the Aberdeen Test Center. See pages 7-8 to learn more.
- **Potential impact of value capture:** FMCSA's R&T Program will not be addressing the subject of value capture in FY 2019, as it is outside the scope of the Agency's safety mission.
- **Improving the mobility of freight:** FMCSA's research to support the safe deployment of truck platooning and automated CMV-related operations also supports improved mobility of freight. Further, the ITD Grant Program supports improved freight mobility. See pages 6, 14, and 25 for more details.
- **Feasibility of micro-transit:** FMCSA's R&T Program will not be addressing the feasibility of micro-transit in FY 2019, as it is outside the scope of the Agency's mission; however, the Agency will provide input to other modes researching this area, as requested.
- **Improving mobility for underserved communities:** FMCSA's R&T Program will not be addressing this issue in FY 2019, as it is outside the scope of FMCSA's mission; however, the Agency will continue to support the safe operation of large trucks and buses nationwide, to include those operating in underserved communities.
- **Cybersecurity:** In FY 2019, FMCSA's R&T Program is planning to conduct cybersecurity evaluations on a closed test track at the Aberdeen Test Center, using its three test tractors. This exploration into the state of CMV cybersecurity will initially evaluate the performance of applicable and available intrusion detection systems (IDS) and intrusion prevention systems (IPS). Additional research will involve an analysis of J1939 CAN bus traffic to quantify the type, frequency and sensitivity of the signal traffic (see page 7).

FY 2019 High-Priority Research Projects

1. Research to Examine Crash Factors and to Provide Strategic Direction for Developing and Testing Crash Countermeasures

Why FMCSA Should Invest in This Research: In FY 2016, FMCSA commissioned the establishment of an expert Research Analysis Committee at the Transportation Research Board to review the Agency's research portfolio and provide suggestions for addressing pressing motor carrier safety challenges and opportunities. The Research Analysis Committee provided FMCSA with four major recommendations, outlined in a letter report. This research project directly relates to two of those recommendations:

- Consider focusing on environmental influences, traffic levels, vehicle technologies, and roadway design in addition to the factors currently recognized as contributing to crashes.
- Evaluate the effectiveness of programs (countermeasures) designed to reduce crashes.

This research also relates to recommendations made by NAS/CNSTAT.

Research Problem: The CMV industry's understanding of the causes of crashes is limited; however, large-scale studies to gain a scientific understanding of the multiple dimensions of causality are very expensive and take years to complete. A cost-effective approach to analyzing crash factors and developing recommended crash countermeasures is needed.

Objectives and Activities: FMCSA will partner with NHTSA and FHWA to conduct a systematic review of crash factors and to develop potential crash countermeasures. Working together, FMCSA and its partners will develop a multi-phased research project to: 1) examine existing USDOT-collected crash data, and 2) augment these data by linking to other USDOT, State, or commercially available data sources. In the final phase, researchers will examine naturalistic driving data to gain a better understanding of the driver behaviors that precipitate a crash, many of which are often underreported, such as distraction and fatigue. At each phase of the project, FMCSA and its partners will hold joint workshops to review findings and develop and refine research priorities, crash countermeasures, and a strategic plan for testing and deploying crash countermeasures.

Others Researching This Issue: NHTSA has established an Electronic Data Transfer Program, which advances the collection of real-time, State-level crash data to enhance our understanding of crash characteristics and where safety challenges are occurring. Separately, FHWA provides annual estimates of vehicle miles traveled (VMT) at the national level, broken out by straight truck, combination truck, and bus. FHWA is looking to produce VMT at smaller geographic areas (State-level, possibly even Census area), but this will likely be a longer-term effort. FMCSA will partner with both NHTSA and FHWA on this research effort and leverage available data from both modes.

Previous Investments and Conclusions: FMCSA and NHTSA conducted the Large Truck Crash Causation Study (LTCCS) to examine serious crashes involving large trucks. The LTCCS investigated a national sample of fatal and injury crashes that took place between April 2001 and December 2003 at 24 sites in 17 States. Each crash involved at least one large truck and resulted in at least one fatality or injury. The total sample of 967 crashes included 1,127 large trucks, 959 non-truck motor vehicles, 251 fatalities, and 1,408 injuries.

For all crashes in the study (single- and multiple-vehicle crashes), trucks were assigned the critical reason in 55 percent of the cases. Driver behaviors accounted for 87 percent of the reasons, and most involved failure to correctly recognize the situation or poor driving decisions. Thirteen percent of the coded reasons involved the truck, weather conditions, or roadway problems. For more information about the LTCCS, visit: <https://ai.fmcsa.dot.gov/ltccs/default.asp?page=about>.

Alignment with DOT Strategic Goals: This project aligns with the USDOT Strategic Goal of *Safety*.

Expected Project Costs:

- **FY 2019:** \$250,000
- **Total:** \$750,000

Non-Federal Financial Contributions: None.

2. FMCSA's Automated CMV Evaluations (ACE)

Why FMCSA Should Invest in This Research: Personal and commercial vehicles equipped with automated driving systems (ADS) and/or connected vehicle technologies may reach the market in a few years. It is critical to test and evaluate these innovative technologies to ensure their safe deployment on our Nation's roadways.

Research Problem: ADS-equipped CMVs and connected commercial vehicle technologies are being developed and introduced to the market at a rapid pace. While technology developers do address some safety considerations during the development phase, they often do not have enough resources to run exhaustive functional safety tests and identify areas of concern.

Objectives and Activities: FMCSA recently repurposed three Class 8 tractors (shown right) that were surplus NHTSA equipment to be used as test vehicles for truck platoon and automated CMV evaluations at the U.S. Army's Aberdeen Test Center (ATC). In FY 2019, FMCSA will partner with FHWA and the U.S. Department of Energy to conduct platooning and automated CMV test track evaluations at the ATC. With its partners, the Agency will perform numerous safety evaluations,



The three trucks FMCSA has acquired are 2012 Freightliner Cascadias, previously used in the Connected Vehicle Safety Pilot and other NHTSA-sponsored programs.

addressing driver and vehicle factors and cybersecurity concerns. Driver-focused evaluations will address driver readiness, the human-machine interface, adaptation to advanced technologies, and communication with others outside the vehicle. Vehicle-focused evaluations will address operational considerations, emergency response, and inspection tools and processes. Cybersecurity research will explore the state of CMV cybersecurity and will initially evaluate the performance of applicable and available intrusion detection systems (IDS) and intrusion prevention systems (IPS). Additional research will involve an analysis of the J1939 CAN bus traffic to quantify the type, frequency and sensitivity of the signal traffic. Findings from these evaluations will inform voluntary guidance and best practices for industry and States. Future research efforts include joint platoon testing with the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) and testing of Society of Automotive Engineers (SAE) level 2-3 technologies.

Others Researching This Issue: The U.S. Army and FHWA are conducting research related to automated truck technology and truck platoons. Additionally, numerous States are interested in or currently conducting intrastate automated truck and truck platoon demonstrations or field operational tests. FMCSA's research is focused specifically on ensuring the safe operation (by drivers and motor carriers) of ADS-equipped CMVs.

Previous Investments and Conclusions: FMCSA is currently conducting research regarding 1) brake performance for the safe operation of trucks in platoon configurations, 2) sensor performance in automated CMV applications, 3) development of baseline safety performance measures for highly automated commercial vehicles, and 4) accelerating industry-wide voluntary adoption of AEB systems in CMVs. These research projects are ongoing. Earlier research on onboard monitoring systems and other sensor-based systems realized the potential safety benefits of these technologies, with further development.

Alignment with DOT Strategic Goals: This project aligns with the USDOT Strategic Goals of *Innovation and Safety*.

Expected Project Costs:

- **FY 2019:** \$838,750
- **Total:** \$2,729,225

Non-Federal Financial Contributions: None.

Anticipated Funding from Other Federal Agencies: The ITS Joint Program Office is contributing \$1.5M in AV software development that will be used by both FMCSA and FHWA AV test vehicles.

3. Develop and Test New Inspection Tools for States to Support ADS-equipped CMV Pilot Testing

Why FMCSA Should Invest in This Research: Before ADS-equipped CMVs are introduced to the market for general purchase and use, extensive testing must be conducted to ensure safety standards are met or exceeded. While undergoing testing, these vehicles will need to be inspected periodically.

Research Problem: An updated suite of inspection tools for use in inspecting ADS-equipped CMVs during and after pilot tests is required.

Objectives and Activities: FMCSA will work with CVSA, NHTSA, and other USDOT modes as appropriate to identify existing inspection technologies that could be applied to ADS-equipped CMVs. After completing this initial market search, the Agency will work to tailor the identified tools (or develop new ones) and later test these tools on different levels (SAE levels 1, 2, and 3) of ADS-equipped CMVs. The goal is to develop a suite of ADS inspection tools that are affordable, accurate, user-friendly, and easy to deploy.

Previous Investments and Conclusions: None.

Alignment with DOT Strategic Goals: This project aligns with the USDOT Strategic Goals of *Innovation and Safety*.

Expected Project Costs:

- **FY 2019:** \$250,000
- **Total:** \$250,000

Non-Federal Financial Contributions: The Commercial Vehicle Safety Alliance and member State CMV Enforcement Agencies are contributing in-kind staff hours to this collaborative effort.

4. Improve Data Sharing and Integrity for Increased Safety

Why FMCSA Should Invest in This Research: FMCSA is pursuing this research in order to implement various data sharing and analysis-related recommendations from the Post-Accident Review Advisory Committee established by Section 5306 of the Fixing America's Surface Transportation Act, 2015 (FAST Act), the TRB Research Analysis Committee, and the NAS/CNSTAT Expert Panel for Improving Methodological Approaches to Understanding Driver Fatigue.

Research Problem: As stated in the NAS/CNSTAT panel report, there is a "need for an assessment of what data on the various causal [crash] factors exist, at what level, and for what populations, and how linkable these data are to other variables."

Objectives and Activities: Consistent with the recommendations of the Post-Accident Reporting Advisory Committee established by the FAST Act, FMCSA is working with NHTSA's Electronic Data Transfer Program, which advances the collection of real-time, State-level crash data to enhance our understanding of crash characteristics and where safety challenges are occurring. In FY 2019, FMCSA will initiate an expansion of its crash data collection to incorporate essential Model Minimum Uniform Crash Criteria Guideline, 5th Edition (MMUCC5) data elements to enable more in-depth analysis of crashes and associated factors in modeling crash predictability.

More precise information on the location of crashes and the other vehicles involved will allow linking of crash data to highway characteristics, freight and passenger transportation trends, population changes, and other data sources to assess the factors that contribute to crashes, to predict the locations of likely future crashes, and to apply resources appropriately to reduce their occurrence. Separately, FMCSA will also continue operations and maintenance activities for the Agency's Data Repository (currently under development), which houses publicly available, de-identified data sets from FMCSA-sponsored research studies.

Others Researching This Issue: NHTSA has established the Electronic Data Transfer Program, which transfers motor vehicle crash data electronically from the States to a Federal warehouse and converts all motor vehicle crash data into uniform definitions.

Previous Investments and Conclusions: FMCSA continually works to improve the quality of crash and inspection data reported by the States through its State Safety Data Quality Program; however, FMCSA's R&T Program does not fund these efforts. The State Safety Data Quality Program has successfully improved data quality since its inception in 2004.

Alignment with DOT Strategic Goals: This project aligns with the USDOT Strategic Goals of *Innovation* and *Safety*.

Expected Project Costs:

- **FY 2019:** \$800,000
- **Total:** \$800,000

Non-Federal Financial Contributions: None.

High-Priority Projects Completed in FY 2017-18

1. Trucking Fatigue Meter

Objectives and Activities: This ongoing Small Business Innovation Research (SBIR) project developed the Trucking Fatigue Meter, a data analytics technology that uses existing streams of trucking data (e.g., electronic logging device data) to evaluate driver fatigue and provide actionable feedback in real-time. Technical merit, feasibility, and commercial potential of this technology were established in Phase I, while development efforts continued through Phase II. The project is now in Phase III—commercialization.

Alignment with DOT Strategic Goals: This project aligns with the USDOT Strategic Goals of *Innovation, Safety, and Accountability*.⁽¹⁾

What Was Learned: The Trucking Fatigue Meter has the potential to reduce fatigue-related crashes and improve highway safety. The Web services were designed to provide objective quantitative feedback to truck drivers, dispatchers, and safety managers about fatigue stressors common in CMV operations (e.g., chronic sleep restriction, extended duty hours, night work). It can provide drivers with guidance about optimal times to drive, when to take a break, and sleep. Dispatchers and safety managers have real-time quantitative data about driver fatigue correlated with business metrics, such as hours-of-service violations, speeding, hard braking, and fuel efficiency.

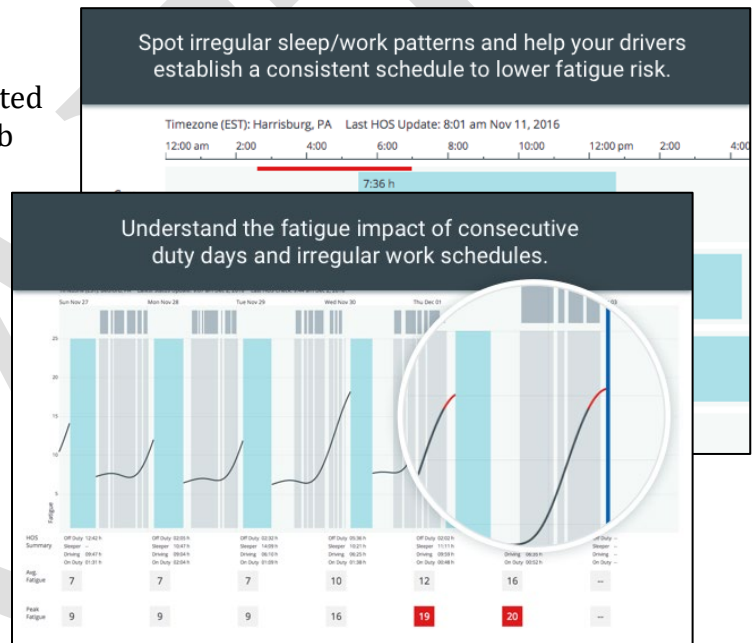


Image Source: Pulsar Informatics

The fatigue dashboard helps motor carriers proactively manage fatigue habits for safety and performance benefits. Specific benefits of the Trucking Fatigue Meter include a reported reduction in safety-critical events (SCEs), increased driver awareness of sleep needs, learning from past incidents based on comprehensive fatigue assessments, and safer load assignments that mitigate fatigue.

The expanded capabilities of the Trucking Fatigue Meter support the selection of operational fatigue countermeasures and the provision of driver training in the domain of fatigue risk management. A feature to analyze trends in SCEs was implemented. This feature will show the total number of SCEs over a given timeframe by specific driver, along with a chart showing the number of days since the last SCE. It offers an easy way to judge whether driver coaching activities have contributed to any change in safety performance.

¹ See the "Small Business" strategy under Accountability, Management Objective 2: Mission Efficiency and Support, in the FY 2018-22 USDOT Strategic Plan, p. 40.

Research Outputs: The sales pipeline for the Trucking Fatigue Meter is growing. Three motor carriers have signed on as subscribing customers; one of those carriers is deploying the system to 2,000 drivers. More information about the Trucking Fatigue Meter can be found at: <https://pulsarinformatics.com/products/trucking>.

Plans for Further Research: Phase III of this SBIR project will extend through FY 2019, in support of expanded capability development and ongoing commercialization of the product.

Non-Federal Stakeholder Contributions: Non-Federal stakeholders include private motor carriers that purchase/subscribe to the Trucking Fatigue Meter.

Total Cost: \$1,272,809

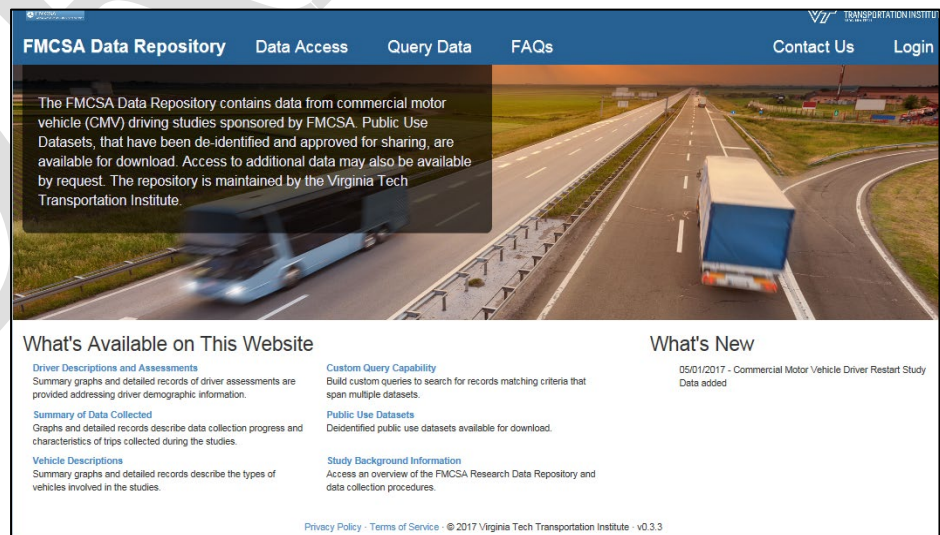
Non-Federal Dollars Leveraged: None.

2. Data Repository

Objectives and Activities: In 2013, the Office of Science and Technology Policy issued a policy memo stating that data sets that have been processed and reduced during Federally funded research projects shall be developed into de-identified data sets that are made publicly available. In accordance with this policy, FMCSA sponsored the development of a permanent, secure Data Repository for data collected during FMCSA research and technology studies. Work on this project began in October of 2016. A functional internal, beta version of the Data Repository became available in May of 2017. FMCSA expects to publish and operate the Data Repository—housing data from several more recently completed FMCSA studies—by the end of 2018.

Alignment with DOT Strategic Goals: This project aligns with the USDOT Strategic Goal of *Innovation*.

What Was Learned: There are many factors that must be taken into consideration when developing a data repository. For example, without uniform data definitions across datasets, it becomes difficult to query data across studies. Other critical considerations include the development of requirements for future data sets produced by FMCSA studies (including data definitions and de-identification of data) and development of procedures for external researchers to access the data. Ensuring that any personally identifiable information is completely secure and inaccessible to the public is the highest priority in a project like this.



Pictured here is a beta version of the FMCSA Data Repository, expected to be operational and available to the public in 2018.

Research Outputs: A secure Data Repository to house research data collected by FMCSA. Data will be made available to researchers who follow the established access and security procedures.

Plans for Further Research: FMCSA will fund ongoing operations and maintenance of the Data Repository by a third-party research organization. Funding for enhanced functionality may be necessary in the future.

Non-Federal Stakeholder Contributions: VTTI recently upgraded their IT infrastructure. FMCSA has leveraged this updated infrastructure to enhance the capabilities of the Data Repository.

Total Cost: \$365,640 (FY 2016 = \$214,000; FY 2019 = \$75,000; FY 2020 = \$76,640)

Non-Federal Dollars Leveraged: None.

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Section 1 – Program Descriptions, FY 2019

FY 2019 RD&T Program Funding Details

RD&T Program Name	FY 2019 Pres. Budget (\$000)	FY 2019 Basic (\$000)	FY 2019 Applied (\$000)	FY 2019 Development (\$000)	FY 2019 Technology (\$000)
R&T Program	\$9,073		\$5,350		\$3,723
• <i>Produce Safer Drivers, Carriers, and Vehicles</i>	\$4,473		\$4,600		
• <i>Autonomous Vehicles</i>	\$4,600		\$750		\$3,723
Totals	\$9,073		\$5,350		\$3,723

FY 2019 RD&T Program Budget Request by DOT Strategic Goal

RD&T Program Name	FY 2019 Pres. Budget (\$000)	SAFETY (\$000)	INFRASTRUCTURE (\$000)	INNOVATION (\$000)	ACCOUNTABILITY (\$000)
R&T Program	\$9,073	\$4,650		\$4,423	
• <i>Produce Safer Drivers, Carriers, and Vehicles</i>	\$4,473	\$2,414		\$2,186	
• <i>Autonomous Vehicles</i>	\$4,600	\$2,236		\$2,237	
Totals	\$9,073	\$4,650		\$4,423	

Research and Technology Funding Request (\$9,073,000)

Program Description/Activities:

FMCSA's R&T Program provides scientific safety research on driver behavior, carrier operations, and technology applications. These contributions have proven critical in identifying Agency enforcement priorities and facilitating technology transfer to the marketplace. Program activities range from demonstrating the efficacy of truck drivers getting proper training and rest to developing best practices for truck platoon and automated CMV deployments. These research efforts provide the underpinnings for empirically answering research questions related to the Departmental goals of *Safety* and *Innovation*. Research includes in-house, contract, congressionally-mandated, and joint-funded studies with other DOT elements, the private sector, and academia.

Statutory Requirements:

FMCSA's R&T Program is statutorily mandated.⁽²⁾ The purpose of the R&T Program is stated in 49 U.S.C. 31108, which establishes a motor carrier and motorcoach research and technology program and delineates the program requirements. Under 49 U.S.C. 31108, paragraph (a)(3)(C), FMCSA may fund research, technology, and development projects that improve the safety and efficiency of CMV operations through technological innovation and improvement.

FMCSA's R&T Program meets the requirements outlined in 49 U.S.C. 31108 by conducting targeted research to improve motor carrier, commercial driver, and CMV safety; improving technology used by enforcement officers when conducting inspections; facilitating transfer of safety technologies to the States through the Innovative Technology Deployment (ITD) Grant Program and other avenues; and addressing hazardous materials safety considerations.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting Safety
Innovation	Improving Mobility

Work conducted by FMCSA's R&T Program primarily aligns with the USDOT Strategic Goals of *Safety* and *Innovation*.⁽³⁾ Research and technology projects primarily address the RD&T Critical Transportation Topic of *Promoting Safety*. Some of FMCSA's research and technology projects overlap with the Critical Transportation Topic of *Improving Mobility* (e.g., working to develop interstate best practices for truck platoon deployments, to enable free-flowing commerce across State lines).

² Pub. L. 103-272, §1(e), July 5, 1994, 108 Stat. 993; Pub. L. 109-59, title IV, §4111(a), Aug. 10, 2005, 119 Stat. 1722.

³ FMCSA's R&T Program supports the USDOT Strategic Goals of *Accountability* and *Infrastructure* in some instances. See pages 15 and 26-27 of this research plan for specific examples.

How the Program Supports USDOT Strategic Goals

FMCSA's primary mission is to reduce crashes, injuries, and fatalities involving large trucks and buses. Consistent with the USDOT Strategic Goal of *Safety*, described in the USDOT Strategic Plan for FY 2018-22, FMCSA's R&T Program:

- Conducts research to improve transportation safety specific to the CMV industry.
- Seeks to work effectively with State, local, and private partners to advance its safety mission.
- Addresses commercial driver behaviors to reduce safety risks.
- Consistently strives to improve safety data analysis to guide decisions.

In support of the USDOT Strategic Goals of *Innovation* and *Accountability*, the R&T Program invests in Small Business Innovation Research (SBIR) projects focused on the development and commercialization of innovative CMV safety technologies.⁽⁴⁾ In support of *Safety* and *Accountability*, FMCSA's R&T Program conducts research to support regulatory reform and relief for motor carriers.⁽⁵⁾ For example, the R&T Program is currently sponsoring the Military Under-21 CMV Driver Pilot Program⁽⁶⁾ to evaluate regulatory alternatives for CMV drivers and motor carriers. The R&T Program is also re-examining the Agency's vision standard for CMV drivers and evaluating the efficacy of the vision waiver program.⁽⁷⁾ Findings from these projects could identify economic efficiencies in industry operations.

Separately, the R&T Program supports and manages the technical aspects of the Agency's ITD Grant Program. The ITD Program supports the USDOT Strategic Goals of *Safety* and *Innovation* (and *Infrastructure*, indirectly) by focusing safety enforcement on high-risk operators; integrating systems to improve the accuracy, integrity, and verifiability of credentials; enabling online application and issuance of credentials; and improving State safety inspection efficiency through electronic screening of commercial vehicles traveling at highway speeds past roadside weigh stations. Electronic screening enables inspectors to identify non-compliant carriers—including unpermitted oversize/overweight carriers, which have an impact on the Nation's infrastructure.

Autonomous Vehicles

Specific to automated vehicles (AV) and in support of the USDOT Strategic Goals of *Safety* and *Innovation*, FMCSA conducts research to ensure the safe operation of automated CMVs on the Nation's highways; provides voluntary guidance to States and industry AV implementers; researches automated CMV driver factors and vehicle safety components; develops cybersecurity guidance for automated CMVs; establishes data elements and data sharing guidance to support AV testing; and works closely with State and industry stakeholders to fully vet and safely deploy automated CMVs and truck platoons. These activities are conducted under the authority of 49 U.S.C. 31108, through FMCSA's R&T Program. FY 2019 R&T Program funds in the amount of \$4,600,000 have been allotted to AV research, technology, and development projects.

⁴ See the "Small Business" strategy (i.e., "Promote small business development opportunities") under *Accountability*, Management Objective 2, on pages 8 and 40 of the FY 2018-22 USDOT Strategic Plan.

⁵ See the "Regulation" strategy (i.e., "Reduce regulations and control regulatory costs") under *Accountability*, Management Objective 1, on pages 8 and 37 of the FY 2018-22 USDOT Strategic Plan.

⁶ <https://www.fmcsa.dot.gov/safety/research-and-analysis/military-under-21-cmv-driver-pilot-program-fast-act-section-5404>

⁷ <https://www.fmcsa.dot.gov/safety/research-and-analysis/examining-fmcsa-vision-standard-cmv-drivers-and-waiver-program>

Impact on Rural Communities

FMCSA's R&T Program does impact rural communities. Rural roadways have a high volume of large truck crashes and fatalities. In 2016, 61 percent of fatal large truck crashes were on rural roads.⁽⁸⁾ FMCSA's research and technology activities aim to improve CMV transportation safety in all locations, including rural communities. Some examples of FMCSA research efforts that impact rural communities include:

- **Nurse tank research:** FMCSA has conducted several phases of research on pressurized nurse tanks, the containers used to transport anhydrous ammonia to agricultural fields for injection in the soil as fertilizer. Nurse tank failures can be catastrophic, causing fatalities and extensive property damage. FMCSA has discovered that certain manufacturing processes can reduce the safety of these nurse tanks.
- **Automated CMV research:** FMCSA's automated CMV research activities support the eventual deployment of automated CMVs in rural areas (e.g., Nevada and the Interstate 10 corridor from California to Florida), where the environment is conducive to automated transport.

Program Objectives:

Primary Goals

FMCSA's R&T Program aims to reduce the number and severity of CMV crashes and enhance the efficiency of CMV operations by: (1) providing data, producing statistics, and conducting systematic studies directed toward fuller scientific discovery, knowledge, or understanding, and (2) identifying, testing, and supporting technology transfer activities and deployment of CMV safety technologies (including automated and connected CMV technologies). Through its activities, FMCSA's R&T Program contributes to the development of expertise, ideas, and tools to advance the state-of-the-art in CMV safety on the Nation's highways and the development and evaluation of future Agency policies, programs, and methodologies.

How the Program Addresses Market Failures

FMCSA's mission is to reduce crashes, injuries, and fatalities involving large trucks and buses. The R&T Program conducts research to support this mission and addresses market failures in which the private sector does not conduct safety research to be shared across the industry. The R&T Program supports the transfer of proven CMV safety technologies to the marketplace.

Research Collaboration Partners:

FMCSA reviews and adjusts its research and technology portfolio each fiscal year to ensure it is addressing relevant, priority issues in support of its safety mission. Issues are identified by the Department and Agency priorities; recommendations from the National Transportation Safety Board (NTSB), the Government Accountability Office (GAO), and other external organizations, such as the National Academy of Sciences (NAS); and Congressional statute. To date, the program's contributions have proven critical in supporting Agency safety rulemakings, identifying enforcement priorities, and facilitating technology transfer to the marketplace.

⁸ FMCSA, Large Truck and Bus Crash Facts 2016.

The R&T Program works with other program offices and external stakeholders to identify research, data analysis, and technology application needs. FMCSA's Research Executive Board (REB), comprised of representatives from FMCSA offices with research and technology interests, periodically reviews proposed research and technology projects. The REB is responsible for evaluating, prioritizing, and approving submitted research and technology proposals, ensuring they align with FMCSA and Departmental priorities and are consistent with budget objectives. During formal REB meetings, program offices have the opportunity to present fact-based and data-driven suggestions for future research projects and to comment on past research efforts during these meetings. All feedback is recorded in meeting minutes and reviewed/processed by R&T Program management, and descriptive REB planning books with planned project descriptions are maintained and referred to throughout the research planning and execution process. This continuous review cycle allows the program to adjust its approach to better meet internal stakeholder needs.

For external stakeholders, the R&T Program conducts satisfaction surveys (e.g., for the annual Analysis, Research, and Technology Forum at the Transportation Research Board [TRB] Annual Meeting) and hosts roundtable discussions, public listening sessions, etc., to gain insights from stakeholders and make program adjustments as needed. All comments and survey responses are recorded and later reviewed by R&T Program Management, who adjust the program approach as appropriate to better meet external customers' needs.

Finally, the R&T Program maintains a register of research recommendations received from other independent organizations and internal task force committees. This register summarizes each recommendation received and Agency responses to these recommendations, including planned/ongoing research projects or other activities related to a particular recommendation.

Internal Partners

FMCSA's R&T Program coordinates motor carrier research, data analysis, and technology programs with other Departmental offices, Federal agencies, academia and governmental entities; public and private transportation research organizations; and private industry, as appropriate.

Internally, the Agency works closely with numerous modes to align research and development goals. Table 2 summarizes FMCSA's internal collaboration partners and anticipated collaboration benefits.

Table 2. Internal DOT Collaboration Partners and Anticipated Benefits.

Collaboration Partner	Anticipated Benefits
Federal Highway Administration (FHWA)	Coordinated and joint truck platoon research efforts; coordinated research on the impacts of heavy trucks on highway infrastructure; data sharing.
Federal Railroad Administration (FRA)	Coordinated research on operator fatigue and fitness for duty.
Federal Transit Administration (FTA)	Coordinated research on ADS-equipped buses and motorcoaches.
Intelligent Transportation Systems Joint Program Office (ITS JPO)	Coordinated and joint research on AV and connected vehicle technologies; maximized financial and staff resources.
Maritime Administration	Coordinated research on automated truck queues at ports and warehouses.
Pipeline and Hazardous Materials Safety Administration (PHMSA)	Coordinated and joint research related to the safe transport and storage of hazardous materials.

Collaboration Partner	Anticipated Benefits
National Highway Traffic Safety Administration (NHTSA)	Coordinated and joint research on automated vehicles (e.g., cybersecurity, vehicle requirements); coordinated and complementary research on braking systems and components, electronic stability control, etc.; data sharing.

External Partners

FMCSA works closely with a select number of external research-based organizations, such as NAS, the Committee on National Statistics (CNSTAT), the National Institute for Occupational Safety and Health (NIOSH), the National Institutes of Health, and the Centers for Disease Control and Prevention. FMCSA partners with these organizations to:

- Conduct expert panel reviews of existing agency programs/research.
- Implement large-scale longitudinal studies on driver health and wellness.
- Develop educational outreach programs aimed at improving driver health and safety.
- Improve agency research methodologies and statistical approaches.

The Agency has a longstanding partnership with TRB and participates in the TRB Annual Meeting, provides research support/guidance via standing committees and task forces, and attends committee-sponsored conferences and workshops.

Specific to AV research, FMCSA is partnering with the U.S. Army and the Department of Energy (and FHWA, internally) to conduct truck platooning and AV-related research on test tracks and dedicated research corridors. The R&T Program is working to establish a partnership with industry trucking associations to accelerate the adoption of automatic emergency braking (AEB) systems in CMVs. Further, FMCSA is working closely with individual States, gathering information on State-specific AV research activities and identifying opportunities for collaboration. For example, in September of 2017, FMCSA and FHWA collaborated with the Virginia State Police to conduct a truck platooning demonstration on I-66 in Northern Virginia.



Learn more about FMCSA's platooning-related research here: www.fmcsa.dot.gov/research-and-analysis/technology/preparing-future-trucking

By conducting joint research projects with other modes, FMCSA is able to streamline research efforts and increase project scope. Research findings from these collaborative efforts benefit multiple modes. Separately, FMCSA often cites research conducted by other modes in support of recommended regulatory changes to reduce burden, justifications for new research, etc. FMCSA will continue to benefit from research conducted by the other USDOT modes. Collaborating with external partners enables FMCSA to update and enhance its research and technology program by implementing recommendations, leveraging complementary research activities, and including stakeholder input in setting strategic research objectives.

Non-government Partners

Non-government groups do partner with FMCSA's R&T Program. For example, the R&T Program frequently partners with CVSA—a nonprofit organization representing State and Provincial truck inspection agencies in the United States, Canada, and Mexico—on CMV inspection and enforcement-

related endeavors, conducting workshops, developing training modules for inspectors, and updating inspection standards and procedures. The R&T Program also partners with industry associations, such as the American Trucking Associations (ATA), to promote safety programs. Additionally, the R&T Program has partnered with many motor carriers while conducting specific research projects or initiatives. Finally, as mentioned above, the R&T Program has a longstanding partnership with TRB, a nonprofit organization that “provides innovative, research-based solutions to improve transportation.” This partnership with TRB enables the R&T Program to identify research gaps and collaborative research opportunities, communicate current and planned research efforts, and offer and obtain guidance from other entities within the transportation industry.

Acquisition/Assistance:

Procurement Processes

The R&T Program utilizes competitive procurement processes. While the Agency occasionally uses full and open competition, most FMCSA research and technology projects are competitively awarded via the Agency’s established indefinite delivery, indefinite quantity (IDIQ) contract with four different research organizations.⁹ The R&T Program follows the guidance and processes established by the FMCSA Acquisitions and Budget Offices. This ensures contracts are awarded and funds are allocated according to Agency best practices.

Acquisition Methods

FMCSA uses a variety of acquisition methods, including a multiple-contractor IDIQ (established through full and open competition), interagency agreements, blanket purchase agreements (established through full and open competition), small business set-asides, and full and open competition. Sole source agreements are used infrequently. As mentioned above, most FMCSA research and technology projects are competed through the Agency’s established IDIQ. Interested research entities on this IDIQ bid on posted research opportunities, providing technical proposals and estimated costs. A technical evaluation team then reviews bids and provides recommendations based on technical merit and price.

Limited Use of Sole-Source Acquisitions

FMCSA’s standard operating procedure is to use a competitive market-based acquisitions approach to select contractor support. In the rare case when the Agency does use sole-source acquisitions, it is because the vendor offers a very specific service or narrow product that no other vendor would be able to provide. For example, FMCSA has funded sole source agreements with the Transportation Research Board, to fund activities associated with the annual Transportation Research Board meeting.

Single- versus Multi-Year Acquisitions

FMCSA utilizes both single-year and multi-year acquisitions. Some research projects are fully awarded up front. Other projects have a base year with one or more option years. This model allows

⁹ The organizations on FMCSA’s current IDIQ contract include the Virginia Tech Transportation Institute, Battelle Memorial Institute, Transanalytics, and the University of Michigan Transportation Research Institute. Future IDIQ contracts may include different research organizations. This approach ensures that the most technically qualified, cost-effective entity wins the contract.

FMCSA to assess the progress of a particular research project and decide whether to invest additional research dollars or redirect funds, if needed.

How the Program Leverages Non-Federal Funds

To help maximize Federal R&T funds, FMCSA contributes annually to the National Surface Transportation Safety Center for Excellence (NSTSCE), an organization established by the Federal Public Transportation Act of 2005 to develop and disseminate advanced transportation safety techniques and innovations. This organization is supported financially and guided by a group of seven public and private stakeholders. Each stakeholder contributes \$200,000, for a combined pool of \$1,400,000 in research funding. FMCSA is a member of the NSTSCE steering committee, which meets biannually to review surface transportation safety research needs. A prioritized list of potential projects and a multi-year strategic plan—which strives to coordinate NSTSCE research activities with those of FMCSA and other Federal research programs—are presented to the steering committee for review and approval. Approved research projects are then developed and conducted by the Virginia Tech Transportation Institute. For more information about NSTSCE, visit: <https://www.vtti.vt.edu/national/nstsce/>.

Technology Transfer (T2):

Program-level T2 Activities:

FMCSA invests in the development, testing, and transfer of innovative technologies through the following programs and activities:

- **R&T Program:** FMCSA's R&T Program develops the knowledge, practices, and technologies needed to solve problems and answer questions that arise in prioritizing enforcement resources and improving the safety of commercial drivers, vehicles, and carriers. Each year, the R&T Program sponsors and conducts numerous technology-focused projects designed to:
 - Improve the safety and efficiency of CMVs through technological innovation and improvement.
 - Improve technology used by enforcement officers when conducting roadside inspections and compliance reviews.
 - Test, develop, or assist in testing and developing any material, invention, patented article, or process related to the R&T Program.
 - Facilitate training or education of CMV safety personnel.

ITD Grant Program: The ITD Grant Program provides funding for States to deploy, support, and maintain CMV information systems and networks. This program is FMCSA's key mechanism for transferring proven enforcement technologies into operational systems for the States. Examples of ITD deployment efforts include the implementation of communications and data exchange mechanisms to facilitate exchange of safety and credentials information within and among States, Federal agencies, and motor carriers, and the targeting of unsafe motor carriers on the highways using license plate and USDOT number reading cameras to identify non-compliant trucks at highway speeds. Each year, through the High Priority (HP) Grant, the ITD Program provides up to \$20M in funding for States to deploy, support, and maintain intelligent transportation systems and commercial vehicle information systems and networks.

HP-ITD grant priorities are published annually in the Agency's notice of funding opportunity (NOFO) for HP-ITD grants. Grant priorities are informed by data-driven Agency priorities and

constant monitoring of the ITD Program, which allows FMCSA to see trends and technologies that have a direct impact on the program. In FY 2018, for example, HP-ITD grant priorities included deploying a work-zone and incident electronic notification system, deploying a CMV truck parking notification system, and deploying thermal imaging technology used in detecting inoperable, defective, or deficient brakes, tires, or exhaust systems that may cause unsafe conditions.

The R&T Program provides program management support for the technical aspects of the ITD Grant Program. The ITD Program Manager (PM) within FMCSA's Technology Division manages projects and provides grant funding to States to improve motor carrier safety and to accelerate the deployment of safety technologies nationally. The ITD PM also manages the day-to-day safety information exchange between States and FMCSA systems, and promotes State adoption of electronic screening and electronic credentialing technologies. Finally, the ITD PM conducts Core compliance reviews of State ITD programs to ensure States are maintaining the core functional requirements of ITD and managing their open ITD grants effectively.

The ITD PM routinely reports to R&T Program leadership on States' enforcement-related technology transfer activities. This informs other Agency research and technology transfer priorities and activities.

- **USDOT Small Business Innovation Research (SBIR) Program:** This program encourages small businesses to develop high-tech, innovative transportation solutions that could be commercialized, leading to entrepreneurial growth and economic stimulation. FMCSA participates in the SBIR Program and administers its own SBIR projects through the John A. Volpe National Transportation Systems Center (Volpe Center). The project selection process is highly competitive, and once selected, projects progress by merit through a three-phased program. Each phase must be successful in order to progress to the next phase.
 - Phase I: Establish technical merit, feasibility, and commercial potential. Phase I projects are relatively short-term, approximately 6 months.
 - Phase II: Continue the work begun in Phase I according to the defined commercial potential. Phase II projects can last 2 years.
 - Phase III: The goal of Phase III is to move toward or obtain commercialization.
- **Automated CMV Research:** FMCSA conducts research to accelerate the testing and deployment of proven safety technologies (such as AEB systems) and partners with industry associations, original equipment manufacturers, and motor carriers to promote the acceptance and adoption of these technologies. FMCSA also promotes safe pilot testing of ADS-equipped CMVs and truck platoons, to further evaluate the safety of these technologies and support their deployment.

T2 Stakeholders

Federal R&T Program staff, partner modes, contracted research and support staff, SBIR awardees, technology vendors, original equipment manufacturers, State partners, motor carriers, and industry associations are involved in FMCSA's technology transfer (T2) activities. T2 beneficiaries include State and local governments, law enforcement, Federal and State commercial vehicle inspectors, motor carriers, and CMV drivers.

Federal R&T Program staff and contracted research and support staff are involved in the initial development and evaluation of CMV safety technologies. R&T Program staff manage technology development and testing contracts, working closely with technology vendors and contracted

researchers. R&T Program staff and contracted support staff also manage the technical aspects of FMCSA's ITD Grant Program (e.g., ensuring States are meeting minimum requirements for Core ITD compliance). SBIR awardees are tasked with proving the technical merit and feasibility of their innovative technologies, further developing the technologies, and ultimately commercializing any final products. Original equipment manufacturers determine the value of installing proven safety technologies in CMVs and make changes as needed to facilitate production. Federal and State partners and motor carriers often participate in testing of innovative technologies ahead of any nationwide T2 activities.

State and local governments, law enforcement, and Federal and State commercial vehicle inspectors benefit from the R&T Program's T2 activities through improved enforcement technologies. For example, through the ITD Grant Program, States obtain grant funding to acquire and install infra-red thermal brake detecting cameras (to identify unsafe brakes, tires, and wheels) and license plate and USDOT number reading cameras to identify non-compliant trucks at highway speeds. Our State partners are also using the ITD Grant Program to further refine and deploy safety systems for fleets, including work zone warning systems for CMV drivers. Motor carriers and CMV drivers also benefit from SBIR-produced technologies, such as the Trucking Fatigue Meter, a data analytics technology that uses existing streams of trucking data to evaluate driver fatigue and provide actionable feedback in real-time.

T2 Audience and Dissemination of Program Results

The R&T Program largely supports other FMCSA program offices; as such, the target audience is often an internal FMCSA program office (e.g., Enforcement or Policy). Specific to T2 activities, the intended audience is usually States, law enforcement and inspectors, and fleets. For projects where the outcome is a final report, the Agency will publish the final report via the FMCSA Web site and/or the National Transportation Library (NTL). Depending on Agency communications priorities, the report may be released in conjunction with a press release, News Digest item, or social media post. Findings may also be shared in public forums (e.g., CVSA meetings, the TRB Annual Meeting, etc.). For projects where the outcome is a technology intended for motor carrier use (e.g., the Trucking Fatigue Meter), outreach efforts to specific motor carriers will be organized. When the project outcome is an enforcement technology, the R&T Program will communicate the availability of that technology (and available grant funding to implement said technology) via the ITD Grant Program, through the annual ITD Grant Program Notice of Funding Availability. Table 3 shows the vehicles FMCSA used in FY 2017 to disseminate R&T Program results.

Table 3. Vehicles Used by FMCSA's R&T Program to Disseminate Program Results, FY 2017

Vehicle Used	Number
Technical publications made available to public	11
Technical publication downloads – NTL	5,161
In-person or webinar presentations delivered to foster technology transfer	6
Workshops or demonstrations to foster technology transfer	4
Research agreements with technology transfer requirements	5

T2 Performance Measurement

FMCSA's R&T Program measures the performance of its T2 activities in multiple ways. First, the Agency tracks State deployments of enforcement technologies through its ITD Grant Program

annual reports—published and available via the NTL—which describe the various enforcement technologies the States are implementing with ITD Grant Program funds. Next, during the commercialization phase, FMCSA regularly receives deployment metrics from SBIR awardees. For example, FMCSA can report that the sales pipeline for the Trucking Fatigue Meter is growing. Three motor carriers have signed on as subscribing customers; one of those carriers is deploying the system to 2,000 drivers. For AV-related technology transfer activities, FMCSA will seek regular updates from original equipment manufacturers regarding how many newly manufactured CMVs are equipped with automated CMV safety systems (e.g., AEB). Finally, FMCSA conducts research to assess the effectiveness of enforcement technologies, such as weigh station e-clearance/pre-screening systems.

T2 Funding Allocation and Staff Resources

Funding and staff resources are allocated to T2 activities for the R&T Program. Within the R&T Program there is a dedicated ITD Program Manager who oversees the technical aspects of the ITD Grant Program. The R&T Program also funds an ITD Program and Technical Support contract (interagency agreement) with the Volpe Center. Contracted staff support the ITD Program Manager and related program activities.

The R&T Program allocates funding and staff resources for SBIR projects. A dedicated R&T staff person manages all SBIR program activities and provides guidance to SBIR awardees as each project progresses through its various phases.

Within the R&T Program there are five staff members focusing on AV research activities. These team members manage a variety of AV research contracts and participate in USDOT and FMCSA AV working groups, attend AV-related conferences and events, collaborate with States and other stakeholders, and work to develop and procure new AV-related research projects. In FY 2019, the Agency has allotted a portion of its research budget to support AV-related T2 activities (e.g., continued funding to support accelerated deployment of AEB systems in CMVs).

Finally, FMCSA allocates funds and staff resources for research conducted under the R&T Program's "Advance Safety through Information-Based Initiatives" strategic objective area, which typically involves technology-focused projects.

T2 Representation in the USDOT Research Hub, NTL, and TRB Research in Progress Database

The R&T Program's T2 activities are represented in the USDOT Research Hub and the NTL Digital Library. When applicable, FMCSA adds project summaries for newly awarded research and technology projects to the USDOT Research Hub and the TRB Research in Progress database. These higher-level project summaries link directly to the master project summaries on the FMCSA Web site, which are updated routinely with information on project funding, summary descriptions of research outputs and impacts, and other relevant project information. Additionally, FMCSA publishes all external-facing final reports via the NTL's Digital Repository and makes those links available on the FMCSA Web site, as appropriate. See Table 3 for NTL download metrics for FY 2017.

Annual Performance Reporting of T2 Activities

Pursuant to 15 U.S.C. 3710(f), FMCSA reports its T2 activities each year in its modal submission for the overall USDOT Technology Transfer Report. The annual USDOT Technology Transfer Report

summarizes Department-wide T2 activities for the past fiscal year and includes success stories from each of the modes. The annual report is submitted to the U.S. Department of Commerce, pursuant to 15 U.S.C. 3710(g)(2).

R&T Program Evaluation/Performance Measurement:

Tracking and Evaluating Progress Towards Objectives and Goals

FMCSA's R&T Program is a support program that focuses on (1) supporting the goals and priorities of the Agency's other program offices, and (2) directives from other Federal organizations (e.g., Congress, GAO, etc.). The R&T Program has specific annual performance goals, which demonstrate the program's outputs and impact across multiple research areas in support of FMCSA's safety mission and the Department's Strategic Goals of *Safety* and *Innovation*. The R&T Program has an established set of annual performance baselines and produces an annual report (internal) detailing yearly accomplishments.

The R&T Program also has detailed processes for tracking the performance of individual research and technology projects. These individual projects have specific goals that support the overall goals of the R&T Program and the Agency in general. R&T Program staff collect performance information for all active research and technology projects. Monthly progress reports are required for all contracts; these reports and other associated project documentation are maintained in an internal R&T Project Management Database. Other information maintained in this database includes project milestones, strategic objective area(s), period of performance dates, project status, etc. The R&T Project Management Database is updated regularly. Portfolio dashboard reports are generated from this database and used at the program management level and higher to guide decisions.

Program Performance Measures

See Table 4 for the measures the R&T Program uses to track program performance.

Table 4. R&T Program Performance Measures.

Measure Name	Description	Calculation Methodology
Mission Support	Number of R&T projects initiated in support FMCSA/DOT priorities.	Numeric tally; summary of each regulatory/policy change, outreach program, or field initiative, its identifiable impact on large truck and bus safety, and how research supported the effort.
ITD Success	Number of States with demonstrated ITD program capabilities.	ITD Program management support tracks this information in various formats. States submit monthly activity reports. Annual program reports detailing grant funding amounts and State-level activities are produced by the R&T Program.
Updated Standards	Adoption of FMCSA identified updates to CVSA's North American Standard inspection procedures or out-of-service (OOS) criteria.	Number of updates incorporated into the North American Standard inspection procedures or OOS criteria; description of the changes and anticipated safety impacts that the changes are expected to yield.
Publications	Number of reports and studies managed and completed by the R&T Program.	Agency support staff maintain a database that tracks all reports and briefs in Agency review. Once published, publication dates and links are added and the report is closed out.

Measure Name	Description	Calculation Methodology
Customer Feedback	Results of customer and stakeholder feedback on quality, performance, and relevance of the R&T Program.	Online surveys conducted in 2018, to date, have been produced/administered in Qualtrics, which processes the data and summarizes findings.
Training	Training materials and courses for inspectors, motor carriers, and drivers.	Number of training courses developed and published; description of each training course and the expected safety impact each course may yield.

Establishing Baselines, Analyzing Trends, and Evaluating Benefits

The R&T Program establishes performance baselines, both at the program level and at the project level. The R&T Program reports its annual accomplishments in an internal annual report, produced at the end of each calendar year. Performance baselines at the project level vary based on the work being conducted. Project statements of work establish baselines and expectations, and contracted research teams submit monthly reports detailing progress. R&T Program staff continually monitor contracted research projects to ensure baselines are met.

The R&T Program also has several mechanisms in place for analyzing emergent trends and evaluating the benefits created through DOT-sponsored research. First, the R&T Program collaborates closely with other USDOT modes, participating in multiple working groups and coordinating joint research efforts where justified; when developing annual research plans and participating in the USDOT Research, Development, and Technology (RD&T) Planning Council, the R&T Program works to harmonize its efforts with those of other USDOT modes, ensuring cross-modal collaboration and efficient use of Federal resources.

Next, the Agency's REB review process includes discussion of the justification for each research initiative; if REB members are aware of other research efforts being conducted by other Federal agencies or State or private organizations, the research idea is re-evaluated and/or removed from the budget request. The REB considers the potential benefits and risks of funding proposed research projects and makes recommendations accordingly.

The R&T Program also works closely with the States and external stakeholders (e.g., industry associations and research institutes) to ensure the Agency's research and technology portfolio addresses current needs in the transportation safety environment. The Agency is a member of the Committee on Truck & Bus Safety (ANB70) of the Transportation Research Board. This committee is made up of many organizations interested in truck and bus safety. As members of this committee, FMCSA provides briefs on upcoming research and technology projects and plans; similarly, FMCSA learns about emerging research trends and the research efforts of other organizations on the committee. By maintaining regular communication with the States, independent committees, and industry stakeholders, FMCSA stays apprised of non-Agency-funded research efforts, using that knowledge to inform its research plans.

Application of USDOT Strategic Plan and Program Evaluation Measures to the R&T Program

While the R&T Program primarily supports the USDOT Strategic Goals of *Safety* and *Innovation*, all four Strategic Goals and numerous Strategic/Management Objectives, Strategies, and Performance Goals in the FY 2018-22 USDOT Strategic Plan apply to the R&T Program, as described below:

- **SAFETY: Reduce Transportation-Related Fatalities and Serious Injuries Across the Transportation System.** In support of the USDOT Strategic Goal of *Safety*, the Strategic Objective of *Systemic Safety Approach*, and the associated Performance Goal to *Reduce Surface Transportation-Related Fatalities*,⁽¹⁰⁾ the R&T Program strives to reduce the number and severity of CMV crashes and enhance the efficiency of CMV operation by providing data, producing statistics, and conducting systematic studies directed toward fuller scientific discovery, knowledge, or understanding. Research conducted by FMCSA contributes to the development of safety technologies (for use by enforcement and commercial carriers) and recommended best practices to improve driver performance and the safe operation of CMVs, thus contributing to a reduction in crashes.

The Agency measures the safety benefits (i.e., lives saved and crashes and injuries prevented) of its enforcement programs annually, using the Carrier Intervention Effectiveness Model (CIEM) and the Roadside Inspection Effectiveness Model (RIEM). The Agency publishes findings annually. All published RIEM and CIEM reports are available in the National Transportation Library, at <https://rosap.ntl.bts.gov>. FMCSA measures and reports on technology transfer efforts annually in the Agency's modal submission to the overall USDOT Technology Transfer Report. Published USDOT Technology Transfer Reports for the last eight fiscal years (FY 2010 through FY 2017) are available here: www.transportation.gov/research-and-technology/dot-tech-transfer-annual-reports.

- **INNOVATION: Lead in the Development and Deployment of Innovative Practices and Technologies that Improve the Safety and Performance of the Nation's Transportation System.** FMCSA's R&T Program supports the USDOT Strategic Goal of *Innovation*, the Strategic Objectives of *Development of Innovation* and *Deployment of Innovation*, and the associated Performance Goals to *Increase Dissemination of DOT-funded Research Reports*, *Increase Production of Tangible DOT-funded Research Outputs*, and *Increase DOT Technology Transfer Activity*.⁽¹¹⁾ The R&T Program identifies, develops, tests, and deploys innovative roadside and onboard technology solutions and practices, including platooning and automated CMV technologies. FMCSA's R&T Program works with other FMCSA program offices, the Department, other USDOT modes, and industry stakeholders to safely accelerate the development, testing, and deployment of truck platoons and ADS-equipped CMVs. Ongoing and planned program activities include safety evaluations of truck platoons and ADS-equipped CMVs; establishment of baseline safety measures for automated CMV and truck platoon operations; development, execution, and oversight of pilot programs; technology demonstrations; development of cybersecurity best practices for users of aftermarket electronic systems and original equipment manufacturers; development of inspection tools and criteria for automated CMVs and platoons; and other research to support AV-related regulatory reform.
- **ACCOUNTABILITY: Serve the Nation with Reduced Regulatory Burden and Greater Efficiency, Effectiveness, and Accountability.** While FMCSA's research and technology projects are primarily focused on the USDOT Strategic Goals of *Safety* and *Innovation*, some

¹⁰ See Safety, Strategic Objective 1: Systemic Safety Approach, in the FY 2018-22 USDOT Strategic Plan, pp. 12-17.

¹¹ See Innovation, Strategic Objective 1: Development of Innovation and Strategic Objective 2: Deployment of Innovation, in the FY 2018-22 USDOT Strategic Plan, pp. 29-35

of them also support the USDOT Strategic Goal of *Accountability* and the following associated Management Objectives:

- (1) The Management Objective of *Regulatory Reform*, and the related Performance Goal to *Control Regulatory Burden by Complying with Executive Orders to Reduce Number and Economic Impact of Regulations*.⁽¹²⁾ The R&T Program supports this Objective and Performance Goal by conducting research to help ensure that rulemaking modifications will not result in negative safety consequences. For example, the R&T Program conducts research to determine whether it is safe for certain CMVs to proceed through railroad grade crossings without stopping or slowing. The current regulation—49 CFR 392.10—requires certain CMVs to stop at all railroad grade crossings, with limited exceptions. Representatives from several industry associations have inquired about the feasibility of amending the regulation to allow certain CMVs to proceed without stopping at railroad grade crossings, especially at crossings that are well-marked and controlled, and on high-speed divided highways. If supported by research findings, the Agency may amend this regulation, thus reducing burden on the industry.
 - (2) The Management Objective of *Mission Efficiency and Support*, and the related *Small Business Strategy* (to promote small business development opportunities).⁽¹³⁾ The R&T Program supports this Objective and Strategy by participating in the USDOT SBIR Program. FMCSA invests in SBIR projects focused on the development and commercialization of innovative CMV safety technologies. The R&T Program administers its SBIR projects through the Volpe Center. Both the Volpe Center and assigned FMCSA project managers monitor SBIR projects, to ensure they are meeting performance goals. SBIR projects that reach the commercialization phase are reported in FMCSA’s annual submission to the USDOT Technology Transfer Report. To learn more about FMCSA’s SBIR Program activities, visit: <https://www.fmcsa.dot.gov/research-and-analysis/research/fmcsa%E2%80%99s-small-business-innovation-research-sbir-program>.
- **INFRASTRUCTURE: Invest in Infrastructure to Ensure Safety, Mobility and Accessibility and to Stimulate Economic Growth, Productivity and Competitiveness for American Workers and Businesses.** FMCSA’s R&T Program indirectly supports the USDOT Strategic Goal of *Infrastructure*, the Strategic Objective of *Life Cycle and Preventative Maintenance*, and the associated Performance Goal to *Improve Conditions of America’s Transportation-Related Infrastructure*⁽¹⁴⁾ by providing technical support to States that are using ITD Grant funds to enhance their enforcement infrastructure (e.g., by implementing virtual weigh stations). States install and maintain weigh stations to enforce truck weight regulations. By implementing virtual weigh stations, States can expand the scope of their truck size and weight enforcement programs, deploying enforcement assets to previously unmonitored areas.⁽¹⁵⁾

¹² See Accountability, Management Objective 1: Regulatory Reform, in the FY 2018-22 USDOT Strategic Plan, pp. 36-37.

¹³ See the “Small Business” strategy, under Accountability, Management Objective 2, on pages 8 and 40 of the FY 2018-22 USDOT Strategic Plan.

¹⁴ See Infrastructure, Strategic Objective 2: Life Cycle and Preventive Maintenance, in the FY 2018-22 USDOT Strategic Plan, pp. 22-24.

¹⁵ FHWA. June 2009. *Concept of Operations for Virtual Weigh Station*. Retrieved from: https://ops.fhwa.dot.gov/publications/fhwahop09051/virtual_weigh_stn.pdf.

FMCSA reports annually on ITD funding and program activities. ITD annual reports provide detailed information on grant recipients and the projects funded by those grants. ITD program management monitors State ITD activities and conducts conformance tests and certification activities to ensure compliance with program requirements. FMCSA also measures the effectiveness of certain ITD program components—such as e-screening—to ensure program investments are resulting in safety benefits. Learn more about the ITD program at <https://www.fmcsa.dot.gov/information-systems/itd/innovative-technology-deployment-itd>. Read about FMCSA's evaluation of e-screening effectiveness here: <https://www.fmcsa.dot.gov/research-and-analysis/technology/effectiveness-weigh-station-pre-clearancee-screening-systems>.

In addition to the USDOT Strategic/Management Objectives, Strategies, and Performance Goals outlined above, the performance measures established in the 2018 R&T Program Evaluation (OST CFO initiative) apply to this program. The measures and associated calculation methodologies are described in detail in Table 4.

Performance Trend Data

Trend information for select R&T Program performance measures and projected FY 2018 targets are included in Table 5. Refer to Table 4 for more information on the R&T Program performance measures.

Table 5. Summarized Trend Data for R&T Performance Measures.

Measure Name	Description	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018 Target
Mission Support	Number of R&T projects initiated in support FMCSA/DOT priorities.	12; refer to FMCSA website for details on active and completed R&T projects.	13; refer to FMCSA website for details on active and completed R&T projects.	19; refer to FMCSA website for details on active and completed R&T projects.	24; refer to FMCSA website for details on active and completed R&T projects.	22; refer to FMCSA website for details on active and completed R&T projects.	22
ITD Success	Number of States (including D.C.) with demonstrated ITD program capabilities.	33 Expanded; 18 Not Yet Core	34 Expanded; 17 Not Yet Core	35 Expanded; 16 Not Yet Core	39 Expanded; 12 Not Yet Core	41 Expanded; 10 Not Yet Core	41 Expanded; 10 Not Yet Core
Updated Standards	Adoption of FMCSA identified updates to CVSA's North American Standard inspection procedures or out-of-service criteria and the National Fire Protection Association's standards.	0	0	0	2	0	0

Measure Name	Description	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018 Target
Publications	Number of reports and studies managed and completed by the R&T Program.	8	13	6	12	6	12
Technology and Best Practices Adoption	Adoption of CMV safety technologies and best practices by the States and the CMV industry.	Reference Appendix A in 2013 CVISN Annual Report.	Reference Appendix A in 2014 CVISN Annual Report.	Reference Appendix A in 2015 CVISN Annual Report.	Reference Appendix A in 2016 CVISN Annual Report.	3 carriers deploying Trucking Fatigue Meter; reference Appendix A in 2017 CVISN/ITD Annual Report (pending publication).	TBD
Customer Feedback	Results of customer and stakeholder feedback on quality, performance, and relevance of the R&T Program.	18 ART Forum evaluations submitted	35 ART Forum evaluation submitted	46 ART Forum evaluations submitted	34 ART Forum evaluations submitted	21 ART Forum evaluations submitted	15 ART Forum evaluations submitted
Training	Training materials and courses for inspectors, carriers, and drivers.	1 training course for commercial drivers (hydrogen hazard awareness training)	N/A	9,400 North American Fatigue Management Program (NAFMP) sessions completed	1 published Web-based training for inspectors (natural gas leak detection); 7,600 NAFMP sessions completed	1 published Web-based training for inspectors (inspecting electric and hybrid-electric CMVs); 7,600 NAFMP sessions completed.	1 Web-based training for motorcoach carriers; 7,000-9,000 NAFMP sessions

Performance Against Metrics

The R&T Program is meeting or exceeding its annual targets, sufficiently responding to Agency priorities, Departmental research and budget requirements, Congressional mandates, Office of Inspector General and GAO directives, etc. The R&T Program conducts a significant amount of safety research with limited resources. Research findings and technology outputs support the efforts of other program offices and benefit the States, the motor carrier industry, and the motoring public in general, through increased roadway safety.

Section 2 - Program Descriptions, FY 2020

Research & Technology

Program Description/Activities:

FMCSA's R&T Program provides scientific safety research on driver behavior, carrier operations, and technology applications. These contributions have proven critical in identifying Agency enforcement priorities and facilitating technology transfer to the marketplace. Program activities in FY 2020 will continue to support the development and deployment of enhanced enforcement technologies, using the ITD Grant Program as a vehicle for technology transfer; improved data collection, sharing, and analysis; and the development of countermeasures to reduce crashes involving large trucks and buses. The R&T Program will analyze the truck and bus driver labor market (e.g., demographics, pay, entry and exit) and the relationship between labor, management and safety, using workforce population data contained in the U.S. Census Bureau's new Longitudinal Employer Household Dynamics (LEHD) database.

AV research will remain a priority in FY 2020. The R&T Program will partner with the U.S. Army Tank Automotive Research, Development and Engineering Center to conduct additional truck platoon field operational tests at the Aberdeen Test Center. Additionally, FMCSA will begin evaluating SAE level 2-3 AV technologies, to identify potential safety risks. The R&T Program will support the Agency's regulatory office in evaluating and managing applications for regulatory relief in the form of waivers, exemptions, or pilots under 49 CFR 381 if AV developers submit requests to test ADS-equipped trucks in ways that require regulatory relief from existing Federal Motor Carrier Safety Regulations.

Finally, the R&T Program will conduct congressionally mandated research, respond to other Federal inquiries, and support identified Departmental and Agency priorities, adjusting its research portfolio and approach as needed.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting Safety
Innovation	Improving Mobility

Work conducted by FMCSA's R&T Program primarily aligns with the USDOT Strategic Goals of *Safety* and *Innovation*, although the Program does support the Strategic Goals of *Accountability* and *Infrastructure* in some instances. Research and technology projects primarily address the Critical Transportation Topic of *Promoting Safety*. Some of FMCSA's research and technology projects overlap with the Critical Transportation Topic of *Improving Mobility*.

How the Program Supports USDOT Strategic Goals

FMCSA's primary mission is to reduce crashes, injuries and fatalities involving large trucks and buses. Consistent with the USDOT Strategic Goal of *Safety*, as described in the USDOT Strategic Plan for FY 2018-22, FMCSA's R&T Program conducts research to improve transportation safety specific to the CMV industry; seeks to work effectively with State, local, and private partners to advance its safety mission; addresses commercial driver behaviors to reduce safety risks; and consistently

strives to improve safety data analysis to guide decisions. In support of the USDOT Strategic Goals of *Innovation* and *Accountability*, the R&T Program invests in SBIR projects focused on the development and commercialization of innovative CMV safety technologies. Also in support of the USDOT Strategic Goal of *Accountability*, the R&T Program conducts research to support regulatory reform and relief. The R&T Program is currently sponsoring the Military Under-21 CMV Driver Pilot Program to assess the feasibility and safety equivalence of regulatory alternatives for drivers and carriers.

Separately, the R&T Program supports and manages the technical aspects of the Agency's ITD Grant Program. The ITD Program supports the USDOT Strategic Goals of *Safety*, *Innovation*, and *Infrastructure* by focusing safety enforcement on high-risk operators; integrating systems to improve the accuracy, integrity, and verifiability of credentials; improving efficiency through electronic screening of commercial vehicles; and enabling online application and issuance of credentials.

Automated CMV Research

Specific to automated vehicles, and in support of the USDOT Strategic Goals of *Safety* and *Innovation*, FMCSA conducts research to ensure the safe operation of ADS-equipped CMVs on the Nation's highways; provides voluntary guidance to States and industry automated vehicle implementers; researches automated CMV driver factors and vehicle safety components; develops cybersecurity guidance for automated CMVs; establishes data elements and data sharing guidance to support AV testing; and works closely with State and industry stakeholders to fully vet and safely deploy automated CMVs and truck platoons.

Problems Addressed by the R&T Program

CMV crashes can be devastating, resulting in loss of life, permanent injuries, and extreme financial hardship. FMCSA's R&T Program seeks to reduce the number and severity of CMV crashes and enhance the efficiency of CMV operation. The R&T Program strives to achieve this by: (1) conducting systematic studies directed toward fuller scientific discovery, knowledge, or understanding, and (2) adopting, testing, and deploying innovative driver, carrier, vehicle, and roadside best practices and technologies (including automated and connected CMV technologies). By expanding the knowledge and portfolio of deployable technologies and innovations, the R&T Program will help FMCSA reduce crashes, injuries, and fatalities and will deliver a program that contributes to a safe and secure commercial transportation system.

Why This Research Is Necessary

The R&T Program serves as the underpinning for empirically answering research questions in support of the Agency's safety mission and the overall Departmental goals of Safety and Innovation. Using research to better understand factors associated with crashes, FMCSA can streamline and prioritize its efforts, focusing on vital Federal safety oversight functions.

FMCSA's R&T Program supports the development of effective CMV crash countermeasures, with an end goal of saving lives and reducing the number of CMV-related crashes that occur on our Nation's highways. The R&T Program also produces voluntary Web-based training modules and tools for CMV inspectors and motor carriers, supporting industry efforts to implement and maintain safety best practices. Additionally, FMCSA's AV research is critical to improved CMV safety. ADS-enabled vehicles could have substantial implications for the motoring public, as 94 percent of all auto

accidents are estimated to result from human error.⁽¹⁶⁾ Personal and commercial vehicles equipped with ADS and/or connected vehicle technologies may reach the market in a few years. It is important to test and evaluate these innovative technologies to ensure their safe deployment on our Nation's roadways.

Others Researching Large Truck and Bus Safety and Related Issues

External: Some independent research organizations (e.g., the American Transportation Research Institute, or ATRI) and motor carrier industry associations (e.g., ATA) conduct research related to safety in the commercial vehicle industry. ATRI surveys the motor carrier industry frequently to identify trends and areas of concern, safety-related and otherwise. The U.S. Army is conducting research related to truck platoons, and other countries are conducting research on truck platoons and ADS-equipped CMVs. FMCSA is aware of the research conducted by these and other external entities, and the Agency uses the resulting literature to inform research plans. While the research conducted by these entities is valuable, FMCSA cannot rely solely on external research findings to inform its oversight activities. As such, FMCSA tailors its research projects to answer inherently governmental research questions.

Internal: FMCSA maintains close awareness of what the other modes are doing relevant to motor carrier safety (e.g., automated vehicle research), and the Agency aligns research efforts where applicable. The FMCSA Research Team maintains close contact with counterparts in other modes to share information and identify collaborative research opportunities. Separately, R&T Program management participates in the USDOT RD&T Planning Council, which provides opportunities to collaborate with other modes in like projects to achieve Department-wide efficiencies.

Previous Investments and Lessons Learned

FMCSA's research, development, and technology efforts are statutorily mandated by 49 U.S.C. 31108, which establishes a Motor Carrier R&T Program. As such, FMCSA has invested in motor carrier research activities since it was established as a separate administration within the U.S. Department of Transportation in 2000. Over this time, FMCSA has learned a great deal about motor carrier, CMV driver, and commercial vehicle safety and contributed to the development of safety-focused policies and enforcement tools, improved industry standards, proven CMV safety technologies, and programs geared to improve driver safety (e.g., the North American Fatigue Management Program and the SmartPark Program). Findings from research conducted by FMCSA's R&T Program can be found in the National Transportation Library:

<https://rosap.ntl.bts.gov/cbrowse?pid=dot%3A1&parentId=dot%3A1>.

Program Timeline

The R&T Program produces tangible outcomes throughout each fiscal year. Final reports with findings from research projects are published on a rolling basis. Through the ITD Program, FMCSA provides States with the opportunity to invest in and deploy effective enforcement technologies using ITD grant funds, which are awarded annually. Some research projects may take more than a year to complete; however, at any given time, FMCSA will be close to completing a number of other research projects. This ensures a steady flow of outcomes, which inform future research plans.

¹⁶ "Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey," National Highway Traffic Safety Administration, February 2015, <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812115>.

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