U.S. Department of Transportation

Office of the Secretary of Transportation

Assistant Secretary for Research and Technology

1200 New Jersey Avenue, S.E.
Washington, DC 20590

May 10, 2018

TO: Dr. Michael Walsh, Technology Partnerships Office
National Institute of Standards and Technology

FROM: Dr. Kevin Womack
Director, Office of Research, Development, and Technology

SUBJECT: U.S. DOT's Technology Transfer (T2) Report for FY2017

Every year, the Department of Commerce (DOC) submits a Federal Laboratory T2 Fiscal Year Summary Report to the President and the Congress in accordance with 15 U.S.C. 3710(g)(2); summarizing the implementation of technology transfer authorities established by the Technology Transfer Commercialization Act of 2000 (P.L. 106-404) and other legislation.

This report summarizes U.S. Department of Transportation's information for DOC's Fiscal Year 2017 Summary Report.

Please submit questions pertaining to this report to Santiago Navarro at Santiago.Navarro@dot.gov or 202-366-0849.

Attachment:

U.S. DOT's T2 Annual Performance Report for FY17

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Annual Technology Transfer Report FY 2017

U.S. Department of Transportation
Office of the Secretary

APRIL 2018

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Introduction

The U.S. Department of Transportation (U.S. DOT) is the Federal steward of the Nation's transportation system. U.S. DOT consists of multiple modal operating administrations (OAs) that carry out mission-related research, development, and technology (RD&T) programs in support of their goals. U.S. DOT's Technology Transfer (T2) Program, which is housed in the Office of the Assistant Secretary for Research and Technology (OST-R), is responsible for coordinating, documenting, and supporting T2 activities across the Department. This report summarizes the implementation of technology transfer authorities established by the Technology Transfer Commercialization Act of 2000 (Pub. L. 106-404) and other legislation.

On October 28, 2011, following a series of reports identifying the status of technology transfer from Federal funds and Federal laboratories, the White House issued the Presidential Memorandum – "Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses." Thus, U.S. DOT continues to increase coordination and collaboration efforts among its OAs and Federal laboratories, as evidenced through the collection and submission of this T2 Annual Performance Report to U.S. DOT's budget examiner in the Office of Management and Budget. This report is also provided to the Department of Commerce's National Institute of Standards and Technology in support of the Commerce Secretary's Annual Summary Report to the President, the Congress, and to the U.S. Trade Representative on the status of technology transfer by Federal laboratories.

U.S. DOT defines T2 as the process of transferring and disseminating transportation-related scientific information to stakeholders who may apply it for public or private use. U.S. DOT's current approach to T2 is diverse and unique to each mode of transportation. Each modal OA conducts mission-specific deployment activities tailored to its mode and type of research. DOT's annual T2 report is available online here.

T2 activities are executed by U.S. DOT agencies and their laboratories:

- Federal Aviation Administration (FAA): William J. Hughes Technical Center (WJHTC), Atlantic City, NJ, and Civil Aerospace Medical Institute, Oklahoma City, OK
- Federal Highway Administration (FHWA): Turner-Fairbank Highway Research Center (TFHRC), McLean, VA
- Office of the Assistant Secretary for Research and Technology (OST-R): John A. Volpe National Transportation Systems Center (Volpe Center), Cambridge, MA
- National Highway Traffic Safety Administration (NHTSA): Vehicle Research and Test Center (VRTC), East Liberty, OH
- Federal Railroad Administration (FRA): Transportation Technology Center, Pueblo, CO

More information about DOT's T2 activities is available on the following websites:

- FAA: http://faa.gov/go/techtran

    - FHWA: https://www.fhwa.dot.gov/innovation/ and https://www.fhwa.dot.gov/goshrp2
- OST-R: https://www.volpe.dot.gov/work-with-us/technology-transfer
- FRA: https://www.fra.dot.gov/Page/P0153

DOT Invention Disclosures, Patenting, Licensing, and Other Measures

The following tables provide data on U.S. DOT's T2 activities from FY 2013 to FY 2017. These tables conform to the guidance provided to Federal agencies by the Department of Commerce. Tables 6-7 are other metrics DOT tracks.

Table 1. Invention disclosures and patents

		FY13	FY14	FY15	FY16	FY17
	Invention Disclosure					
1	Number of new inventions disclosed	13	3	0	0	3
	Patents					
2	Number of patent applications filed	5	0	5	0	7
3	Number of patents received	1	1	1	1	0
4	Number of foreign patents filed	N/A	N/A	N/A	N/A	N/A
5	Number of foreign patents received	N/A	N/A	N/A	N/A	N/A

Table 2. Income-bearing licenses

		FY13	FY14	FY15	FY16	FY17
	Licenses					
6	Total active licenses	3	1	2	2	4
7	Total new licenses	1	0	1	2	1
	Income Bearing Licenses					
8	Total active income-bearing licenses	3	1	2	2	4
9	New income-bearing licenses	1	0	0	0	1
10	Total active invention licenses	3	1	2	0	0
11	New invention licenses	1	0	0	0	0
12	Exclusive licenses	0	1	0	0	0
13	Partially exclusive licenses	0	0	0	0	0
14	Non-exclusive licenses	3	0	2	2	4

		FY13	FY14	FY15	FY16	FY17
	Note: FAA licenses are non-exclusive.					
	Elapsed Amount time to Grant Licenses					
15	Average (months)	N/A	N/A	N/A	N/A	N/A
16	Minimum (months)	N/A	N/A	N/A	N/A	N/A
17	Minimum (months)	N/A	N/A	N/A	N/A	N/A
	License Income					
18	Total license income	N/A	N/A	N/A	N/A	N/A
19	Total invention license income	N/A	N/A	N/A	N/A	N/A

Table 3. Licensing income

		FY13	FY14	FY15	FY16	FY17
	Earned Royalty Income					
20	Earned royalty income from top 1% of licenses	N/A	N/A	N/A	N/A	N/A
21	Earned royalty income from top 5% of licenses	N/A	N/A	N/A	N/A	N/A
22	Earned royalty income from top 20% of licenses	N/A	N/A	N/A	N/A	N/A
23	Minimum earned royalty income	N/A	N/A	N/A	N/A	N/A
24	Maximum earned royalty income	N/A	N/A	N/A	N/A	N/A
25	Median earned royalty income	N/A	N/A	N/A	N/A	N/A
	Disposition of Earned Royalty Income ($ thousands)					
26	Total amount of earned royalty income received	$8.8	$22.6	$11.8	$15.3	$19.8
27	Percent of earned royalty income distributed to inventors	42	32	42	32	33
28	Percent of earned royalty income distributed to the agency or laboratory	N/A	N/A	58	68	67
29	Licenses terminated for cause	N/A	N/A	N/A	N/A	N/A

Table 4. Cooperative research and development agreements

		FY13	FY14	FY15	FY16	FY17
	Cooperative research and development agreements (CRADAs)					
30	Number of active CRADAs	40	51	48	68	65
31	Number of newly executed CRADAs	8	10	9	22	6
32	Active CRADAs with small businesses involvement	8	10	11	12	12
33	Number of small businesses involved in active CRADAs	3	5	10	12	12
	Traditional CRADAs					
34	Active traditional CRADAs	3	7	48	62	66
35	Newly executed traditional CRADAs	0	2	9	22	6
	Non-traditional CRADAs					
36	Active non-traditional CRADAs	0	0	0	1	1
37	Newly executed non-traditional CRADAs	0	0	0	1	0

Table 5. Small businesses, startups, and young companies

		FY13	FY14	FY15	FY16	FY17
	Others					
38	Total number of small businesses supported	26	30	35	65	148
39	Total number of startups and young companies supported	N/A	N/A	N/A	0	0

Note: The increase in row 38 from FY16 to FY17 reflects implementation of improved tracking of DOT's T2 activities.

Table 6. Other performance measures deemed important by the agency

		FY13	FY14	FY15	FY16	FY17
	Agency specific agreements					
40	Collaborative relationships	26	30	35	152	355
41	University Transportation Centers	35	35	35	32	32

Note 1: The increased number for items in rows 40-41 are from activities identified and deemed part of this reporting requirement.

Note 2: The increase in row 40 from FY16 to FY17 reflects implementation of improved tracking of DOT's T2 activities.

Table 7. Stakeholder engagement activities

		FY13	FY14	FY15	FY16	FY17
	Vehicles used while engaging stakeholders to disseminate results					
42	Technical publications made available to public – Volpe Center	N/A	N/A	N/A	73	71
43	Technical publications made available to public – U.S. DOT operating administrations	N/A	N/A	N/A	N/A	180
44	Technical publication downloads – National Transportation Library	N/A	N/A	N/A	N/A	5.6 million
45	Stakeholder events, e.g. webinars, presentations delivered, workshops, etc.	N/A	N/A	N/A	N/A	4,397
47	Research agreements with technology transfer requirements	N/A	N/A	N/A	N/A	91

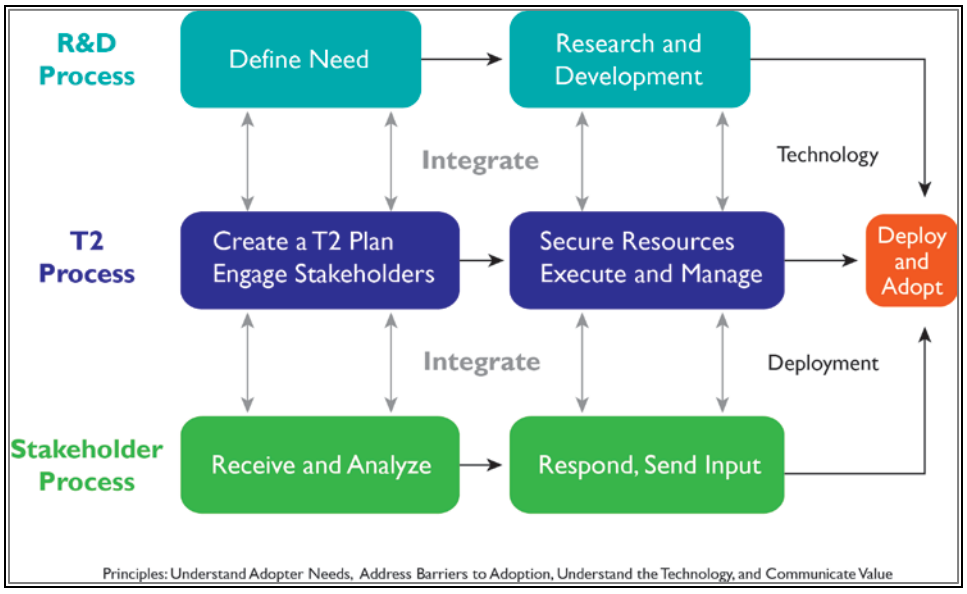
U.S. DOT's Efforts to Streamline Technology Transfer

The importance of T2 within U.S. DOT is reflected in its new Strategic Plan for FY 2018 to 2022, which was released in February 2018. Citing Innovation as one of the four main strategic goals in the plan, U.S. DOT strives to lead in the development and deployment of innovative practices and technologies that improve the safety and performance of the Nation's transportation system. Under that strategic goal, Deployment of Innovation is a key objective, and T2 is identified as one of the strategies to be used to accomplish that objective. The relationship of T2 to the Department's research and development (R&D) process and to stakeholder engagement is shown in Figure 1.

DOT's Strategic Objective for Deployment of Innovation

Technology Transfer: Strengthen the technology transfer process to facilitate adoption and commercialization of market-ready transportation technologies.

The T2 activities of OST-R and the different OAs within the Department are described in more detail below.



Source: U.S. DOT

Figure 1. Relationships among research and development (R&D), T2, and stakeholders

The Office of the Assistant Secretary for Research and Technology

OST-R is responsible for coordinating, documenting, and supporting T2 activities across the Department. The T2 activities of OST-R focus on research collaboration, knowledge transfer, and information dissemination, which all lead to the practical application of research.

Specific efforts include:

- Improving public access to the results of research funded by U.S. DOT. As detailed further below, OST-R accomplishes this task through the National Transportation Library (NTL), the Repository and Open Science Access Portal (ROSA P), and the U.S. DOT Research Hub.
- Tracking the progress of technologies that have been adopted and implemented by internal and external stakeholders.
- Developing T2 training materials to help research and development (R&D) personnel incorporate various T2 practices into their research programs.
- Aligning U.S. DOT's acquisition, research, and T2 processes by incorporating T2 deliverables into R&D funding agreements.
- Coordinating the Department's response to Executive Orders and other T2 Administration mandates, such as the Presidential Memorandum, *Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses,* October 2011.

Highlights of specific programs or offices within OST-R that are crucial to its T2 efforts are provided next.

National Transportation Library

Established in 1998, NTL serves as a central clearinghouse for transportation data and information of the Federal Government. NTL is administered by the Bureau of Transportation Statistics, which is part of OST-R. Since 2013, NTL has been the centerpiece of U.S. DOT's response to the White House Office of Science & Technology Policy's memorandum titled *Increasing Access to the Results of Federally Funded Scientific Research*, serving as the public repository and point of access for research funded by U.S. DOT. NTL also collects and shares transportation data and information produced by other agencies. In FY 2017, there were more than 5.6 million downloads from NTL.

NTL has recently created an all-digital collection of transportation resources called ROSA P. This repository is designated as the full-text repository for funded research under the Department's Public Access Plan. Content types found in ROSA P include text, links to websites, datasets, images, video, other multimedia, and maps. By the first quarter of FY 2017, the repository had approximately 55,000 records.

Figure 2. The ROSA P logo

Research Hub

The U.S. DOT's Research Hub is an online, searchable database and contains all of U.S. DOT's sponsored RD&T projects. The database acts as a central repository for information on active

and recently completed projects from U.S. DOT's OAs. It provides a comprehensive account of the Department's research portfolio at the project level. The database also provides links to research reports and other products generated by completed projects.

The FAST Act requires U.S. DOT to have a consolidated research database that lists the research abstracts, activities, and outputs of U.S. DOT's research portfolio at the project level. U.S. DOT intends to meet this requirement by expanding the Research Hub database, adding new content, and improving functionality to provide the required comprehensive account of the Department's research. This "Research Hub 2.0" will be used to identify opportunities for collaboration and conduct cross-modal research reviews. A beta version of Research Hub 2.0 is currently available to the public.

Volpe National Transportation Systems Center

Housed within OST-R, the John A. Volpe National Transportation Systems Center (Volpe Center) provides multidisciplinary and multimodal transportation expertise on behalf of U.S. DOT's OAs, U.S. DOT's Office of the Secretary, and external organizations. Within the Volpe Center, the Innovative Research Program Office is heavily involved in U.S. DOT's T2 activities by administering U.S. DOT's Small Business Innovation Research (SBIR) program and supporting the T2 Program Office in OST-R. The Volpe Center provides OST-R with a broad range of assistance, including research and implementation, process analysis, process design, and communication. Other offices within the Volpe Center support the T2 efforts of the OAs.

Small Business Innovation Research Program

U.S. DOT's SBIR program is a highly competitive award system that provides qualified domestic small businesses with opportunities to pursue research on, and develop innovative solutions to, our Nation's transportation challenges. The SBIR program favors research that has the potential for commercialization through products and applications sold to the private-sector transportation industry, state DOTs, U.S. DOT, or other Federal agencies. The Department's SBIR program is administered by the Volpe Center on behalf of the Office of the Secretary.

Figure 3. The logo of U.S. DOT's SBIR program

Federal Aviation Administration

The Federal Aviation Administration (FAA) supports multiple pathways to deployment and operational transition of research results and new technologies to advance aviation safety, efficiency, and environmental objectives. Many of these deployment pathways are created by research partnerships. FAA enhances and expands its R&D capabilities through partnerships with other government, industry, academic, and international organizations. By partnering with other organizations, FAA gains access to both internal and external innovators, promotes the transfer of FAA technologies to the private sector for other civil and commercial applications, and expands the U.S. technology base. Other T2 mechanisms used by FAA are described below.

Deployment of New Airport Technology to Improve Infrastructure

Often helped by financial assistance grants from the FAA's Airport Improvement Program (AIP), airport operators design and implement capital improvements to their airport infrastructure. The FAA provides technical and engineering design guidance to airport operators by issuing advisory circulars and engineering specifications. Operational transition of the outputs of airport technology research is reflected in the engineering guidance and technical instructions contained in advisory circulars and the airport compliance inspections and certification procedures. To facilitate the deployment of beneficial technologies resulting from airport technology research, the FAA's airport line of business can enable AIP grant eligibility for those technologies. The AIP grant incentivizes operator adoption and implementation and thus serves as a research product deployment strategy.

Cooperative Research and Development Agreements

The FAA's WJHTC, Technology Transfer Program, uses cooperative research and development agreements (CRADAs) to facilitate the operational transition of research products. Research transition support is an important characteristic of CRADAs because they provide an initial validation of the operational suitability and potential effectiveness of a particular technology solution, which increases the likelihood of its eventual commercialization. In FY 2017, FAA had 58 active CRADAs, including 6 new CRADAs that were established during the fiscal year.

Federal Highway Administration

The Federal Highway Administration (FHWA) has embraced a culture of innovation and actively supports and advances innovation across the entire breadth of its activities. FHWA has woven innovation into its organizational structure and business practices. For example, the Office of Innovative Program Delivery works across FHWA and with its partners to identify and promote innovations for implementation. In addition, FHWA's Office of Technical Services and its Division Offices provide technical assistance to FHWA's state and local partners to deploy innovations.

FHWA works through multiple programs and initiatives to transfer technological improvements and innovative practices to state and local DOTs, which are responsible for much of the actual construction and maintenance of the Nation's highways. These programs, some of which are described below, reach every state and thousands of stakeholders annually.

Across the agency, FHWA advances innovation through two primary methods—the identification and development of innovative technologies and practices, and the transfer of innovation at the Federal, state, and local levels. *Approximately 10 percent of the agency's staff-years is spent on conducting technology transfer activities.*

Highlights of FHWA's T2 activities include:

- **Office of Research, Development, and Technology (RD&T):** The FHWA's Office of RD&T is located at the Turner-Fairbank Highway Research Center (TFHRC), a Federally owned and operated national research facility. The center houses more than 20 laboratories,

data centers, and support facilities, and conducts applied and exploratory advanced research in vehicle-highway interaction, nanotechnology, and a host of other types of transportation research in safety, pavements, highway structures and bridges, human-centered systems, operations and intelligent transportation systems, and materials.

- **Every Day Counts (EDC):** EDC is a FHWA program to identify and rapidly transfer and deploy proven-but-underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce congestion, and improve environmental outcomes. FHWA works with State, local, and tribal transportation departments to identify a new collection of innovations to champion every two years. FHWA then provides technical assistance, training, and other resources to support the implementation and widespread adoption of the chosen innovations.

- **Advanced Transportation and Congestion Management Technologies Deployment Program (ATCMTD):** ATCMTD awards competitive grants to develop model deployment sites for the implementation of transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment. In 2017, the program awarded 10 grants totaling $53.6 million to states to fund the transfer and implementation of advanced technologies that will improve and enhance the performance of the Nation's highway system.

- **Implementation of the Strategic Highway Research Program (SHRP2):** SHRP2 is a partnership of FHWA, the American Association of State Highway and Transportation Officials (AASHTO), and the Transportation Research Board (TRB). SHRP2 consisted of from more than 100 research projects designed to address the most pressing problems facing the Nation's highway system. TRB conducted the research, and now FHWA and AASHTO are jointly implementing the resulting SHRP2 solutions. Through the SHRP2 Implementation Assistance Program, $155 million in financial support and technical assistance has been provided to transportation agencies from all 50 states to test SHRP2 solutions. Nearly 305,000 individuals have been engaged in the program through peer exchanges, workshops, and training.

- **Accelerated Innovation Deployment (AID) Demonstrations:** The AID Demonstration program provides incentive funding to state DOTs, Federal land management agencies, tribal governments, metropolitan planning organizations, and local governments to offset the risks associated with deployment of an innovation on a project. Funds are available to cover the full cost of implementation of an innovation on a project (up to $1 million) in areas such as planning, financing, operations, pavements, structures, materials, environment, and construction. Through FY 2017, a total of 69 AID Demonstration grants worth nearly $48 million have been awarded.

- **State Transportation Innovation Council (STIC) Incentive program:** FHWA fosters collaboration between stakeholders within the transportation community through the STICs, which bring together public and private transportation stakeholders in each state

to evaluate innovations and spearhead their deployment. The STIC Incentive program makes available up to $100,000 per state each year to support or offset the costs of standardizing innovative practices in a state transportation agency or another public-sector STIC stakeholder.

Intelligent Transportation Systems Joint Program Office

The Intelligent Transportation Systems (ITS) Joint Program Office (JPO) is responsible for conducting research on behalf of U.S. DOT and all major modes to advance transportation safety, mobility, and environmental sustainability through electronic and information technology applications, known as ITS. As new ITS technologies and systems evolve into market-ready products, JPO addresses issues associated with adoption and deployment. The office works closely with deployers to ensure a smooth transition from initial adoption (seen as part of the overall R&D lifecycle) to widespread deployment. The main goal of the adoption phase is to improve market understanding of and commitment to the new technologies. JPO's primary mechanism for educating the public sector's transportation workforce about ITS is the Professional Capacity Building (PCB) Program.

Table 8. Performance metrics for the ITS PCB Program, FY 2017

ITS PCB Activity	FY 2017
ITS PCB website	92,541 sessions (daily average: 254)
Webinars, online courses, and workshops	37 (3,032 attendees)
Archived and on-demand training content	46,042 users

ITS Professional Capacity Building Program

The ITS PCB Program is responsible for the design, development, and delivery of transferring knowledge through educational opportunities to spur the deployment of ITS technologies. These activities keep transportation stakeholders informed about the advances in ITS technologies and how they can be applied to solve real-world transportation challenges. The ITS PCB Program works with the managers of U.S. DOT's ITS research programs to devise, coordinate, and implement outreach and technology transfer activities. The PCB Program also works in partnership with professional associations, universities, and the training programs of U.S. DOT's modal administrations to engage the broad technical and organizational expertise needed to develop and deliver ITS learning. Some performance metrics of the ITS PCB's activities in FY 2017 are shown in Table 8.

Federal Railroad Administration

The mission of the RD&T program of the Federal Railroad Administration (FRA) is to ensure the safe, efficient, and reliable movement of people and goods by rail through basic and applied research, as well as the development of innovations and solutions. Safety is U.S. DOT's primary strategic goal and thus serves as the principal driver of FRA's RD&T program. FRA develops

technology that is used by FRA's inspectors to enforce safety regulations. Other technology developed by FRA is adopted by the railroad industry. In both cases, the agency funds research projects through all levels of technology readiness from basic principles to system deployment. Most funding goes toward moving projects from proof of concept to prototype demonstration in the railway environment. Taking the prototype to implementation of a commercial product is usually performed by suppliers to the rail industry.

FRA encourages industry involvement in its R&D program and coordinates its technology development and deployment activities with the rail industry, in part through its relationship with the Association of American Railroads (AAR). FRA's R&D program is coordinated with the AAR's Strategic Research Initiatives to avoid duplication and to cosponsor research when appropriate. In addition, FRA's Transportation Technology Center in Pueblo, CO, is managed and maintained by a wholly owned subsidiary of AAR. This Center has nearly 50 miles of test track and numerous test facilities for conducting R&D. Since its dedication as the High-Speed Ground Test Center in 1971, the Center has played an important part in research, development, and testing of rail infrastructure and equipment.

National Highway Traffic Safety Administration

The National Highway Traffic Safety Administration (NHTSA) uses several strategies for deploying its research and technology results into practice. These range from technology demonstrations and field tests to consumer education programs.

Technology Demonstrations and Field Tests

NHTSA has a long history of deploying new technology developments into the field to collect data on their real-world performance and consumer acceptance. A recent example was the Vehicle-to-Vehicle (V2V) Model Deployment in Ann Arbor, MI, where thousands of vehicles were equipped with dedicated short-range communications technology. The purpose of the deployment was to test how well V2V technology performed, how it supported safety applications, and how consumers received it. The findings from this deployment have given NHTSA important data to use when developing regulatory guidelines for V2V technology.

Vehicle Research and Test Center

Staff at the Vehicle Research and Test Center (VRTC), NHTSA's in-house laboratory, conduct research and vehicle testing in support of NHTSA's mission to save lives, prevent injuries, and reduce traffic-related health care and other economic costs. Studies performed cover the areas of crash avoidance, crashworthiness, biomechanics, and defects analysis. These activities support development of the Federal Motor Vehicle Safety Standards, which ensure safer vehicles through enhanced vehicle performance, improved occupant protection systems, better structural integrity of vehicles, increased understanding of driver behavior, and the use of intelligent systems to enhance drivers' ability to avoid crashes and travel safely.

Federal Motor Carrier Safety Administration

FMCSA's primary mission is to reduce crashes, injuries, and fatalities involving large trucks and buses. In support of that mission, FMCSA invests in the development, testing, and transfer of innovative technologies through the following programs and activities:

- **Research and Technology (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;
  - Improve the technology used by enforcement officers when conducting roadside inspections and compliance reviews; and
  - Facilitate the training or education of CMV safety personnel.
- **Innovative Technology Deployment (ITD) Grant Program:** The ITD program is FMCSA's key mechanism for transferring proven enforcement technologies into operational systems for the states. The program provides funding for states to deploy, support, and maintain commercial motor vehicle (CMV) information systems and networks. One example of ITD efforts is the deployment of infrared screening tools that identify CMVs with unsafe brakes by measuring the temperature of wheels of CMVs in motion. FMCSA's state partners are also using the ITD grant program to refine and deploy safety systems for fleets such as work-zone warning systems.

Pipeline and Hazardous Materials Safety Administration

The Pipeline and Hazardous Materials Safety Administration (PHMSA) sponsors R&D projects focused on providing near-term solutions that will increase the safety and reliability of the nation's pipelines and hazardous materials transportation. PHMSA has a consensus-based, collaborative RD&T program that is bringing new technology to market and is helping to strengthen pipeline integrity in the United States. PHMSA investment continues beyond proof of concept and concludes when the pre-commercial technology is effectively demonstrated in the intended operating environment.

Demonstrations promote the deployment and utilization of new technologies through observations and participation by pipeline operators, equipment vendors, standards organizations, and pipeline safety officials. PHMSA considers demonstrations to be just one stage in the T2 process, but they can be considered a major milestone for achieving an ultimate research goal.

Through its R&D awards, PHMSA mandates several actions that the researcher must take to promote project results. For example, all technical reports produced through PHMSA-sponsored research are promoted to decisionmakers and stakeholders via trade journals, public conferences, or other industry events.

Maritime Administration

The majority of the research sponsored by the Maritime Administration (MARAD) evaluates the effectiveness of technologies and concepts. Studies focus on the identification of problems and potential solutions, or forecasting the future direction and demands on the maritime industry. For the most part, research is carried out using contracts or cooperative agreements with industry partners and academia. MARAD works closely with industry to identify research needs, formulate research initiatives to address specific issues, and transfer findings to the industry. Because MARAD is primarily a promotional agency, its influence on regulatory development is limited. However, its research program does support technological research and assessment that advances environmental compliance and transportation and environmental policy development. MARAD works closely with its industry, academic, and Federal partners through hosted workshops, meetings of cooperative research programs, and Federal advisory committees and partnerships.

Success Stories

The following success stories show how U.S. DOT-funded research results are being deployed in a wide range of transportation settings and are producing public benefits.

1. From Planning to Deployment of Connected Vehicle Technologies

Sponsored by the U.S. DOT's ITS JPO, the Connected Vehicle (CV) Pilot Deployment Program is a national effort to deploy, test, and operationalize cutting-edge mobile and roadside technologies and enable multiple CV applications. In early FY17, U.S. DOT awarded three cooperative agreements collectively worth more than $45 million to design, build, and test the Nation's most complex and extensive deployment of integrated wireless in-vehicle, mobile device, and roadside technologies.

The three deployment sites are testing vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) applications in different settings for different purposes:

- New York City: Improve the safety of travelers and pedestrians in a dense urban setting.
- Tampa, FL: Relieve congestion and improve safety during morning commute hours.
- Wyoming: Improve safety and efficiency of commercial vehicle operations along a rural interstate corridor.

Source: ITS JPO

Figure 4. Goals for CV Pilot Deployment Program

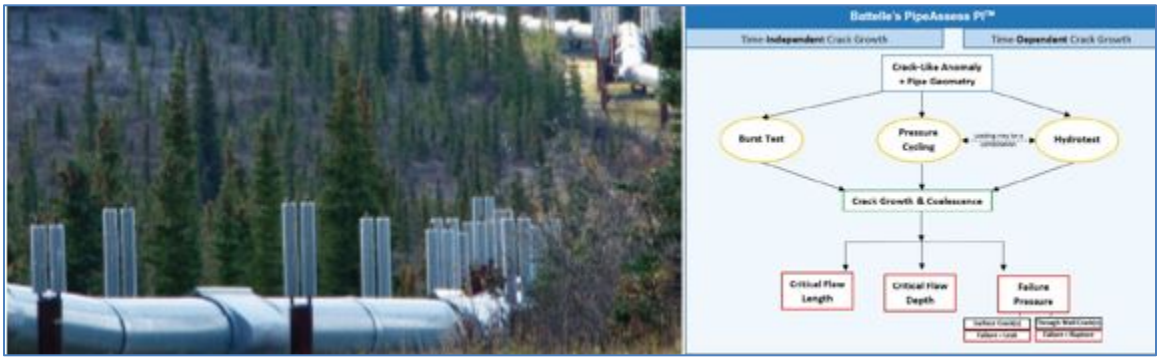
As shown in Figure 4, the intent of these pilot deployments is to encourage partnerships of multiple stakeholders to deploy applications that use data captured from multiple sources across all elements of the surface transportation system to support improved system

performance and enhanced performance-based management. The pilot deployments are also expected to support an impact assessment and evaluation effort that will inform a broader cost-benefit assessment of CV concepts and technologies.

2. PipeAssess PI™ Axial Crack Software Developed to Identify Seam Failures

PHMSA sponsored research, development, and the deployment of PipeAssess PI™ Axial Crack software, which enables evidence based repair and replacement decisions that can reduce costs through optimization of re-inspection intervals and hydrotesting. The work directly supported the closure of Safety Recommendation P-09-001 by the National Transportation Safety Board, which instructed PHMSA to eliminate catastrophic longitudinal seam failures in electric resistance welded pipe. Such pipe failures could release gas propane and negatively impact residential areas.

The software received an R&D 100 Award from R&D Magazine in 2017. This prestigious award recognizes the most significant technologies created by the Nation's scientists and engineers. A version of the software is being licensed by PHMSA's contractor to commercial clients. More information on the software is available here.



Source: Battelle

Figure 5. A pipeline running through a wooded setting (left) and a high-level overview of the capabilities of the PipeAssess PI software (right)

3. Global Vehicle Target for Automotive Testing

NHTSA collaborated with the European New Car Assessment Program, the Insurance Institute for Highway Safety, vehicle manufacturers, suppliers, and Dynamic Research, Inc., to develop the global vehicle target (GVT). The GVT is a full-sized artificial vehicle designed to look like an actual passenger car to the sensors presently used by automotive safety systems. However, unlike an actual car, the GVT can be repeatedly struck from any approach angle without harm to those performing the tests or the vehicles being evaluated (Figure 6).

Source: NHTSA

Figure 6. GVT (top left) over the LPRV, LPRV (bottom left), and car impacts GVT at 25 mph (right)

The GVT is one component of the guided soft target (GST) system designed to safely evaluate crash-avoidance technologies in pre-crash scenarios. The GST system is comprised of the GVT, a low-profile robotic vehicle (LPRV), an operator's base station, and a remotely operated safety steward dead-man switch. Constant wireless communication between the LPRV and base station allow for precise closed-loop control. Collaborators intend to use multiple copies of GVT for future research. NHTSA anticipates using this technology to facilitate exploratory automated vehicle performance evaluations. Specifically, NHTSA will assess traffic jam assist, blind-spot intervention, intersection crash avoidance, and automatic emergency braking system performance. Subsequent results will help facilitate the development of objective test procedures. In the longer term, NHTSA anticipates using the GVT, or multiple GVTs, to safely, accurately, and repeatedly perform complex test scenarios as part of the agency's research test program.

4. A Mobile Solution for Assessment and Reporting Infrastructure Damage

When disaster strikes, time is of the essence. Every minute, hour, and day matters when making damage assessments in the aftermath of a powerful hurricane, flood, or storm. Technology saves time and can be critical to getting roads and bridges repaired and open to traffic again after a natural disaster, especially when the damage is widespread and difficult to access. FHWA's Emergency Relief and Emergency Relief for Federally Owned Roads programs collaborated with local government and private industry stakeholders to develop an app designed to simplify laborious and time-consuming data collection for FHWA, state DOTs, Federal land management agencies, and Tribal governments. FHWA's Mobile Solution for Assessment and Reporting (MSAR) allows officials to gather field data via mobile device, making the process faster and easier by shortening a process that once took about 18 hours to 20 minutes. FHWA estimates that MSAR will save taxpayers an estimated $1.2 million per disaster.

Photo credit: David J. Phillip, Associated Press

Figure 7. An example of the water rescues that occurred during Hurricane Harvey in Houston, TX, in August 2017

FHWA's Texas division office, the Texas Department of Transportation (TxDOT), and local public agencies have used MSAR to assess damages and to complete more than 900 reports. FHWA stakeholders used MSAR to assess damage created by Hurricane Harvey, which caused catastrophic flooding in southeastern Texas in August 2017. During the Hurricane Harvey response, FHWA and TxDOT saved an estimated 17,000 hours of staff time by using MSAR.

5. Air Traffic Management Technology Demonstration

The Volpe Center and the FAA convened a Safety Risk Management panel to review the Air Space Technology Demonstration (ATD-2) Phase 1 demonstration in Charlotte, NC, on May 9–11, 2017. This panel fostered collaboration with stakeholders from FAA, participating airlines, and National Aeronautics and Space Administration (NASA) (sponsor) to identify any potential safety risks associated with the demonstration, as well as to specify corresponding mitigations for risks identified. This review included an assessment of safety issues related to the integration of the ATD-2 system with FAA's Time-Based Flow Management system and also analyzed issues associated with the operation of the ATD-2 system itself. NASA's ATD-2 project aims to reduce congestion on the airport surface and improve the efficiency of air traffic flows in airspace regions neighboring and downstream of major airports. Phase 1 of the demonstration program provides tools for scheduling departing aircraft in a manner that reduces runway congestion and allows departures to fit

more efficiently into the overhead stream. FAA will use the lessons learned from the ATD-2 demonstration in the future development of decision-support systems.

Photo credit: tham/iStock photo

Figure 8. Airport congestion reduces the efficiency of air traffic

6. Safer Grade Crossings: Evaluating the Effects of Pavement Markings

At highway-rail grade crossings, there is a particular space between and next to train tracks called the "dynamic envelope." This area is the critical space where a collision between a vehicle and a train could occur. In one recent year, roughly one-third of all rail-related fatalities happened at highway-rail grade crossings. In collaboration with FRA (the research sponsor) and the Florida Department of Transportation (FDOT), the Volpe Center conducted a short-term evaluation to help identify infrastructure that would make dynamic envelopes more visible and reduce the possibility of vehicles stopping on tracks (Figure 9).

In 2017, the Volpe Center, FRA, and FDOT collaboratively identified highway-rail grade crossings that received pavement markings and signage modifications. The team then installed video data collection systems and evaluated driver stopping behavior before and after the installation to determine the effectiveness of the improvements in reducing instances of vehicles stopping on the tracks. Following the success of the markings and signage treatments, FDOT adopted and implemented Volpe's recommendations at multiple crossings. Other railroads and state DOTs have explored similar pavement markings and

signage treatments. Volpe will continue to work with the FRA and the railroad industry to make grade crossings safer.

Source: U.S. DOT Volpe Center

Figure 9. Pavement markings evaluated at a highway-rail grade crossing in Florida

7. FHWA Collaborates on Pavement Preservation's When, Where, and How

In the fourth round of its Every Day Counts (EDC-4) initiative, FHWA is collaborating with agencies to identify and implement strategies for preserving their networks that take whole-life costs into consideration. The "when" and "where" components of the pavement preservation initiative supports preserving highway investments by managing transportation pavements proactively. The "how" component promotes quality construction and materials practices.

As part of EDC-4, 16 states and the U.S. Virgin Islands plan to demonstrate and assess the "when and where" components of pavement preservation. Another 27 states and U.S. DOT's Office of Federal Lands Highway (FLH) expect to make it a standard practice to manage pavements proactively to preserve highway investments. Eleven states, Puerto Rico, and the U.S. Virgin Islands plan to demonstrate and assess the "how" component of pavement preservation in EDC-4. Another 30 states and FLH plan to institutionalize the use of quality construction and materials practices to preserve pavements. Kentucky's Transportation Cabinet evaluated a comprehensive pavement preservation effort over a 5-year span, while using a diamond grinding approach to correct surface imperfections on 536 lane-miles of concrete pavement. The program cost approximately $100 million, but the cost of non-preservation treatments would have exceeded $1 billion.

8. Continuous Lower Energy, Emissions, and Noise Program

Through the Continuous Lower Energy, Emissions, and Noise (CLEEN) program, FAA is working with industry to accelerate the development and commercial deployment of

environmentally promising aircraft and engine technologies, as well as sustainable alternative fuels. FAA helps the companies in the CLEEN Consortium accelerate their technologies through a crucial phase in their maturation, culminating in full-scale ground and flight test demonstrations and showing readiness for product implementation. At the conclusion of the development effort for a CLEEN technology, each participating company is invested in the technology's success and confident in its maturity to move into product development for entry into service. Once this occurs, the CLEEN technologies will realize their fuel burn, emissions, and noise benefits for years to come.

FAA initiated the first phase of the CLEEN program in 2010 by entering into five-year agreements with five producers of aircraft, aircraft components, or aviation fuels. From 2010 to 2015, the FAA invested a total of $125 million. With the funding match from the five companies, the total investment exceeded $250 million. Several technologies developed by the CLEEN program have been tested and are in use today.

Table 9. Goals for the CLEEN I and CLEEN II programs

Goal Area	CLEEN I Goals (2010-2015)	CLEEN II Goals (2015-2020)
Noise (cumulative below FAA Stage 4 standard)	-32 decibels	-32 decibels
Landing and take-off emissions of nitrogen oxides (below Committee on Aviation Environmental Protection/6 standard)	-60 percent	-75 percent
Aircraft fuel burn	-33 percent	-40 percent

In 2015, FAA initiated a follow-on program, CLEEN II, which continues efforts to achieve the CLEEN goals. CLEEN II, which will run from 2015 to 2020, is a partnership with eight companies or consortia of companies. FAA plans to invest $100 million in CLEEN II, with cost-sharing from the industry partners that will match or exceed the Federal contribution. FAA anticipates that developed CLEEN II aircraft technologies will be on a path for introduction into commercial aircraft by 2026. Table 9 shows the goals for the CLEEN I and II programs.

9. FRA Develops Safety System that Detects Potential Soil Erosion Damage

FRA's Research, Development and Technology program developed a new detection system (Figure 10) to detect potential soil erosion damage. Many railroad bridge piers are susceptible to damage caused by scour and other changing soil conditions. Scour is the engineering term for the erosion of soil surrounding a bridge foundation (piers and abutments). Bridge scour occurs when fast-moving water around a bridge removes sediment from around the bridge foundation, leaving behind scour holes. These holes

(pockets), as shown in Figure 11, can seriously compromise the bridge's integrity and cause track outages and even bridge failure if not detected early. The system can continuously measure the structural response of each railroad bridge pier in the U.S. If a dangerous condition is detected, an automatic alert is sent to bridge inspectors.

Figure 10. Sensor installed on a bridge in Richmond, TX

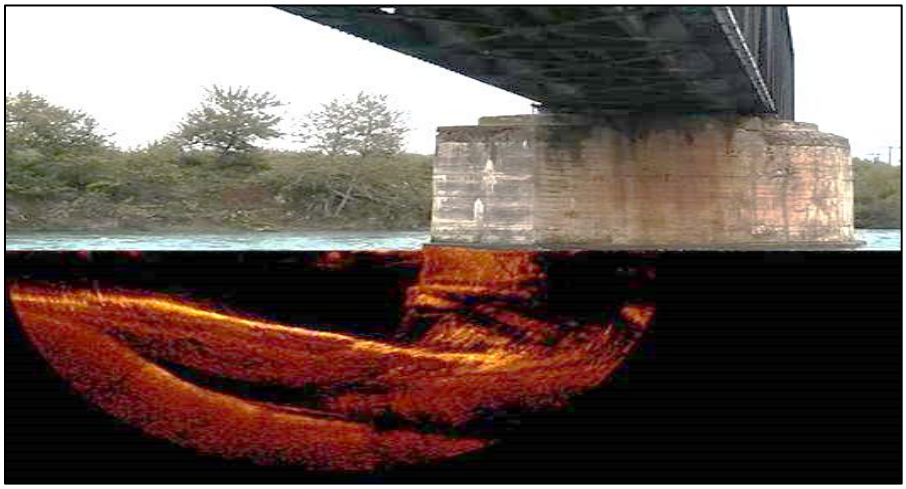


Figure 11. Canadian Pacific railroad bridge with large scour pocket

Since 2012, FRA stakeholders including Union Pacific, BNSF, Canadian Pacific, Metro-North Railroad, Long Island Railroad, Southeast Pennsylvania Transit Authority, and others have installed this technology on bridges. These bridges are located across the continental United States and span vital waterways, such as the Mississippi River, Missouri River, Santa Ana River, and the Lake Washington Ship Canal. Some bridge owners have also adopted the technology to detect bridge impacts from barges and motor vehicles. Canadian Pacific used the technology to monitor a bridge in 2017 with a large scour pocket, which allowed rail traffic to keep moving safely until the pocket could be filled.

In 2017, the U.S. Army Corps of Engineers installed the detection system on a bridge as part of a project in Southern California. The bridge consists of three lines carrying both freight and passenger trains. The Prado Dam upstream of the bridge will increase its flood flow releases from 10,000 ft^3/sec to more than 30,000 ft^3/sec. The sensors will be left in place after construction to monitor any signs of scour due to the increased flood flow.

10. Positive Train Location

Positive Train Location (PTL), a multi-year development effort led by FRA, culminated in 2017 with a successful technology transfer to railroads and their suppliers. This system, shown in Figure 12, uses global positioning system (GPS) technology that is augmented with inertial sensors to provide locomotive onboard systems with very high-precision train location data even under GPS-challenged environments (e.g., tunnels, urban canyons). This helps prevent train collisions by enabling train systems to determine with a higher degree of confidence which track a train is using while traveling in multiple track territory. As a mechanism for maintaining safe train spacing, the technology is also foundational for the development of rail automation. Under FRA funding and management, the system was conceptualized, prototyped, and tested at the Transportation Technology Center in Pueblo, CO. Currently, the technology is fully transferred from FRA to railroads and suppliers. It is being unit-tested by Union Pacific and BNSF railroads and is expected to be commercially available off-the-shelf in 2018.

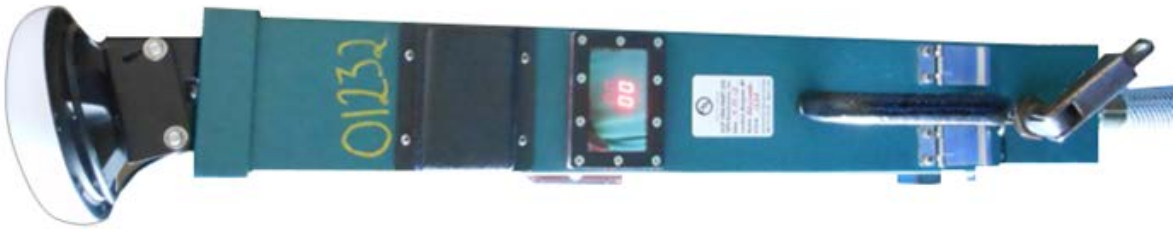
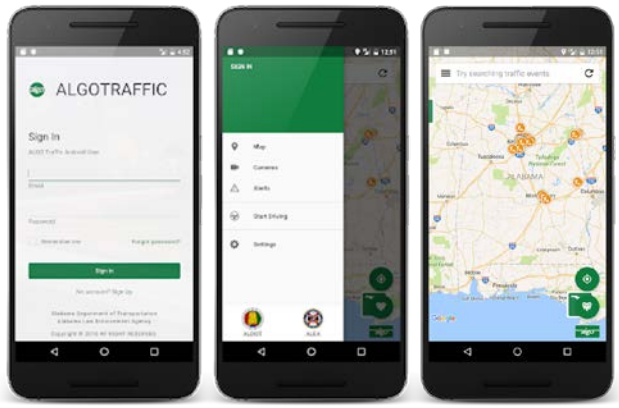


Figure 12. Positive Train Location: integrated end-of-train device

11. Work Zone Alert Systems

FMCSA has made discretionary grants available to the States, the District of Columbia, and the U.S. Territories to address work zone safety. Its Commercial Vehicle Information Systems and Networks (CVISN) and its Innovative Technology Deployment (ITD) (FY 2017–FY18) grant programs were established to prioritize projects focused on deploying a work zone or incident notification system designed to alert CMV drivers of an active work zone, traffic congestion, or an incident. Alabama and Arizona are currently using ITD/CVISN grant funds to deploy work zone alert systems.

Alabama designed a basic system for establishing work-zone-related geofences and triggering an alert when a smartphone user enters a geofenced area. This project is fully deployed. The Alabama "ALGO" and "ALGO Traffic" apps (Figure 13) are available to provide truckers with real-time audio alerts on work zones and other traffic incidents. Alabama has reported 20,000 downloads for iPhone and 10,000 downloads for Android since deployment. To view the ALGO Traffic homepage, visit https://algotraffic.com.



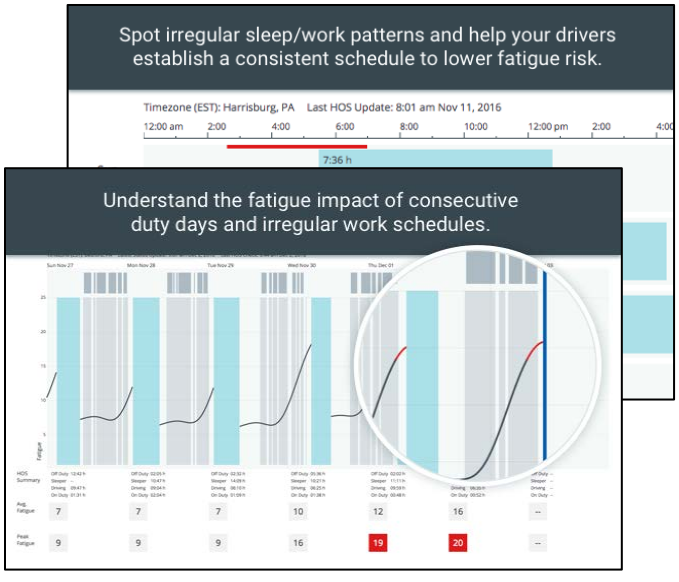
Source: Google Play

Figure 13. Alabama's ALGO and ALGO Traffic apps

12. Trucking Fatigue Meter

FMCSA is currently sponsoring Phase III (commercialization) of a SBIR product called the Trucking Fatigue Meter. The Trucking Fatigue Meter has the potential to reduce fatigue-related crashes and improve highway safety. This data analytics technology uses existing streams of trucking data (e.g., electronic logging device data) to evaluate driver fatigue and provide actionable feedback in real-time. 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).

The application 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. Specific benefits include a reported reduction in safety-critical events, increased driver awareness of sleep needs, learning from past incidents based on comprehensive fatigue assessments, and safer load assignments that mitigate fatigue.



Source: Pulsar Informatics

Figure 14. Screenshots of the Trucking Fatigue Meter application

A feature to analyze trends in safety-critical events shows the total number of such events over a given timeframe by specific driver, along with a chart showing the number of days since the last event. The sales pipeline for this product is growing. Three motor carriers have signed on as subscribing customers; one of those carriers is deploying the system to 2,000 drivers. For more information on the Trucking Fatigue Meter, visit here. For more information on the USDOT SBIR program and current FMCSA SBIR projects, visit here.

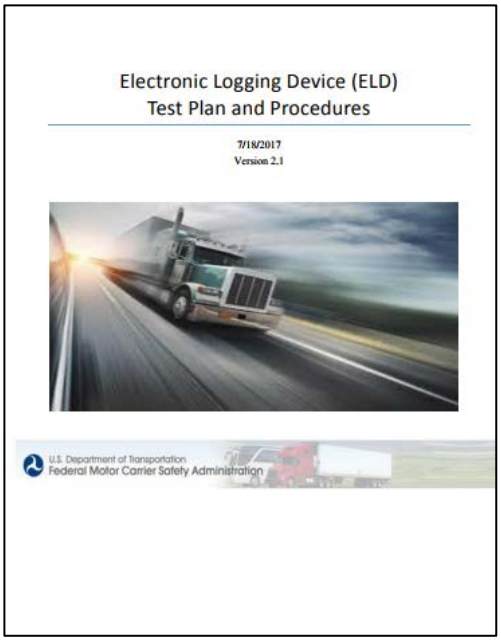
13. Technical Specifications and Compliance Testing for Electronic Logging Devices

To improve CMV safety and reduce the overall paperwork burden for motor carriers and drivers, FMCSA published the final rule titled "Electronic Logging Devices and Hours of Service Supporting Documents" (also known as the ELD Final Rule) in December 2015. This rule, which went into effect on December 18, 2017, established:

- Requirements for the mandatory use of ELDs by certain drivers required to prepare hours-of-service records of duty status.
- Minimum performance and design standards for ELDs that will require certification and registration with FMCSA.
- Requirements for supporting documents for hours of service.
- Measures to address concerns about harassment resulting from the mandatory use of ELDs.

To ensure consistency among manufacturers and devices, FMCSA developed the ELD technical specifications for the ELD Final Rule, as well as ELD compliance test procedures (see Figure 15). The CMV industry and ELD providers had an overall positive reaction to the ELD technical specifications and the test procedures. The compliance test procedures were published and made available free of charge to ELD vendors to help with their self-certification. The test procedures have been used by more than 350 ELD providers to date and use continues to grow as more ELD providers enter the marketplace.

To learn more about the ELD Final Rule and the ELD technical specifications, visit here. To review the ELD compliance test procedures, visit here.



Source: FMCSA

Figure 15. Cover of the ELD Test Plan and Procedures

List of Acronyms

AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
AID	Advanced Innovation Deployment Demonstrations
AIP	Airport Improvement Program
ATCMTD	Advanced Transportation and Congestion Management Technologies Deployment
ATD	Anthropomorphic test devices
ATD-2	Airspace Technology Demonstration 2
CLEEN	Continuous Lower Energy, Emissions, and Noise
CMV	Commercial motor vehicle
CRADA	Cooperative research and development agreement
CV	Connected vehicle
CVISN	Commercial Vehicle Information Systems and Networks
DOC	Department of Commerce
DOT	Department of Transportation
EDC	Every Day Counts
ELD	Electronic logging device
FAST Act	Fixing America's Surface Transportation Act
FAA	Federal Aviation Administration
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FLH	Federal Lands Highway
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
FY	Fiscal year
GPS	Global positioning system
GST	Guided soft target
GVT	Global vehicle target

ITD	Innovative Technology Deployment program
ITS	Intelligent transportation systems
ITS PCB	Intelligent Transportation Systems Professional Capacity Building Program
LPRV	Low-profile robotic vehicle
MARAD	Maritime Administration
NASA	National Aeronautics and Space Administration
NHTSA	National Highway Traffic Safety Administration
NTL	National Transportation Library
OA	Operating administration
OST-R	Office of the Assistant Secretary for Research and Technology
PCB	Professional capacity building
PHMSA	Pipeline and Hazardous Material Safety Administration
PTL	Positive train location
Pub. L.	Public Law
R&D	Research and development
R&T	Research and technology
RD&T	Research, development, and technology
ROSA P	Repository and Open Science Access Portal
SHRP2	Second Strategic Highway Research Partnership Program
SBIR	Small Business Innovation Research Program
STIC	State Transportation Innovation Council
T2	Technology transfer
TFHRC	Turner-Fairbank Highway Research Center
TRB	Transportation Research Board
TxDOT	Texas Department of Transportation
U.S. DOT	United States Department of Transportation
U.S.C.	United States Code
V2I	Vehicle-to-infrastructure
V2V	Vehicle-to-vehicle
VRTC	Vehicle Research and Test Center