**U.S. Department of Transportation**

Office of the Secretary of Transportation

Deputy Assistant Secretary
for Research and Technology

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

April 29, 2024

**INFORMATION MEMORANDUM**

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

**FROM:** Robert C. Hampshire, Ph.D.
Deputy Assistant Secretary for Research and Technology and
Chief Science Officer

Robert Hampshire
Digitally signed by Robert Hampshire
Date: 2024.05.14 06:55:23 -04'00'

**SUBJECT:** Fiscal Years 2022 and 2023 Technology Transfer (T2) Annual Summary Reports

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

This report provides the United States Department of Transportation's (U.S. DOT) information for the Fiscal Years 2022 and 2023 Annual Summary Report. The reporting period for this report is two years in order for U.S. DOT reporting to come into sync with the DOC reporting cycle.

Please submit questions pertaining to this report to Lloyd Rue, RDT Portfolio Manager.

Attachment

- Fiscal Years 2022 and 2023 Technology Transfer (T2) Annual Summary Reports

FY 2022 – 2023

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

# ANNUAL Technology Transfer REPORT

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Table of Acronyms and Abbreviations

| | |
|---|---|
| 3D | Three-dimensional |
| AAR | Association of American Railroads |
| ADA | Americans with Disabilities Act |
| AFFF | Aqueous film forming foams |
| AI | Artificial intelligence |
| AID | Accelerated Innovation Deployment Demonstration |
| AIP | Airport Improvement Program |
| AMRP | Annual Modal Research Plan |
| ATC | Alternative technical concept |
| ATCMTD | Advanced Transportation and Congestion Management Technologies Deployment |
| BTS | Bureau of Transportation Statistics |
| CAD | Computer-aided dispatch |
| CAMI | Civil Aerospace Medical Institute |
| CLEEN | Continuous Lower Energy, Emissions, and Noise Program |
| CMV | Commercial motor vehicle |
| CRADA | Cooperative research and development agreement |
| CRISI | Consolidated Rail Infrastructure and Safety Improvement |
| CV | Connected vehicle |
| CVSA | Commercial Vehicle Safety Alliance |
| D-B | Design-build |
| D-B-B | Design-bid-build |
| DOC | Department of Commerce |
| DOD | Department of Defense |
| DOT | Department of Transportation |
| EDC | Every Day Counts |
| EDC-6 | Every Day Counts, sixth round (2021-2022) |
| EMS | Emergency medical services |
| FAA | Federal Aviation Administration |
| FHWA | Federal Highway Administration |
| FMCSA | Federal Motor Carrier Safety Administration |
| FRA | Federal Railroad Administration |
| FTA | Federal Transit Administration |
| FY | Fiscal year |
| HCWP | Highway Construction Workforce Partnership |
| IKA | Innovation and Knowledge Accelerator |
| IT | Information technology |
| ITD | Innovative Technology Deployment Grant Program |
| ITS | Intelligent transportation systems |
| ITS JPO | Intelligent Transportation Systems Joint Program Office |
| ITS PCB | Intelligent Transportation Systems Professional Capacity Building Program |
| LED | Light-emitting diode |
| MARAD | The Maritime Administration |
| META | Maritime Environmental and Technical Assistance Program |
| NAFMP | North American Fatigue Management Program |
| NextGen TIM | Next-generation traffic incident management |
| NHTSA | National Highway Traffic Safety Administration |

| | |
|---|---|
| NTL | National Transportation Library |
| OA | Operating administration |
| OST-R | Office of the Assistant Secretary for Research and Technology |
| PHMSA | Pipeline and Hazardous Material Safety Administration |
| PTC | Positive train control |
| R&D | Research and development |
| R&T | Research and technology |
| RD&T | Research, development, and technology |
| ROSA P | Repository and Open Science Access Portal |
| SBIR | Small Business Innovation Research Program |
| STIC | State Transportation Innovation Council |
| T2 | Technology transfer |
| TFHRC | Turner-Fairbank Highway Research Center |
| TMC | Traffic management center |
| TSI | Transportation Safety Institute |
| TTC | Transportation Technology Center |
| U.S. DOT | United States Department of Transportation |
| U.S.C. | United States Code |
| UAS | Unmanned aircraft system |
| UAV | Unmanned aerial vehicle |
| UTC | University Transportation Centers |
| V2V | Vehicle-to-vehicle |
| Volpe Center | John A. Volpe National Transportation Systems Center |
| VRTC | Vehicle Research and Test Center |
| WZDx | Work zone data exchange. |

# 1 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 related legislation, and T2 accomplishments by the OAs in the specified fiscal years.

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 Summary Report to U This report is also provided to the Department of Commerce's (DOC) National Institute of Standards and Technology in support of the DOC Secretary's Annual Summary Report to the President, Congress, and to the U.S. Trade Representative on the status of T2 by Federal laboratories.

U.S. DOT defines T2 as a set of activities including information dissemination that are intended to lead to the transportation community's adoption and use of the products of research and development. In addition, the goal of T2 activities is to accelerate commercialization of the results from R&D projects and the deployment of transportation innovations. U.S. DOT's current approach to T2 allows each OA to conduct deployment activities that are tailored to its mission and to the types of research it sponsors. U.S. DOT's annual T2 reports are available online.

T2 activities are executed by U.S. DOT agencies and their following research centers:

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

More information about U.S. DOT's T2 activities and research centers is available on the following websites:

- FAA Technology Transfer Program
- FHWA Center for Accelerating Innovation
- FRA Transportation Technology Center
- DOT Volpe Center Technology Transfer
- Tech Transfer Activities at DOT
- FTA Research and Innovation
- ITS Joint Program Office Technology Transfer
- PHMSA Research and Development
- MARAD Innovation, Research, and Technology
- FMCSA Analysis, Research, and Technology
- NHTSA Research

# 2 U.S. DOT Invention Disclosures, Patenting, Licensing, and Other Measures

The following tables provide data on U.S. DOT's T2 activities from Fiscal Year (FY) 2017 to FY 2023. Prior fiscal year data have been added to the tables below to provide historical context. These tables conform to the guidance that the DOC has provided to Federal agencies. Table 4 contains other metrics that U.S. DOT tracks. Zeroes ("0") denote the agency did not use the mechanism in the reported year. "N/A" denotes that data was not available at the time of this report.[1] [2]

**Table 1: Inventions, Disclosures and Patenting**

| Table 1 | Invention Disclosures and Patenting | FY19 | FY20 | FY21 | FY22 | FY 23 |
|---|---|---|---|---|---|---|
| 1 | Invention Disclosures Received | 2 | 3 | 2 | 3 | 2 |
| 2 | Total Patent Applications Filed | 2 | 2 | 2 | 2 | 2 |
| 3 | Total U.S. Patent Applications Filed | 2 | 2 | 2 | 0 | 1 |
| 4 | Total Foreign Patent Applications Filed | 0 | 0 | 0 | 0 | 0 |
| 5 | Total PCT Applications Filed | 0 | 0 | 0 | 0 | 0 |
| 6 | Total Patents Issued | 0 | 1 | 0 | 1 | 3 |
| 7 | Total U.S. Patents Issued | 0 | 1 | 0 | 1 | 3 |
| 8 | Total Foreign Patents Issued | 0 | 0 | 0 | 1 | 0 |

**Table 2: Licenses**

| Table 2 | Licenses | FY19 | FY20 | FY21 | FY22 | FY 23 |
|---|---|---|---|---|---|---|
| 9 | Invention Licenses, Total Active | 5 | 5 | 0 | 1 | 0 |
| 10 | New Invention licenses | 0 | 0 | 0 | 2 | 0 |
| 11 | New Invention Licenses granted to small businesses | N/A | N/A | N/A | 0 | 0 |
| 12 | Income-Bearing Licenses, Total Active | 6 | 4 | 0 | 0 | 0 |
| 13 | New Income-Bearing Licenses | 1 | 0 | 0 | 0 | 0 |
| 14 | Exclusive Income-Bearing Licenses, Total Active | 0 | 1 | 0 | 0 | 0 |
| 15 | Partially Exclusive Income-Bearing Licenses, Total Active | 0 | 0 | 0 | 0 | 0 |
| 16 | Non-Exclusive Income-Bearing Licenses Total Active | 4 | 4 | 0 | 0 | 0 |
| 17 | Other Licenses, Total Active | NA | N/A | N/A | 0 | 0 |
| 18 | New Other Licenses | N/A | N/A | N/A | 0 | 0 |

[1] Guidance from *Guidance for Preparing Annual Agency Technology Transfer Reports Under the Technology Transfer Commercialization Act,* p. 3. April 2013

[2] For FAA, the FY21 column in Table 1 reports applications and patents assigned to FAA. Additional applications and patents were generated from FAA-funded agreements (e.g., contracts, grants, and other transaction authorities: OTAs).

| | | | | | | |
|---|---|---|---|---|---|---|
| 19 | New Other Licenses Granted to Small Businesses | N/A | N/A | N/A | 0 | 0 |
| **Elapsed Amount of Time for Granting Invention Licenses** | | N/A | N/A | N/A | | |
| 20 | Average (months) | N/A | N/A | N/A | 0 | 0 |
| 21 | Minimum (months) | N/A | N/A | N/A | 1 | 0 |
| 22 | Maximum (months) | N/A | N/A | N/A | 0 | 0 |
| 23 | Licenses Terminated for Cause | 0 | 0 | 0 | 0 | 0 |

*Note: FAA licenses are non-exclusive.*

**Table 3: Income from Licensing**

| Table 3 | Income from Licensing | FY19 | FY20 | FY21 | FY22 | FY 23 |
|---|---|---|---|---|---|---|
| 24 | Invention License Income (in thousands $) | 8.2 | 19 | 0 | 0 | 0 |
| 25 | Other License Income | N/A | N/A | N/A | 0 | 0 |
| 26 | Total Earned Royalty Income (ERI) | 8.2 | 19 | 0 | 0 | 0 |
| 27 | ERI from Top 1% of Licenses | 0 | 0 | 0 | 0 | 0 |
| 28 | ERI from Top 5% of Licenses | 0 | 0 | 0 | 0 | 0 |
| 29 | ERI from Top 20% of Licenses | 0 | 0 | 0 | 0 | 0 |
| 30 | Minimum ERI | 0 | 0 | 0 | 0 | 0 |
| 31 | Maximum ERI | 0 | 0 | 0 | 0 | 0 |
| 32 | Median ERI | 0 | 0 | 0 | 0 | 0 |
| 33 | Percent of earned royalty income distributed to inventors | 25 | 25 | 0 | 0 | 0 |
| 34 | Percent of earned royalty income distributed to the agency or laboratory | 75 | 75 | 0 | 0 | 0 |

**Table 4: Collaborative Agreements**

| Table 4 | Collaborative Agreements | FY19 | FY20 | FY21 | FY22 | FY 23 |
|---|---|---|---|---|---|---|
| 35 | Total Active CRADAs | 44 | 49 | 45 | 43 | 39 |
| 36 | New CRADAs | 10 | 7 | 5 | 7 | 3 |
| 37 | New CRADAs Involving Small Businesses | 8 | 6 | N/A | 1 | 3 |
| 38 | Other Collaborative Agreements | 0 | 0 | N/A | N/A | N/A |
| 39 | Newly executed non-traditional CRADAs | 0 | 0 | N/A | N/A | N/A |
| 40 | Small businesses supported | 7 | 45 | 37 | N/A | N/A |
| 41 | Startups and young companies supported | N/A | 8 | N/A | N/A | N/A |

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

The importance of T2 within U.S. DOT is reflected in the U.S. DOT Research, Development and Technology Strategic Plan FY 2022-2026, which was released in December 2022[3]. T2 aims to facilitate adoption and commercialization of market-ready transportation technologies, as shown in the plan's T2 section titled "Technology Transfer and Deployment," which details the Department's strategic vision and priorities for T2 over the next 5 years.

Citing *transformation* as one of the six main strategic goals in the plan, U.S. DOT strives to invest in purpose-driven research and innovation to meet the challenges of the present and modernize a transportation system of the future that serves everyone today, and in the decades to come.

Table 5 summarizes the T2 priorities and objectives specified in the RD&T Strategic Plan. The T2 activities of OST-R and the different OAs within the Department are described in more detail below.

**Table 5: T2 Priorities and Objectives**

| T2 Priorities | 2022-2026 Objectives |
|---|---|
| Ensure research investments are fully leveraged through the demonstration and deployment of the resulting products and technologies | • **Research Planning:** Require that T2 performance measures be incorporated into project lifecycle planning at an early stage<br>• **Early-Stage Identification:** In partnership with the modes, identify potential research and lab efforts ripe for demonstration.<br>• **AMRP Linkage:** Ensure that the deployment opportunities are connected with AMRPs. |
| Accelerate technology commercialization and deployment of transportation innovations | • **Technology Coordination:** Develop a centralized function to institute structured channels to commercialize transportation innovations.<br>• **Communicate Successes:** Continually improve mechanisms to share promising research, outcomes of demonstration projects, and available patents and licenses for scalability.<br>• **Investor Outreach:** Host investor/T2 events to raise awareness of viable technologies.<br>• **Process Improvement:** Create processes that align statutory requirements with Federal public access and open science mandates to increase research uses. |
| Identify leading-edge transportation technologies or products that could be manufactured in the United States | • **Domestic Technology Scans:** Identify U.S. government-funded technologies and products that are market-ready for domestic commercialization and deployment.<br>• **Encourage Domestic Production:** Work with stakeholders to initiate and expand U.S production pipelines for technology efforts. |
| Advance coordinated interagency approaches to innovation and research solicitations with the goal of reducing barriers to program participation and streamlining access to funding opportunities | • **Partnership Development:** Create novel, cross-agency approaches to solicitations that meet multi-agency goals and outcomes<br>• **Expanded Outreach:** Continue to engage communities, partners, and consortia on upcoming opportunities. |

[3] https://www.transportation.gov/rdtstrategicplan

## *3.1 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 and technology results.

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 submitting research results to 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 the Department's R&D and T2 activities through:
- Key performance indicators for research outcomes and their uses.

The collection and sharing of T2 success stories.
Aligning U.S. DOT's R&D budget, research, and T2 processes by incorporating T2 deliverables into R&D funding agreements.

OST-R's T2 efforts are implemented via the agencies, programs, and services listed below, each of which are detailed in the later sections:

- Bureau of Transportation Statistics
- National Transportation Library
- Office of Research, Development, and Technology
- Volpe National Transportation Systems Center
- Small Business Innovation Research (SBIR) Program
- U.S. DOT Research Hub
- University Transportation Centers
- Annual Modal Research Plans
- Transportation Safety Institute

### *3.1.1.1 Bureau of Transportation Statistics*

The Bureau of Transportation Statistics (BTS) is the preeminent source of statistics on commercial aviation, multimodal freight activity, and transportation economics. BTS assures the credibility of its products and service through transparent data collection, thorough vetting of data quality, and rigorous analysis free from political influence. BTS promotes innovative methods of data collection, analysis, visualization, and dissemination to improve operational efficiency, examine emerging topics, and to create relevant and timely information products that foster understanding of transportation and its transformational role in society. The BTS Director is, by law, the senior advisor to the Secretary of Transportation on data and statistics.

### *3.1.1.2 National Transportation Library*

Administered by BTS, the National Transportation Library (NTL) serves as a central clearinghouse for transportation data and information of the Federal Government. Since 2013, NTL has been the centerpiece of U.S. DOT's response to the White House Office of Science & Technology Policy's memorandum *Increasing Access to the Results of Federally Funded Scientific Research* (2013), by 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. The NTL is the permanent,

publicly accessible home for research publications from throughout the transportation community, the gateway to all U.S. DOT data, and the help line for Congress, researchers, and the public for information about transportation. NTL creates and maintains an all-digital collection of transportation resources, the *Repository and Open Science Access Portal* (ROSA P). The Department's Public Access Plan identifies this repository as the full-text repository for research funded by the Department. Content types found in ROSA P include text, links to websites, datasets images, video, other multimedia, and maps.

#### *3.1.1.3 Office of Research, Development, and Technology*

Housed in U.S. DOT's Office of the Secretary, OST-R's Research Development and Technology (RD&T) Office plays a lead role in research coordination within the Department and with a wide range of national and international stakeholders. OST-R focuses on collecting, synthesizing, and disseminating information and statistics on the Department's RD&T activities and its products to ensure that all Open Science, Public Access, and other research funding and product transparency mandates are met.

#### *3.1.1.4 Volpe National Transportation Systems Center*

Housed within OST-R, the 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. The Volpe Center provides OST-R with a broad range of assistance, including research and implementation, process analysis, process design, and communication. 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. Other offices within the Volpe Center support the T2 efforts of the OAs.

##### *3.1.1.4.1 Small Business Innovation Research [SBIR] 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 departments of transportation (DOTs), U.S. DOT, or other Federal agencies. The SBIR Program also provides commercialization services to the small businesses—market research, intellectual property protection assistance, and consulting—to promote the commercial value of innovations and technologies and support T2 activities. The Volpe Center administers the Department's SBIR program on behalf of the Office of the Secretary.

#### *3.1.1.5 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 an 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 Fixing America's Surface Transportation (FAST) Act (Pub. L. 114-94) as amended by the Infrastructure Investment and Jobs Act (Pub. L. 117-58)[4] 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 met this requirement by expanding the Research Hub database,

[4] 49 U.S.C. 6502.

adding new content, and improving functionality, to provide the required comprehensive account of the Department's research portfolio.

#### *3.1.1.6 University Transportation Centers*

U.S. DOT invests in the future of transportation through its University Transportation Centers (UTC) Program, which awards and administers grants to consortia of colleges and universities across the United States. Each UTC is a consortium of two- and four-year colleges and universities that come together to form a unique center of transportation excellence for transportation research, T2, education, and workforce development. UTC grants were selected based on their proposed activities in research, education, and technology transfer; these grants require routine reporting on T2 activities in semi-annual progress reports and are required to report the activities in a specific format for each research project that directly addresses outputs, outcomes, and impacts of projects and is updated as needed.

#### *3.1.1.7 Annual Modal Research Plans*

The Fixing America's Surface Transportation ["FAST"] Act as amended by the Infrastructure Investment and Jobs Act,[5] requires each OA and Joint Program Office within the Department to submit an annual modal research plan (AMRP) to the Assistant Secretary for Research and Technology for review and approval. The plans are required to provide a comprehensive research plan for the upcoming fiscal year and detailed planning for research and T2 activities. The AMRPs include sections on T2 deployment and evaluation. The AMRPs also give OST-R the opportunity to identify opportunities for collaboration and cooperation among and between OA research teams.

[5] 49 U.S.C. 6501

# 4 Operating Administrations' T2 Activities and Programs

## *4.1 Federal Aviation Administration [FAA]*

### *William J. Hughes Technical Center and Civil Aerospace Medical Institute [WJHTC] and Civil Aerospace Medical Institute [CAMI]*

FAA research is primarily applied R&D designed to help the agency develop policies, regulations, certifications, guidance, and standards that increase safety and modernize the National Airspace System (NAS). The FAA operates state-of-the-art research facilities in two locations: the William J. Hughes Technical Center in Atlantic City, NJ and the Civil Aerospace Medical Institute and the Flight Research and Analysis Group at the Mike Monroney Aeronautical Center in Oklahoma City, Oklahoma. Each location provides unique research, development, and test and evaluation platforms necessary to facilitate upgrades, improvements, and operational sustainment. The laboratories serve as a resource for government-industry partnerships. Collaboration internally and across federal agencies, academia, the U.S. military, and the aviation industry is important for sharing research and information, developing policy, and promoting best practices globally.

The FAA maintains partnerships with over 300 stakeholders representing academia, industry, international entities, technical societies, and other federal agencies. Collaboration is accomplished through various mechanisms, including Cooperative Research and Development Agreements (CRADAs), Centers of Excellence (COE) grants, cooperative grants, national consortiums, interagency agreements, patent license agreements, and other avenues. These methods provide partners access to the agency's facilities and subject matter experts to conduct advanced research.

#### 4.1.1 Cooperative Research and Development Agreements (CRADAs)

The FAA's Technology Transfer program promotes the dissemination of federally funded research and innovations to the commercial marketplace. The program facilitates the exchange of the FAA's knowledge, facilities, and capabilities with industry, academia, and other federal partners. The program's primary technology transfer mechanism is the *CRADA*. These agreements offer unique collaborative opportunities for the FAA to work with domestic and international partners from academia and industry to address complex aviation challenges. With the addition of three new CRADAs in FY 2023, the FAA has established more than 400 collaborative agreements since the program began. This year, the agency had 46 active CRADAs.

#### 4.1.2 Centers of Excellence (COE) and Aviation Research Grants

Congress established the COE program through the Omnibus Budget Reconciliation Act of 1990 - Public Law (P.L.) 101-508, title IX – Aviation Safety and Capacity Expansion Act, now codified, in relevant part at section 44513 of title 49 of the U.S. Code. The COE program aims to advance aviation technologies and expand the agency's research capabilities while educating the next generation of aviation professionals. The program enables critical collaboration and coordination between government, academia, and industry. More specifically, using selection criteria provided under the law, the FAA Administrator and the Secretary of Transportation conducted an open and rigorous competitive process to select COE members throughout the United States. In FY 2023, the FAA provided $43M in COE grants to conduct critical aviation research through government, academia, and industry collaboration.

Established by Congress under the FAA Research, Engineering, and Development Authorization Act of 1990 (P. L. 101-508) and the Aviation Security Improvement Act of 1990 (P.L. 101-604), aviation research grants are an essential mechanism to advance critical research for the long-term growth of civil aviation

and aerospace. The program funds academic and nonprofit research institutions to conduct innovative applied research in scientific and engineering disciplines relevant to the FAA mission. This research allows the agency to gain knowledge and understanding of current and emerging topics. Aviation research grants and cooperative agreements focus on innovative research that the FAA Administrator considers key to the long-term growth of civil aviation or research that is focused on preventing catastrophic failures. This year, the agency awarded $1M in aviation research grants/cooperative agreements.

## *4.2 Federal Highway Administration [FHWA]*

FHWA embraces a culture of innovation and actively supports and advances innovation across the broad range of its activities, devoting approximately 10 percent of its staff-years to conducting T2 activities annually. 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 in each state provide technical assistance to FHWA's state and local partners to deploy innovations. FHWA's Federal Lands Highway program works with Federal partners like the National Park Service to deploy transportation innovations on Federal lands.

FHWA works through multiple programs and initiatives to transfer technological improvements and innovative practices to state and local DOTs that are responsible for construction, operations, 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:

1. Identification and development of innovative technologies and practices, and
2. Transfer of innovation at the Federal, state, and local levels.

FHWA T2 efforts are implemented via the agency's programs, and services listed below, each of which is detailed in the following sections:

- Office of RD&T at the Turner-Fairbank Highway Research Center (TFHRC)
- Every Day Counts
- FHWA Resource Center
- Advanced Transportation and Congestion Management Technologies Deployment Program
- Accelerated Innovation Deployment Demonstration Program
- State Transportation Innovation Council (STIC) Incentive Program
- ITS Professional Capacity Building Program

### 4.2.1 Office of Research, Development, and Technology

The FHWA's Office of RD&T is located at the TFHRC, a federally owned and operated national research facility. The center houses 15 laboratories and support facilities, and conducts applied and exploratory advanced research in:

- Vehicle-highway interaction
- Nanotechnology
- Safety
- Pavements
- Highway structures and bridges
- Human-centered systems

- Operations
- Intelligent transportation systems, and
- Materials.

### 4.2.2 Every Day Counts

A State-based program, Every Day Counts (EDC) identifies, rapidly transfers, and deploys proven but underutilized innovations that make our transportation system adaptable, sustainable, equitable and safer for all. Every two years, FHWA works with state, local, Tribal, and territorial transportation departments to identify a new collection of innovations to promote. FHWA then provides technical assistance, training, and other resources to support the implementation and widespread adoption of the innovations identified.

### 4.2.3 FHWA Resource Center

The Federal Highway Administration's Resource Center is home to the agency's expert task force. The Resource Center helps FHWA's Division Offices, state DOTs, metropolitan planning organizations, and other transportation partners in overcoming challenging technical and partnership hurdles by providing personalized technical assistance, customized training, and ongoing support. The expert technical teams introduce and support the implementation of new innovations and share their vast knowledge of national and international best practices.

### 4.2.4 Advanced Transportation and Congestion Management Technologies Deployment Program

The Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Program awards competitive grants to develop model deployment sites for the implementation of cutting-edge transportation technologies. In FY 2021, the program awarded 10 grants totaling $49.6 million for projects ranging from advanced real-time traveler information to integrated corridor management and vehicle communications technologies. From FY 2016 to FY 2021, the program provided $256 million to projects in multiple states. FHWA opened the competition for the sixth round of awards in June 2021.

### 4.2.5 Accelerated Innovation Deployment (AID) Demonstration Program

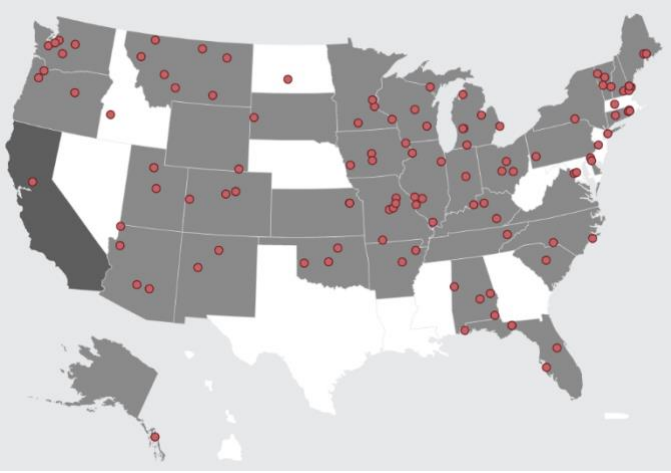


**Figure 1.** Map of locations of AID demonstration projects

The Accelerated Innovation Deployment 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. To date, FHWA has awarded 127 AID Demonstration grants worth over $95.8 million.

### 4.2.6 State Transportation Innovation Council (STIC) Incentive Program

FHWA fosters collaboration between stakeholders within the transportation community through the STIC Incentive Program, which brings together public and private transportation stakeholders in each state to evaluate innovations and spearhead their deployments. The STIC Incentive Program funds up to $100,000 to 125,000 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.

## *4.3 Federal Motor Carrier Safety Administration [FMCSA]*

The primary mission of the Federal Motor Carrier Safety Administration (FMCSA) 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 its:

- Research & Technology Program
- Innovative Technology Deployment Grant Program
- Automated CMV Research

These programs are detailed in the following sections.

### 4.3.1 Research & Technology Program

FMCSA's Research & Technology (R&T) Program develops the knowledge, practices, and technologies to improve enforcement technologies and 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 commercial motor vehicles (CMVs) through technological innovation and improvement,
- Improve the technology used by enforcement officers when conducting roadside inspections and compliance reviews, and
- Facilitate the training or education of CMV safety personnel.

### 4.3.2 Innovative Technology Deployment Grant Program

The Innovative Technology Deployment (ITD) Grant Program is FMCSA's key mechanism for transferring proven enforcement technologies into operational systems for the states. Each year, ITD provides up to $20 million in funding for states to deploy, support, and maintain ITS and commercial vehicle information systems and networks. Grant priorities include deploying:

- Work-zone and incident electronic notification systems,
- CMV truck parking notification systems, and
- Thermal imaging technology to detect inoperable, defective, or deficient brakes, tires, or exhaust systems that may cause unsafe conditions.

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. As another example, ITD helped to implement a communications and data exchange mechanism to facilitate communicating safety and credentials within and among states, Federal agencies, and motor carriers. ITD also assisted in the implementation of cameras that can help identify noncompliant trucks by reading license plates and U.S. DOT numbers on trucks while they are traveling at highway speeds.

### 4.3.3 Automated CMV Research

FMCSA conducts research to accelerate the testing and deployment of proven safety technologies, like automatic emergency braking 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 automated CMVs and truck platoons to further validate the safety of these technologies and support their deployment.

## *4.4 Federal Railroad Administration [FRA]*

The mission of FRA's Office of Research, Development, and Technology (RD&T) program is to ensure the safe, efficient, and reliable movement of people and goods by rail through applied research and to develop innovations and solutions to rail transportation problems. Safety is the primary U.S. DOT priority and the principal driver of FRA's RD&T program. FRA develops technology that its inspectors use to enforce safety regulations. Other technologies developed by FRA have been 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. Suppliers to the rail industry usually use FRA prototypes to create commercial products.

FRA encourages industry involvement in its R&D program and coordinates its technology development and deployment activities with the rail industry. FRA works closely with industry stakeholders throughout the R&D life cycle to increase user adoption of research products and services. FRA directly supports technology development and implementation (Technology Readiness Level) and is integrated with the research project life cycle through planning, stakeholder engagement, resource identification, and research activity execution. Understanding industry stakeholder needs and potential barriers to adoption allows FRA Program Managers (PMs) and stakeholders to effectively communicate the value and benefit of FRA research products. PMs create partnerships across the industry, increasing the likelihood of technology adoption. As the subject matter experts (SMEs) in their respective areas, PMs work with internal and external stakeholders to develop new technology. RD&T will continue to share information with the railroad industry through conferences, working groups, seminars, webinars, symposia, and summits. In FY 2022, the FRA Track Research Division conducted its first Track Support and Substructure Symposium, a virtual, all-day event, providing academia, suppliers, researchers, and industry the opportunity to learn more about RD&T research.

FRA's Transportation Technology Center in Pueblo, Colorado, a 55 sq. mile test facility, is where a good portion of FRA T2 originates. It has over 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. TTC is at the forefront of rail vehicle safety and dynamics research. Its Impact Facility is where freight and passenger railcars undergo full scale rigorous crashworthiness and crash energy management testing to ensure the

safest active fleets possible. TTC also has one-of-a-kind machines – the Simuloader, Mini-Shaker Unit, Vibration Test Unit, and Squeeze Test Fixture – for structural characterization of trucks and carbodies. When combined with on-track testing, researchers can continue to put new or improved rolling stock through the paces before entering service. Over time, FRA plans to expand training capacity and capabilities at TTC to accommodate other specialized areas such as Positive Train Control, autonomous vehicles, tank car quality assurance, grade crossings, emergency response to accidents and accident investigations.

Most of FRA's RD&T research results are described in technical reports published in FRA's eLibrary, which makes research results accessible to the railroad industry and the public. Some RD&T contracts include funding for vendors to disseminate RD&T research results at various events. Information regarding RD&T work can also be found on the OST-R Research Hub. In FY 2018, FRA RD&T amended its process and began publishing research to the National Transportation Library to ensure that research results are widely available and searchable. In FY 2022 and FY 2023, updates were collected on RD&T projects to highlight potential successes as projects reached their completion date.

## *4.5 Federal Transit Administration [FTA]*

The Federal Transit Administration's (FTA's) research activities are designed to respond to issues facing public transit systems today and in the future. FTA continues to focus on three broad research program areas: safety, infrastructure, and mobility innovation. FTA prioritizes research spending on demonstration and deployment activities—usually approximately 70 percent of available research funds. This enables FTA to test promising research findings with public transit agencies. The evaluation of demonstration programs provides information that helps encourage transit agencies to implement potential solutions.

An essential part of FTA's national leadership role is to ensure that promising research findings and technologies benefit public transportation. FTA uses a variety of mechanisms to cultivate relationships with key parties and disseminate research results. Speakers share information about research findings at key industry events. FTA also publishes research reports and posts them on its website. FTA conducts webinars in-house and through partner organizations. Additionally, in the mobility innovation research program, FTA funds the Shared-Use Mobility Center for a project called the Innovation and Knowledge Accelerator (IKA), which is a structured, supported learning and information exchange system. The IKA also includes an initiative to enable colleagues to exchange information via communities of practice. Similarly, FTA is phasing in a standardized approach for disseminating research results in the safety and infrastructure program areas.

## *4.6 Intelligent Transportation Systems Joint Program Office [ITSJPO]*

The Intelligent Transportation Systems Joint Program Office (ITS JPO) is responsible for conducting research on behalf of U.S. DOT and all surface modes to advance transportation safety, mobility, and environmental sustainability through electronic and intelligent transportation applications. As new ITS technologies and systems evolve into market-ready products, ITS JPO addresses issues associated with adoption and deployment. The office works closely with those deploying ITS technologies to ensure a smooth transition, from initial adoption (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. ITS JPO's primary mechanism for educating the transportation workforce about ITS is the Professional Capacity Building (PCB) Program.

### 4.6.1 ITS Professional Capacity Building Program

ITS is constantly evolving as new technologies emerge and existing technologies become more ubiquitous. The ITS PCB program offers a number of in-person and web-based trainings (available on the ITS PCB Website (www.pcb.its.dot.gov). Recent trainings developed in collaboration with the National Highway Institute (NHI) include:

- ITS: What, Why, and How
- Improving Highway Safety with ITS
- ITS Cybersecurity Training *(in development)*
- ITS Systems Engineering Training *(in development)*

The ITS PCB Program is also working to promote ITS's role in the Safe Systems Approach. A series of **ITS and Safety Micro-Learning videos** are being developed to highlight the role of ITS in addressing safety challenges. Plans are also underway to set-up Peer Exchanges to bring together representatives from state and local agencies to share lessons learned and best practices for advancing ITS deployments that address real-world transportation safety challenges.

Advancing the deployment of vehicle-to-everything (V2X) technologies is a priority of the ITS JPO. As such, the ITS PCB Program is developing new **Interoperable Connectivity (or V2X) in-person trainings** that will be delivered at ITS State Chapters and other conferences/events. These trainings are being developed modularly and will accommodate a variety of topics ranging from V2X Basics to more technical topics. The ITS JPO is also working with staff at the Turner Fairbank Highway Research Center (TFHRC) to develop V2X tools and provide technical assistance to deployers – along with an equipment loan program. A variety of V2X outreach materials are being developed to assist state and local agencies advance the deployment of V2X technologies.

A newer offering of the ITS PCB Program, the **Accelerating V2X Cohort** was stood up to allow representatives from state and local agencies share their experiences, challenges, best practices, and documentation as they deploy V2X technologies. Sharing this knowledge will assist future deployers in understanding some of the technical challenges related to deployment so they can more easily deploy consistent and interoperable systems. The cohort consists of over thirty public agencies with active V2X projects, many funded by U.S. DOT Grants.

The ITS PCB Program also partners with academic institutions to assist in training the future workforce. The program recently stood up the **ITS Academic Cohort** consisting of representatives from university, community college, and technical and trade school programs to discuss how best to incorporate relevant topics into curricula. The ITS PCB Program is working with this group to review and pilot existing ITS PCB academic resources; discuss teaching practices; and identify critical gaps and opportunities for developing new resources. In collaboration with the National Operations Center of Excellence (NOCoE) and institute of Transportation Engineers (ITE), the ITS PCB Program also conducts a student competition – the Transportation **Technology Tournament (TTT)**. The TTT enables student teams to work directly with public agencies to solve real-world transportation problems utilizing ITS and TSMO solutions and approaches. By participating in the tournament, students gain real-world experience in ITS while networking with transportation professionals.

## *4.7 Maritime Administration [MARAD]*

The Maritime Environmental and Technical Assistance (META) program of the Maritime Administration (MARAD) partners with Federal, state, and local agencies, the maritime industry, and academia to execute projects that provide all concerned parties with useful information and insight on maritime

environmental issues. For the most part, this 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 research findings to industry. MARAD is also partnering with ITS JPO for joint T2 activities to assist ports in the planning, funding, and deployment of ITS applications.

Technology testing, validation, and verification are fundamental parts of the META program. These activities generate information about the costs, benefits, and performance of technologies, which assists industry in choosing among technology options and making decisions regarding capital investments. At the same time, META provides opportunities that are otherwise unavailable to innovators to perform R&D outside of the laboratory in real or near-real operations.

MARAD makes test results, reports, studies, and industry guidelines available through its website, the Research Hub, and most partners' websites. Technical papers from the projects are regularly presented to journals, industry magazines, the Transportation Research Board, and other public venues.

## *4.8 National Highway Traffic Safety Administration [NHTSA]*

Within NHTSA, the Office of Vehicle Safety Research conducts research and tests the safety performance of motor vehicles and motor vehicle equipment to help the agency develop data-driven policies, safety standards, guidance, and best practices to improve roadway safety. NHTSA's research portfolio includes advanced vehicle safety technologies to address human behavioral concerns, including distracted and impaired driving; reliability and security of complex safety-critical electronic control systems; vehicle cybersecurity; new and emerging technologies, including advanced driver assistance systems and Automated Driving Systems. The Agency uses several strategies for deploying its research and technology results. These range from technology demonstrations and field tests to behavioral research. In 2019, NHTSA revamped its process for the dissemination of research products. It now includes dedicated personnel to ensure work products are placed into the U.S. DOT Research Hub and the National Transportation Library (NTL) Digital Library.

NHTSA T2 efforts are focused in the areas listed below, each of which will be detailed in the following sections:

- Technology demonstrations and field tests
- Behavioral safety research
- Vehicle research and testing

### 4.8.1 Technology Demonstrations and Field Tests

NHTSA has a long history of evaluating new vehicle technologies in the field to collect data on their real-world performance and user acceptance. Recent field tests are focused on Advanced Driver Assistance System (ADAS) technologies, such as crash avoidance (e.g., Automatic Emergency Braking, Lane Keeping Assist), driver assistance (e.g., Adaptive Cruise Control, Lane Centering Assistance), and partial driving automation (i.e., SAE Level 2) features for light and heavy vehicles. Examples include:

- Heavy Vehicle Collision Avoidance System Field Study: Field study of latest generation collision avoidance systems, including Automatic Emergency Braking and Lane Departure Warning, on Class 8 heavy trucks to assess system performance and opinions of commercial fleet operators.
- Telematics-Based Field Studies of Vehicle Systems: Field studies leveraging highly detailed telematics data from participating manufacturers to assess system performance and usage of

partial driving automation systems and other ADAS features.

### 4.8.2 Behavioral Safety Research

The purpose of the behavioral research conducted by NHTSA is to find ways to change the behavior of drivers and other roadway users to increase safe behavior (e.g., seat belt use) and reduce unsafe behaviors (e.g., alcohol- and drug-impaired driving). This research provides the scientific basis for state and community traffic safety programs. Behavioral safety research has contributed significantly to the widespread adoption of numerous programs proven to reduce crashes. Examples include:

- National Click It or Ticket Program
- Adoption of standardized field sobriety tests by law enforcement officers
- Passage of primary seat belt and distracted-driving laws
- Advancement of graduated driver licensing laws
- A greater understanding of older-driver issues, and
- Development and testing of effective pedestrian and bicyclist safety programs.

### 4.8.3 Vehicle Research and Test Center

Staff at the Vehicle Research and Test Center (VRTC), NHTSA's in-house laboratory, conduct research and vehicle testing, supporting NHTSA's mission to save lives, prevent injuries, and reduce traffic-related crashes and other economic costs. Research and testing activities conducted at the VRTC support agency decisions and actions with respect to:

- New vehicle systems and issues
- Consumer information programs
- Development of test dummies
- Injury criteria development, and
- Safety issues that require quick reaction or are sensitive in nature (e.g., defect investigations and cybersecurity).

The full range of testing and research capabilities available at VRTC allows the agency to study emerging safety issues rapidly and provide benefits to the American public quickly.

## *4.9 Pipeline and Hazardous Materials Safety Administration [PHMSA]*

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 of the transportation of hazardous materials. PHMSA has a consensus-based, collaborative RD&T program that is bringing new technology to market and is helping to strengthen pipeline integrity. PHMSA investment continues beyond proof of concept and concludes when the pre-commercial technology is effectively demonstrated in the intended operating environment.

Through its R&D awards, PHMSA mandates several steps for researchers to undertake to promote project results. Mandated actions include promoting commercialization at the end of the contract, such as demonstrating a technology in front of pipeline operators, equipment vendors, standards organizations, and pipeline safety officials. In addition, all technical reports produced through PHMSA-sponsored research are promoted to decision makers and key entities via trade journals, public conferences, or other industry events. PHMSA also publishes pipeline research on the website for its research program, as well as in the U.S. DOT Research Hub and NTL Digital Library. To date, PHMSA has

35 commercialized technologies as a result of its Pipeline R&D projects.

PHMSA held an R&D Forum and a “Public Meeting” from October 31 through November 1, 2023. Approximately 175 stakeholders attended in person, and an additional 406 attended virtually. The Forum included presentations and exhibits from 23 recipients of PHMSA R&D funding for research projects to communicate the technologies and results of its research.

# 5 Success Stories

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

## *5.1 Federal Aviation Administration [FAA]*

The following FAA success stories highlight U.S. DOT-funded research results deployed in a wide range of transportation settings, producing U.S. public benefit.

### 5.1.1 Improved Aviation Fire Survivability

Over the last 50 years, the likelihood of death by fire in a survivable aviation accident has dropped by more than 50 percent. The FAA is working to eliminate all aircraft fire hazards, whether from cabin components (seat cushions, wiring, and storage bins) or post-crash impacts. Research is being conducted across five program areas: cargo fire safety, hazardous materials fire safety, propulsion power and fuels fire safety, materials flammability and cabin safety, and advanced fire research. The research aims to improve passenger safety by making the aircraft more resistant to fire and developing detection systems to suppress or extinguish a cabin fire, allowing for an aircraft's safe landing. Since aviation fire safety is a global issue, the FAA and several international airworthiness authorities, including Transport Canada Civil Aviation, the United Kingdom Civil Aviation Authority, European Union Aviation Safety Agency, Brazil's National Civil Aviation Agency, Australia's Civil Aviation Safety Authority, and the Civil Aviation Authority of Singapore, have partnered on research to advance safety through the Fire and Cabin Safety Research Group. The agency has also developed a Fire Safety website as a hub for aircraft fire safety knowledge, containing decades of laboratory research and updated with the most recent findings.

*An FAA fire safety technician exposes aircraft materials to an open flame.*

*The FAA uses actual aircraft fuselages and cargo compartments to test and evaluate causes of aviation fires and the latest means of suppression and prevention.*

**Figure 2. FAA fire safety tests. (Source: FAA)**

### 5.1.2 Greener Aviation Fuels

Removing lead from gasoline across more than 175 countries has achieved $2.4 trillion in health, social and economic benefits. Hi-octane, leaded aviation gasoline (avgas) is the only remaining transportation fuel in the United States that contains lead. In the fall of 2023, the Environmental Protection Agency (EPA) announced a final endangerment finding that airborne emissions from leaded avgas pose a public health hazard. The FAA is collaborating with the EPA to develop companion regulations and a final timeline for banning lead in aviation fuels. The FAA has already commenced an action under the Eliminate Aviation Gasoline Lead Emissions (EAGLE) initiative to safely eliminate leaded aviation fuel by the end of 2030 without adversely affecting the existing piston-engine fleet. In 2023, the agency completed pre-screening testing on the UL100E fuel which successfully passed detonation testing and a 150-hour engine durability test at the FAA's William J. Hughes Technical Center under the Piston Aviation Fuels Initiative (PAFI), a collaborative industry/government testing program. This is the first unleaded fuel to pass the PAFI 150-hour durability pre-screening test and a major step toward full-scale testing and a defined pathway to a fleet authorization of unleaded avgas in accordance with Section 565 of the 2018 FAA Reauthorization Act.

### 5.1.3 Accurate Fuel Flow Rates Help Reduce Impact to the Environment

The Aviation Sustainability Center (ASCENT) developed a new methodology to accurately calculate fuel flow rates for commercial jet taxi operations at airports. This new methodology has been published by SAE International, an international aerospace standards-setting organization, and is now incorporated into FAA's Aviation Environmental Design Tool (AEDT). Accurately calculating fuel flow rates for commercial jet taxi airport operations – which are movements of aircraft while on the ground under its own power – is important because it helps reduce fuel consumption and emissions. Fuel burn during taxi operations is a significant

**Figure 3. ASCENT Logo**

contributor to total fuel burn for commercial aircraft. The ASCENT Center of Excellence is a cooperative aviation research organization co-led by Washington State University and the Massachusetts Institute of Technology. The center is funded by the FAA, NASA, the Department of Defense, Transport Canada, and the Environmental Protection Agency. The center works to create science-based solutions for the aviation industry's biggest challenges.

### 5.1.4 Keeping The Air Safe Up There

In rare instances, certain mechanical issues can cause fumes (from engine oil, hydraulic fluid, or deicing fluid – known as bleed air contaminants) to enter an aircraft cabin. These contaminants can lead to serious symptoms such as dizziness, fatigue, headaches, and impaired vision. The FAA conducted vital research to evaluate sensor technologies that warn of bleed air contamination, as well as chemical sampling to assess the potential health effects of these contaminants. FAA researchers from the William J. Hughes Technical Center and the FAA Office of Aerospace Medicine teamed with Kansas State University, the U. S. Navy, and industry participants including Air Sense Avionics, Pegasor, Syft Analytics, Honeywell, Boeing, and Pratt and Whitney to conduct the research. In support of this multi-year, multi-phase project, in May (pictured) researchers conducted tests on a grounded Boeing 747 airframe to assess the reliability and accuracy of sensor technologies with the potential to warn of bleed air contamination in the cabin. Engine and auxiliary power unit (APU) bleed air was used as it heats and cools the aircraft cabin and flight deck in commercial transport aircraft. A malfunction with either the engine or APU can result in the ingestion of oil or hydraulic fluid into the bleed air stream, potentially contaminating passenger-occupied spaces. The results are an important step in identifying potential techniques to prevent contamination events and improve the quality of cabin air for the flying public.

### 5.1.5 FAA Keynote Speaker Shares Expertise at International Conference

Dr. Richard Lyon, a Fire Safety Branch researcher at the William J. Hughes Technical Center, was honored as the keynote speaker at the 19th European Meeting on Fire Retardant Polymeric Materials. This biennial conference was hosted by the Swiss Federal Laboratories for Material Science and Technology in Dübendorf, Switzerland on June 26-29, 2023. More than 200 participants from around the world attended the 4-day meeting, which included 139 oral and poster presentations on new developments in flame retardants for polymeric materials (plastics) used in transportation, electric vehicles, additive manufacturing, and telecommunications, with emphasis on environmental impact. Dr. Lyon's keynote speech described the innovative FAA research using a physical burning model to relate bench-scale and microscale combustion measurements, as well as to identify material and product-specific parameters that can be used to rank flammability. Earlier in 2023, Dr. Lyon and two colleagues were awarded a patent (US11579103B2) for their innovation. Dr. Lyon also co-chaired the "Flame Retardant Innovations in Emerging Markets" session and participated as a member of the Scientific Committee. This is another example of an FAA researcher sharing their expertise for the benefit of the American public and international community.

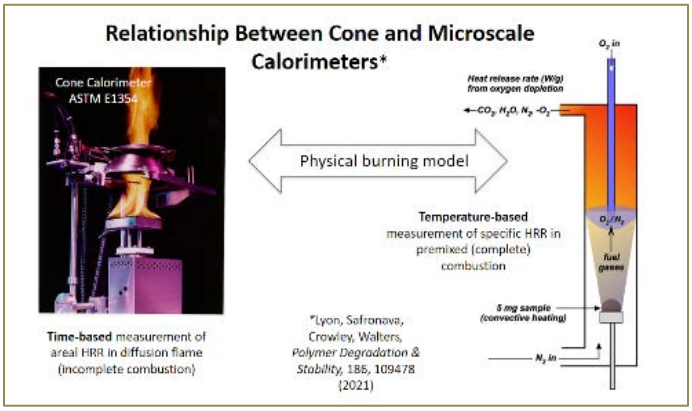



**Figure 4. Cone and Microscale Relationship. (Source: FAA)**

### 5.1.6 Paving the Way for electric Vertical Takeoff and Landing (eVTOL) Vehicles

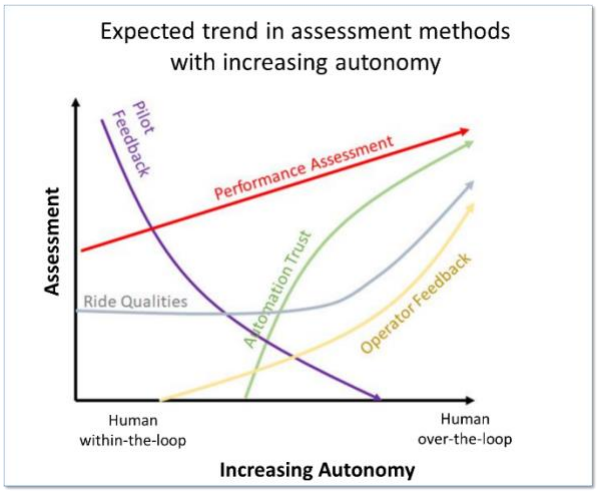



**Figure 5. Increased Autonomy Trend Line. (Source: FAA)**

The aviation industry is on the cusp of a revolution with the advent of electric vertical takeoff and landing (eVTOL) and advanced air mobility (AAM) vehicles. Many established companies and startups are pursuing this new technology. The FAA, in collaboration with Federal agencies and industry, is working to meet the expected demand for these new entrants. However, these vehicles, which almost exclusively feature fly-by-wire flight control systems with advanced flight control system response-types, are very different from existing aircraft. There is a critical need to develop a new certification process to ensure that eVTOL and AAM vehicles can operate safely within the National Airspace System (NAS). In 2023, the FAA published an 85-page report to ensure compliance of eVTOL vehicles. Developing Means of Compliance for eVTOL Vehicles: Phase II Final Report is the result of ongoing research conducted by FAA researchers from the William J. Hughes Technical Center Software and Systems Branch and engineers from the Compliance and Airworthiness Division in the Central Regional Office. The report documents a mission-oriented approach to defining Handling Qualities Task Elements that will serve as a means of compliance for eVTOL aircraft under FAA Part 23 certification requirements. The team developed a representative eVTOL configuration and simulated flight test maneuvers to research control law transitions, envelope protections, and automation. The results are an important step in implementing an effective process to ensure these new vehicles can safely and effectively operate in the NAS.

## *5.2 Federal Highway Administration [FHWA]*

### 5.2.1 Next-Generation Traffic Incident Management

Every year in the United States, there are an estimated 6 million collisions reported by police, 32 million motorist assists, and 174,000 vehicle fires. Each incident places responders and motorists at high risk of secondary collisions at the scene or in the queue behind a prior incident. These incidents also cause congestion, negatively impacting the economy and the public's quality of life. Traffic incident management (TIM) has become the state of the practice to reduce the dangers and mitigate the impacts of incidents.

Through its Every Day Counts program, FHWA is helping its state, local, and Tribal partners take TIM to the next level using innovative approaches that will continue to improve safety and travel reliability while saving lives, time, and money. Next-generation traffic incident management (NextGen TIM) increases the focus on local agency TIM programs while integrating new and emerging technology, tools, and training strategies. It enables agencies to improve TIM strategies by implementing new options such as back-of-queue warning, navigation-app notification of active responders in the vicinity, notification-based incident detection using crowdsourced data, and more.

#### *5.2.1.1 Applying TIM Locally*

Although TIM efforts have been focused on high-speed roadways, the concepts of TIM are applicable to all roads. NextGen TIM applies TIM to local roadways by encouraging the application of low-cost

solutions like stakeholder meetings, development of policies and procedures, and participation in TIM training. When officers from the Oro Valley Police Department in Arizona became focused on TIM practices and began tracking TIM-related metrics in computer-aided dispatch (CAD), roadway and incident clearance times were reduced by 32 percent during the first six months of 2018.

#### *5.2.1.2 Promoting TIM Training*

**Figure 6. TIM strategies are applicable on local as well as high-speed roads. (Source: Grady Carrick)**

NextGen TIM continues to promote TIM training with innovative remote delivery approaches and new content. NextGen TIM strives to institutionalize training through policies, ensuring training will continue even after TIM training champions move on [6]. Technology-focused training will be available to supplement the National Responder Training Program. TIM-related lessons will provide information on integrated CAD, unmanned aerial systems (UAS), connected and automated vehicles, TIM data collection and use, and traffic management centers (TMCs). The Arizona Highway Patrol estimates that by implementing training and other TIM strategies, it saves 44,000 hours of patrol time per year, the equivalent of about 25 full-time officers.

#### *5.2.1.3 Advancing Data Use*

NextGen TIM focuses on advancing the collection, analysis, and use of incident data. With better data and analytics, agencies can quantify program performance, demonstrate program effectiveness, and improve TIM planning and resource management. TIM data can come from public safety CAD system time stamps, police traffic crash reports, or TMCs. Real-time data dashboards are an effective way to analyze and present data to promote organizational goals. Georgia reduced clearance times for commercial vehicle crashes by 82 percent with data from its Towing Recovery Incentive Program. Puerto Rico deployed a mobile app for safety service patrols to augment the exchange of incident data and accurate reporting.

#### *5.2.1.4 Integrating Technology*

CAD integration facilitates the timely sharing of information between public safety and transportation agencies and improves coordination of resources, traveler information, and safety. CAD integration streamlines and improves analysis and reporting of TIM performance measures and reduces time for law enforcement agencies to notify the public. CAD integration also allows departments of transportation (DOTs) to mobilize resources faster, improve traveler information, and enhance the depth and accuracy

6 https://www.fhwa.dot.gov/goshrp2/Solutions/Reliability/L12_L32A_L32B/National_Traffic_Incident_Management_Responder_Training_Program

of data for performance analysis.

**Figure 7. Using measurements from photos captured by unmanned aerial systems accelerates crash investigations. (Source: North Carolina Department of Transportation)**

Unmanned aircraft systems (UAS) reduce responder time on incident scenes, accelerate crash investigations, and offer a cost-effective measuring and mapping alternative. UASs are remotely controlled by a pilot and can be easily flown over a traffic crash scene to capture high-definition images. UAS image processing is capable of photogrammetry, in which measurements can be taken from the images. Using known measurements in the UAS image allows measurement between any two points in the image. In North Carolina, the Highway Patrol and state DOT found that UAS mapped a two-car crash in 25 minutes, while three-dimensional laser mapping required nearly two hours.

Additional technologies include video-sharing and alert systems. Video sharing allows cameras mounted on service patrol vehicles to stream images from incident scenes to TMCs, as well as TMC images back to responder vehicle computers. Responder-to-vehicle alert systems improve safety by increasing advance warning of incidents. When responder vehicles are stopped along roadways, approaching drivers can be warned through in-vehicle navigation providers that receive alerts when responder vehicle emergency lighting is activated.[7]

### 5.2.2 Advancing Project Bundling — O Momentum[8] [9]

Transportation agencies are using project bundling to capitalize on economies of scale more often and on more diverse projects than ever before. Project bundling streamlines project delivery by combining environmental analysis and permitting, design, and contracting for greater efficiency. Some state, local, and tribal agencies have used their past successes to develop business rules for selecting bundles early in the planning and programming process. This creates agency-wide efficiencies by making project bundling a standard way of doing business.

FHWA has created tools to help agencies implement a more advanced approach to project bundling. A self-assessment resource is now available to help an agency work its way from a developing program to one in which bundling is the standard for delivering a program of projects. The self-assessment is based on 25 nationally proven practices, each linked to resources in a project bundling resource database that includes case studies, contracts, programs, and research. The database is available on FHWA's Bundled Facilities Overview web page, along with case studies, webinars, and lessons learned on bundling programs.[10]

[7] Additional reference: Talking TIM webinar series
[8] In this EDC Outtake, Royce Meredith of the Kentucky Transportation Cabinet (KYTC) describes how KYTC is expanding its use of project bundling. https://www.youtube.com/embed/Ry5LjSSn3NI?feature=oembed
[9] Advanced Project Bundling: Examples Beyond Bridges webinar, https://connectdot.connectsolutions.com/plvv4usybsts/
[10] Royce Meredith of the Kentucky Transportation Cabinet describes its use of project bundling.

#### *5.2.2.1 Bundling Beyond Bridges*

Bridge bundling took the spotlight in recent years due to the backlog of bridges in poor condition. For example, the Oregon DOT identified 271 bridges for replacement and strategically bundled the projects based on location and work type. Bundling three bridges on Interstate 5 over the Willamette River saved an estimated 16 percent, or $31 million.

**Figure 8. This roadway in Oakwood, GA, was improved as part of the city's pavement management. (Source: City of Oakwood, GA)**

The focus has now expanded to "project" bundling, which includes projects to alleviate traffic bottlenecks, replace culverts, create smoother pavements, address safety hot spots and high-risk rural roads, and make lighting, sign, and Americans with Disabilities Act (ADA) improvements.

Minnesota DOT removed the ADA scope from three proposed paving projects in the same city and bundled them into a new, single project that included 150 ADA ramps and sidewalks. The agency has also bundled bridges, signs, maintenance projects such as noise walls, and rural intersection safety equipment.

The city of Oakwood, Georgia, with a population of 4,000 and 22 lane miles of pavement, partnered with nearby cities to lower costs associated with pavement management and preservation treatments. Combining work with neighbors increased the scale of the project, attracting more bidders and reducing the cost of milling by nearly 80 percent.

Indiana DOT (INDOT) adopted project bundling as a standard practice based on historical data that demonstrated value when projects are bundled well, and it is incorporating artificial intelligence to further expand project bundling benefits. A machine-learning platform uses INDOT's historical and asset management data, along with business rules, to automate and optimize bundle selections over multiple program years. This approach has increased bundling savings by 40 percent and is expected to save INDOT $108 million over the next 4 years.[11]

### 5.2.3 Advancing Effective Contracting Method Alternatives[12] [13]

Traditionally, highway projects have been let by state DOTs and local agencies after the design is completed and awarded to the lowest responsive bidder, a contracting method known as design-bid-build (D-B-B). As part of Special Experimental Project Number 14, FHWA has partnered with state DOTs to explore contracting options that better deliver projects of an increasingly complex nature. Although D-B-B is still the prevalent method, several alternatives have proven more effective for design-construction collaboration, addressing risk, and incorporating innovation by involving contractors earlier

[11] View the Advanced Project Bundling: Examples Beyond Bridges webinar to learn more about the Indiana, Minnesota, and Oakwood, GA, projects.

[12] Example: The Sellwood Bridge project in Multnomah County, OR, used CM/GC contracting to incorporate innovations such as slide-in bridge construction and 3D modeling.

[13] Example: This Colorado DOT U.S. 550–U.S. 160 Connection South project video includes a segment on why the agency chose to use D-B contracting.

in the process. The result, as confirmed by FHWA research, is better projects that deliver transportation benefits to the public faster and often for less cost.

#### *5.2.3.1 Expanding the Alternatives*

Through its EDC initiative, FHWA has highlighted several alternative contracting methods that facilitate earlier contractor involvement. These methods have since become standard practices for most state DOTs. The first two rounds of EDC promoted the alternative contract methods known as design-build (D-B) and construction manager/general contractor (CM/GC). With D-B, an agency identifies the scope of work, solicits for and receives proposals, and selects a D-B team to assume the risk and responsibility for the design and construction phases. In CM/GC, the agency hires a contractor to act as a construction manager during the design phase. They work together, along with the agency's independent cost estimator, to establish a price and schedule for the construction portion of the contract, during which the contractor acts as the general contractor. With this design-construction integration, early work packages allow the team to complete long-lead-time construction activities more efficiently.

EDC's second round also included alternative technical concepts (ATCs), a procurement procedure that allows proposers to submit innovative ideas during bidding that improve on the contracting agency's design or construction criteria. Agencies have used ATCs most effectively with D-B, and some have used them with D-B-B. Caltrans has estimated savings due to D-B ATCs of nine percent over a four-year program.

#### *5.2.3.2 Partnering for Success*

Every Day Counts (EDC) built networks between state and local agencies and other stakeholders that facilitated working together on these mutually beneficial initiatives. Peer exchanges and other activities allowed agencies already implementing alternative contracting methods to share lessons learned and effective strategies with those new to their use, increasing their chances of success. EDC also provided technical support through its deployment teams as well as FHWA funding opportunities for pilot projects and other deployment activities. The raised awareness and acceptance of alternative contracting methods by both agencies and industry accelerated adoption in many states. For CM/GC, when the second round of EDC began in 2013, there were 10 states with enabling legislation; now, there are around 30.

"We're also starting to see more contracts where agencies are using ATCs with D-B-B, and part of that is deciding which project is a good candidate," said John Huyer, FHWA Office of Infrastructure. "FHWA recently worked out a programmatic agreement with the Missouri DOT for promoting ATCs on D-B-B projects, and it's now in Missouri DOT's strategic plan. D-B-B ATC use is also branching off into other areas. For example, Michigan DOT has used it for controlling and maintaining traffic."

### 5.2.4 Crowdsourced Data to Improve Real-Time Roadway Monitoring

Crowdsourcing for operations turns transportation system users into real-time sensors on system performance, providing low-cost, high-quality data on traffic operations, conditions, and patterns. Public agencies at the Federal, State, and local levels are increasing their situational awareness and the quality. and quantity of operations data using crowdsourcing. Doing so enables agency staff to cost-effectively apply proactive strategies and make better decisions that lead to safer and more reliable travel. Thirty-eight States attained demonstration, assessment, or institutionalized stages of crowdsourcing for operations implementation in the fifth round of EDC (2019-2020).

Tennessee DOT (TDOT) has used crowdsourced data to detect crashes and stopped vehicles faster. In

conjunction with the University of Tennessee, TDOT used Waze speed, incidents, and traffic jam data to enhance queue detection techniques that previously relied on traditional intelligent transportation system (ITS) roadway sensors. Adding crowdsourced data greatly expanded the geographic coverage area and timeliness of TDOT's queue detection and response capabilities. The crowdsourced data enabled TDOT to identify the backs of queues 1.1 minutes faster on average than by just using ITS vehicle detectors and monitoring cameras at fixed locations.

By joining the Waze Connected Citizens Program (CCP), the Maryland Department of Transportation (MDOT) can more effectively share road closure incidents in real time with users of the application. MDOT has also begun archiving and analyzing crowdsourced data available through the CCP partnership for its potential to complement the agency's robust traffic monitoring systems. Findings from data verification efforts are confirming the value of investing in this new data source. MDOT expects analyses will inform future ITS infrastructure deployment, while real-time information will help more quickly detect and respond to incidents on freeway and arterial facilities.

### 5.2.5 Crowdsourcing for Advancing Operations

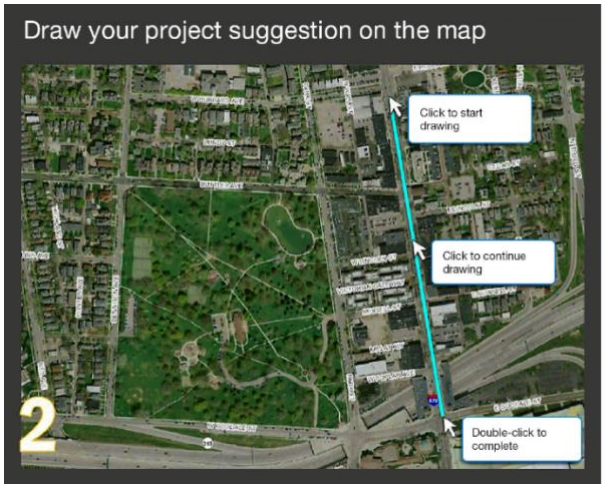
Crowdsourcing is a low-cost, powerful tool that leverages the public to collect data to improve traveler information, traffic incident management, signal timing, weather-responsive management, work zone management, and more. Crowdsourcing overcomes gaps in geographic coverage of traditional ITS monitoring systems, lags in information timeliness, monitoring equipment costs, and jurisdictional data stovepipes. FHWA promoted the use of crowdsourced data to improve operations during the fifth round (2019-2020) of its EDC initiative.

Agencies such as the Indiana Department of Transportation (INDOT) have found that even a single integrated, archived, and shared crowd-sourced data stream can transform traffic operations. INDOT processes speed data from 6,500 interstate and 35,000 non-interstate segments every minute to provide real-time dashboards for incident detection at traffic management centers (TMC). TMC operators also use the dashboards to monitor work zone delays, and law enforcement officers at work zone sites can monitor queues and identify potential crashes. The data feed real-time travel estimates for over 200 routes through dynamic message signs. In all, INDOT uses vehicle probe data for nearly a dozen operational capabilities.

INDOT stores the vehicle probe data and enables engineers to query the data for multiple purposes. Using the data, traffic engineers now prioritize corridors for signal retiming rather than simply retiming on a three-year cycle. The data supplant costly floating car studies to confirm signal timing improvements. Retiming the nine-mile U.S. 31 arterial corridor, for example, saved 116,000 hours a year in travel time, equivalent to $2.75 million. By using vehicle probe data, INDOT has begun retiring ITS devices and will eliminate 50 percent of roadside sensors. The agency will also forego a planned ITS field device expansion. INDOT will save $28 million in ITS infrastructure deployment costs and $750,000 per year in communications service and maintenance costs by using probe data.

### 5.2.6 Public Involvement Communication Tools for a 21st Century Audience

Involving the public in transportation planning and project development can help agencies accelerate project delivery by identifying concerns early in the decision-making process. Virtual public involvement strategies enhance agencies' efforts to engage the public by supplementing traditional processes such as face-to-face meetings with digital technology. Virtual public involvement strategies include mobile apps, project visualizations, crowdsourcing methods, virtual town halls, and mapping tools (as shown in 8).




*Credit: Mid-Ohio Regional Planning Commission*

**Figure 9. The Mid-Ohio Regional Planning Commission encouraged the public to offer project ideas by drawing on its interactive map. (Source: FHWA)**

During the fifth (2019-2020) and sixth (2021-2022) rounds of its EDC initiative, FHWA has promoted the adoption of new public involvement tools, including convenient virtual strategies. Twenty-three States are demonstrating and assessing virtual strategies to engage the public. Eight States have institutionalized virtual public involvement techniques and are using them regularly for planning and project development, including Colorado, Florida, Iowa, North Carolina, Ohio, Texas, Vermont, and Washington State.

For example, the Colorado DOT used virtual town halls to gather input for its statewide long-range transportation plan update, allowing the agency to easily reach urban, suburban, and rural stakeholders. Roughly 58,000 people participated in the virtual town halls, including 17,000 from rural regions. Additionally, the Mid-Ohio Regional Planning Commission developed an interactive map to gather input during the development of its metropolitan transportation plan, which yielded 300 suggestions from more than 700 people.

### 5.2.7 High-Friction Surface Treatments Reduce Roadway Departures

Transportation agencies are installing high-friction surface treatments (HFST), an early EDC innovation, as part of their focus on reducing rural roadway departures. HFST is a cost-effective safety countermeasure in which a polish-resistant aggregate such as calcined (heat-treated) bauxite aggregate is bonded to the pavement surface using a polymer resin binder to improve and maintain pavement friction, helping motorists keep better control in dry and wet driving conditions. HFST is used at locations with high risk for crashes—such as curves, ramps, and intersections—to reduce crashes and the related injuries and fatalities.

With funding from FHWA's Accelerated Innovation Deployment Demonstration program, South Dakota DOT deployed HFST as a lane departure countermeasure on four curves, including two on rural U.S. 14A in the Black Hills area. In the five years after the HFST application on one of the rural curves, no crashes have been reported, compared to 12 crashes during the five years before the HFST project. Because of the success of the pilot project, SDDOT expanded HFST to 15 locations that experienced crashes with winter road conditions as a contributing factor and saw a 66 percent crash reduction over three years. SDDOT has added HFST to its safety countermeasure toolbox and plans two HFST projects every other year, bundling them by region to obtain better pricing than for individual projects.

Pennsylvania DOT has installed HFST at about 500 locations statewide, including rural roads. A PennDOT

crash data analysis of 47 locations from seven contracts where HFST was installed found that for an investment of just over $3 million, the return in reduced fatalities, injuries, and property damage was more than $8.5 million. Injury crashes at these locations went from 190 to 71, a 63 percent decrease, and fatalities dropped from eight to zero.

## *5.3 Federal Motor Carrier Safety Administration [FMCSA]*

### 5.3.1 North American Fatigue Management Program

The North American Fatigue Management Program (NAFMP) was developed in 2000 by medical and sleep scientists from Canada and the United States. The program aims to prevent driver fatigue and eliminate fatigue-related crashes by offering easy-to-access online fatigue prevention training and education to commercial motor vehicle drivers, motor carrier executives and managers, freight shippers and receivers, dispatchers, driver managers, driver's spouses and families, safety managers, and trainers. In 2013, through a shared agreement between Transport Canada and FMCSA, the NAFMP was made available as a website and online interactive learning management system. Since then, it has been available at no cost to drivers, motor carrier safety officers and administrators, and government safety officials.

Over the years, responsibility for the support and operation of the NAFMP alternated between FMCSA and Transport Canada, which became contractually cumbersome and eventually led to an extended outage of the website and a significant drop in page views and overall utilization. In 2021, Transport Canada and FMCSA, working with the NAFMP Steering Committee, initiated the transfer of hosting and operation of the NAFMP to the Commercial Vehicle Safety Alliance (CVSA). Web traffic has increased significantly since CVSA adopted the site and made several functional and aesthetic enhancements in December 2021. CVSA initiated user outreach activities that included a press release to 17,000 contacts, trade press articles, and an interview in the Sirius XM Radio Road Dog Trucking with Dave Nemo. CVSA also held six webinars, two conference information sessions, two CVSA committee agenda inclusions, distributed handouts at three events, and moderated forums for each of the ten LMS Module courses. In the fourth quarter of 2021, there were 4,538 page views by 2,069 users, with a peak of 646 home page views on January 4, 2022.

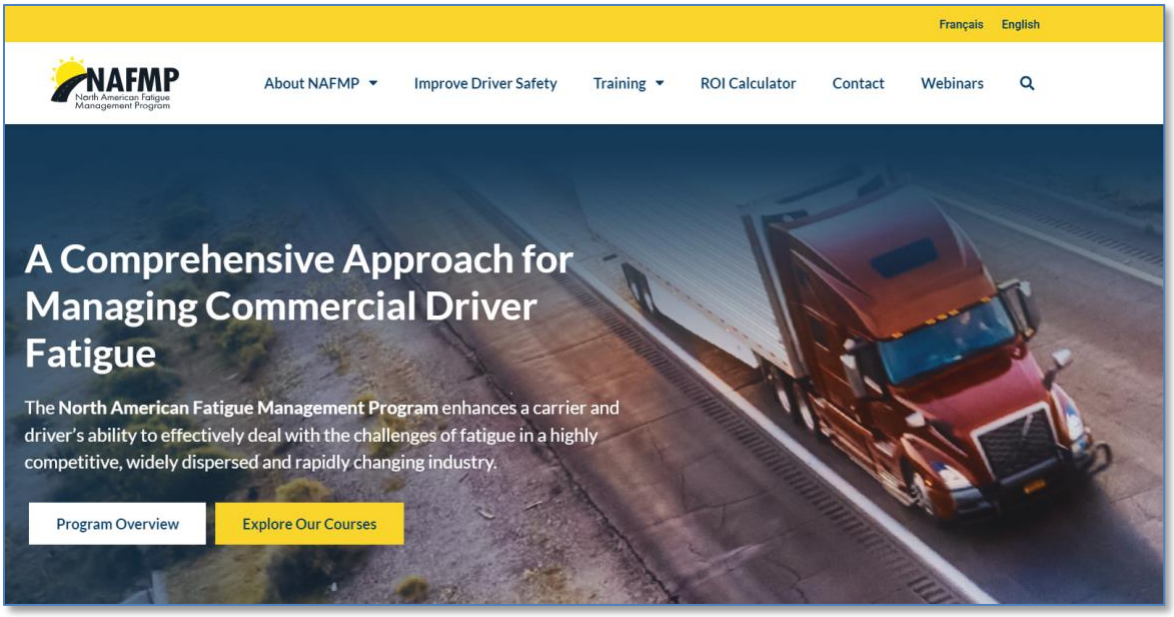



**Figure 10. Screenshot of NAFMP's homepage**

## *5.4 Federal Railroad Administration [FRA]*

### 5.4.1 Machine Vision Technology for Pre-stressed Wire Control

More than 10 years ago, Kansas State University received FRA funding through the Broad Agency Announcement program to research prestressed concrete for railroad ties. With additional resources coming from Nucor LMP, the research team created a special purpose 3D scanning system to improve railway safety.

The technology allows for the scanning, processing, and reporting of 24 inches of wire within microns of precision. The scanner can detect and collect 3 million measurements to identify geometric features that affect wire performance in pre-stressed concrete ties.

Insteel Industries, Inc., the nation's largest manufacture of steel wire reinforcing products for concrete applications, has ordered a system for one of its plants. Additional scanning machines are on order for other organizations.

### 5.4.2 Autonomous Drone Flight over Railroad Track

In a project beginning in 2021, FRA collaborated with VisioStack, Inc. to investigate using drones for certain track inspections. Drones have enabled FRA and the railroads to overcome limitations such as line-of-sight operations and lack of GPS coordinates. This research addresses Federal Aviation Administration (FAA) beyond visual line-of-sight restrictions on drones, which had previously been a limiting factor in their use in railroad applications. With this new technology, railroads will be better able to obtain FAA waivers to fly drones for longer-distance inspections.

Partnering with Florida East Coast Railway and CSX, VisioStack successfully completed an autonomous drone flight with the aim of potentially using drones for track inspection in June 2023. Two flights were conducted to showcase the drones automated machine vision capabilities and navigate the drone without the use of GPS or pilot input. The flights totaled over 8 miles at a speed of 22.4 mph, crossing

over obstacles such as power lines, both single and double-track lines, and a bridge 85 feet high.

### 5.4.3 AI-based System for Highway-Rail Grade Crossings

FRA and Federal Highway Administration collaborated with Wi-Tronix to develop an AI-based system for highway-rail grade crossing functionality. The AI system was designed with the following objectives: line-of-sight calculation, gate arm misalignment detection, warning-time activation validation, and compliance with the 49 CFR Part 234 regulations for highway-rail grade crossings. Utilizing front-facing cameras, operators can monitor critical safety infrastructure at highway-rail grade crossing remotely at any time.

Wi-Tronix partnered with a North American Class I railroad to test the accuracy of the developed AI systems. The AI models accurately detect the functionality of gate arms and mast light flashers at highway-rail grade crossing. The second phase of effort functionality allows for validation of warning time activation requirements.

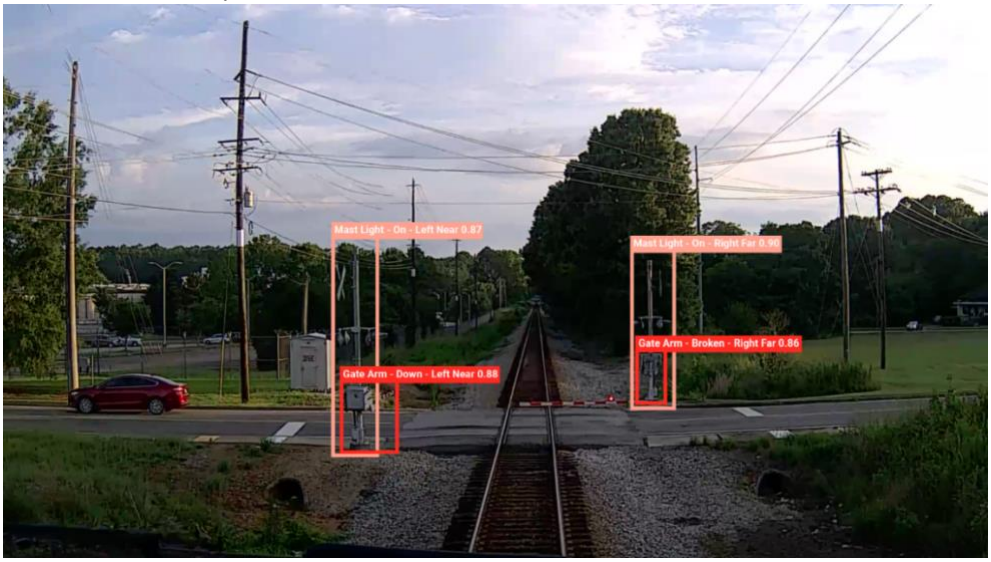



**Figure 11. AI view identifying potential hazards on rail. (Source: Wi-Tronix)**

### 5.4.4 Railroad Systems Issues – Workforce Development Survey

In FY 2022, FRA conducted a survey to investigate workforce-related issues affecting Class I freight, Amtrak, labor unions, and shortline and regional railroads. From October 2021 to January 2022, 450 surveys were distributed containing 30 Likert statements covering various workforce issues.

The responses collected from the individuals expressed a pattern of commonality among the following topics: Staffing Challenges, Work-Life Balance, Workforce Diversity, and Data Sharing. The collected information will allow FRA to make more informed decisions on how to improve working conditions in the rail industry.

### 5.4.5 AI Trespassing System

With the help of the FRA's Consolidated Rail Infrastructure and Safety Improvement (CRISI) competitive grant program awarding $1.6 million towards the project, the partnership has prompted the creation of an AI-monitored system to record live trespassing data. This task is performed by the installation of forward-facing cameras being installed at the front of Brightline's Siemens Charger locomotives which

will collect real-time data to be used to train and test the system. This system will be implemented along the Florida East Coast Railway corridor with the goal of decreasing trespassing activities and potential collisions.

## *5.5 Federal Transit Administration [FTA]*

FTA's mission is to Improve America's Communities through Public Transportation – and the vision is to provide a "Better Quality of Life for All, built on Public Transportation Excellence." FTA focuses research on the following goals to:

- Enhance Safety
- Improve Equity
- Address Climate and Sustainability
- Build Resiliency
- Connect Communities, and

Enhance Economic Strength and Global Competitiveness.

FTA prioritizes research spending on demonstration and deployment activities—usually approximately 70 percent of available research funds. This enables FTA to test innovative technologies and new process solutions with public transit agencies. The evaluation of demonstration programs provides information to help transit agencies implement the most promising findings.

An essential part of FTA's national innovative research leadership role is to ensure that promising research findings and technologies benefit public transportation. FTA uses a variety of mechanisms to cultivate relationships with key parties and disseminate research results. These approaches include: Sharing information about research findings at key industry events.

- Publishing research reports and posting them on FTA website.
- Conducting webinars in-house and through partner organizations.
- Investing in technical assistance centers that facilitate communities of practice enabling peer to peer information exchanges.

As an example, in the mobility innovation research program, FTA funds the Shared-Use Mobility Center for a project called the "Innovation and Knowledge Accelerator (IKA)," which is a structured, supported learning and information exchange system. The IKA also includes an initiative to enable colleagues to exchange information via communities of practice. Similarly, FTA is phasing in a standardized approach for disseminating research results in the safety and infrastructure program areas.

More recently, FTA published a link to "Mobility Standards and Guidelines Resources" (MSGR) tool. The tool is designed to interactively inform stakeholders on the available standards, open-source specifications, and case studies associated with the interoperability among various components of the Mobility on Demand (MOD)/Mobility as a Service (MaaS) ecosystem. The tool encourages knowledge and data sharing for the transit community.

FTA has also developed the next iteration of the "Strategic Transit Automation Research" (STAR) plan outlining FTA's research agenda on transit bus automation technologies. One of the goals of the STAR 2.0 plan is to transfer knowledge to the transit stakeholder community.

### 5.5.1 Expanding FTA Technology Transfer (T2)

FTA is developing a Notice of Funding Opportunity (NOFO) to establish a Technology Transfer (T2) program. The T2 program will facilitate the enhancement of transit delivery and the ability to make

improvements to the public transportation system. Accelerating the rate of Innovation within and among transit agencies can bring benefits to the public and T2 can help by addressing the challenges associated with adopting new technology.

The goals of the T2 program are to:

(1) Facilitate the wide-spread deployment and adoption of FTA's research products in the public transportation industry;

(2) Further support the commercialization and production of technologies developed in the United States (U.S.), in part, through federally funded Research and Development;

(3) Strengthen U.S. manufacturing while encouraging technology transfer and allowing small businesses and nonprofit organizations to retain ownership of intellectual property and help commercialize their federally funded innovations.

## *5.6 Intelligent Transportation Systems Joint Program Office [ITSJPO]*

### 5.6.1 Ensuring Work Zone Safety

In 2019, the ITS JPO's multimodal Data for Automated Vehicle Integration initiative launched a Work Zone Data Exchange (WZDx) project to get data on work zones into vehicles to help automated driving systems and human drivers navigate more safely. That project led to the WZDx specification, which was established to make travel on public roads safer and more efficient by providing ubiquitous access to data regarding work zone activity. In conjunction with FHWA, the ITS JPO co-led the earlier stages of the WZDx specification and remains actively involved with the project.

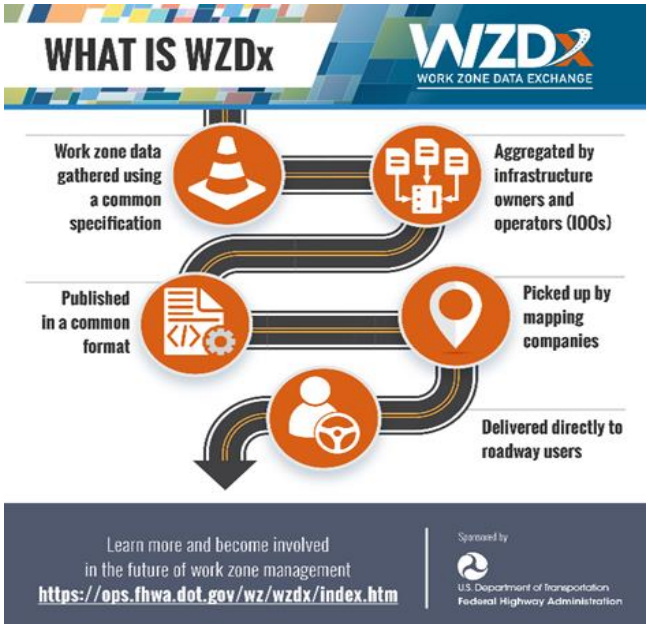



**Figure 12. Definition of the Work Zone Data Exchange. (Source: ITS JPO)**

The WZDx specification is an open-source data specification that enables infrastructure owners and operators to make live, accurate, and actionable work zone data available for third-party use, such as by mapping companies. That means smarter roads where navigation systems, drivers, and eventually automated vehicles can be informed about work zones in their path, improving roadway safety nationwide. Work zone data can also help inform agencies who are responsible for integrating transportation systems management and operations strategies.

The Work Zone Data Working Group published version 3.1 of the WZDx specification in April 2021. Other recent developments include the Early Adopters' Guide and Work Zone Data Survey Report. The WZDx Feed Registry lists active data feeds from seven state DOTs.

To encourage adoption of WZDx, U.S. DOT awarded $2.4 million in January 2021 for 13 WZDx demonstrations projects. FHWA also launched the "Put Work Zones on the Map" campaign — an effort to raise awareness about WZDx and engage potential partners, including State and local DOTs, construction companies, mapping companies, and vehicle and vehicle technology manufacturers.

## *5.7 Maritime Administration [MARAD]*

### 5.7.1 Energy Efficiency, Emissions Reduction, and Decarbonization Portfolio

In recent years, there has been a greater focus on sector-wide greenhouse gas emissions reduction both domestically and internationally. Recognizing the multiple components of the U.S. maritime industry, from ships of various sizes and operational profiles to ports and terminals, several challenges have come to the forefront such as determining the preferred low carbon fuel or technology, fuel or technology availability in the necessary supply quantities, and determining what infrastructure is needed. Since 2021, a significant portion of the Maritime Environmental and Technical Assistance Program (META) funds have been allocated towards maritime decarbonization projects to address many challenges. Projects funded under this portfolio include various studies, *in situ* demonstrations of new fuels and technologies, industry guides, and multimodal modeling toolsets. A list of ongoing projects within this portfolio that were initiated in 2022 and 2023 include:

- Demonstration of a microgrid using low carbon technologies for cargo handling operations.
- Marine vessel liquid hydrogen tank design study for the use of liquid hydrogen as a propulsion fuel.
- Vessel-based carbon capture and storage feasibility study and technoeconomic analysis.
- Demonstration of carbon capture technology onboard a U.S. cargo vessel.
- Development of a vessel emissions inventory database designed to obtain a more realistic inventory within the U.S. EEZ.
- Regional, low carbon fuel studies that identify maritime sector components (i.e. vessels, ports, and terminals) and probable low carbon fuel options for regions of the U.S. Regions currently being studied include the Great Lakes, the Gulf of Mexico, and California.
- Lifecycle emissions analyses (Well-to-Wake) of low-carbon options for US maritime vessels. Specifically, this effort focuses on several domestic vessel types and compares battery-electric versus internal combustion engines. Note: this study builds off of previous lifecycle emissions analyses for alternative fuels previously funded through META.
- Low carbon fuel testing and verification for domestic marine engines.
- Vessel alternative fuel and energy calculator toolset. The toolset was designed to allow vessel operators baseline greenhouse gas emissions and provides other resources for owner/operators to reduce their greenhouse gas emissions.
- Multimodal transportation optimization tool for energy and emissions assessment for freight movement between origin and destination pairs.

In addition to ongoing projects, META recently completed the following:

- Vessel Energy Efficiency and Decarbonization Guide – completed in the Fall of 2022, the guide allows vessel owner/operators determine the overall efficiencies and costs associated with energy efficiency and decarbonization technologies.

- Battery Electric Workboat Technoeconomic Analysis – completed in the Fall of 2023, this study investigated the cost and emission impacts, feasibility, and scalability of battery-operated domestic workboats.
- Blue Carbon Study – completed in the Fall of 2023, this study identifies carbon sequestration capabilities of submerged aquatic vegetation in a port setting. Results of the study can be used by the port community to assist with greenhouse gas mitigation strategies.

### 5.7.2 Ships' Ballast Water and Hull Fouling Portfolio

With the implementation of U.S. and international ballast water regulations to prevent the spread of aquatic nuisance species (ANS), there has been the need to develop and/or validate methods to support compliance by the U.S. shipping industry. Many of the projects funded by META have served as the basis for standards and methods that assist the U.S. maritime industry in implementing domestic and international regulations. Importantly, ISO standards are critical to the industry because they facilitate trade, remove opportunities for unfair competition ("level the playing field"), improve marine safety, and encourage responsible environmental stewardship.
While past focus has been on ballast water compliance, the issue of hull-mediated transfers of ANS is a growing concern. 2022-2023 META projects related to ANS include:

- Development of an ISO standard for evaluating the performance of Compliance Monitoring Devices (CMDs) - CMDs provide a relatively quick, indicative analysis of ballast water to determine compliance with discharge regulations; the standard provides confidence in the device analyzing the treated water.
- Development of an ISO standard that provides detailed and rigorous procedures for the impartial and independent performance testing for all forms of in-water cleaning systems, with or without capture (and processing and disposal of debris), of all types of biofouling, and on all external submerged surfaces. Use of a validated system will ultimately save ship operators time and money by allowing for in-water cleaning of hulls in lieu of being turned away from a port for an overly fouled hull.
- Completed evaluation of a proactive in-water cleaning system on the MARAD vessel M/V *Cape Wrath.* This project served as an additional validation of the method developed for quantifying the efficacy of a hull cleaning system.
- Completed field sampling and laboratory experiments to investigate the fate, behavior, and bioavailability of microplastics released from ship coatings. The goal of this work was to evaluate the level of risk emanating from ship hull coatings.

## *5.8 National Highway Traffic Safety Administration [NHTSA]*

### 5.8.1 Rulemaking to Reduce Read-End Crashes and Pedestrian Fatalities

In 2019, there were 6,272 pedestrian fatalities in motor vehicle crashes, representing 17 percent of all motor vehicle fatalities. A further 76,000 pedestrians were injured in motor vehicle crashes. In addition, there were nearly 2.2 million rear-end police-reported crashes involving light vehicles, which led to 1,798 deaths and 574,000 injuries. Deaths and injuries in more recent years are even greater. NHTSA conducted research into test procedures, test devices, and vehicle countermeasures to address this growing problem. This research included studies on forward collision warning, automatic emergency braking (including crash-imminent braking and dynamic brake support) (see *fig. 12*), and pedestrian automatic emergency braking. It also included development and certification of global vehicle targets (see *fig. 13*) and adult and child pedestrian test devices, and hundreds of fleet tests with vehicles equipped with automatic emergency braking in lead vehicle stopped, lead vehicle decelerating, and lead

vehicle moving test conditions. It also included hundreds of tests in pedestrian crossing paths (running, walking, adult, child) and along road tests (facing and walking away from the vehicle, in both stopped and moving conditions) (see *fig. 14*). These tests were also conducted in dark and daylight conditions, as many pedestrian fatalities occur in darkness. In FY2022/2023, this research formed the technical basis to support the development of a Notice of Proposed Rulemaking (NPRM) for a new Federal Motor Vehicle Safety Standard (FMVSS) to require automatic emergency braking systems on light vehicles that can reduce the frequency and severity of both rear-end and pedestrian crashes. The NPRM was successfully published in the Federal Register on June 13, 2023. This proposed action represented a crucial step forward in implementing USDOT's January 2022 National Roadway Safety Strategy (NRSS) to address the rising numbers of transportation deaths and serious injuries occurring on this country's streets, roads, and highways, including actions to protect vulnerable road users, including pedestrians.

**Figure 15. Robotic Steering Controller and Brake Controller (Source: NHTSA)**

**Figure 14. Global Vehicle Target. (Source: NHTSA)**

**Figure 13. Pedestrian Automatic Emergency Braking. (Source: NHTSA)**

### 5.8.2 New Generation of Crash Test Dummies

NHTSA has a long history of conducting crash tests with female and male crash test dummies to assess the safety performance of vehicles. Further, the Agency spent most of the last decade developing advanced crash test dummies that better assess human injury risk in vehicle crashes. The first of this next generation of dummies was recently proposed for standardization for use in government crash test programs and were developed based on extensive test data to better match human kinematics. The new female and male crash test dummies (*see fig. 15*) provide additional instrumentation in updated body regions that expands their injury-prediction capability. Use of the advanced crash test dummies will encourage a more thorough understanding of occupant safety for future vehicle designs. The next generation of crash test dummies have been included on the regulatory agenda, enabling their use by industry.

**Figure 16. Advanced Crash Test Dummies: From Left to Right: 1) THOR (Frontal Impact) 5th percentile Female; 2) THOR 50th percentile Male; 3) WorldSID (Side Impact) 5th percentile Female; 4) WorldSID 50th percentile Male advanced crash test dummy. (Source: NHTSA)**

### 5.8.3 Improving State and Local User Access to Research Findings

NHTSA's *Countermeasures That Work (CMTW)* is a basic reference to assist State Highway Safety Offices and other professionals interested in behavioral traffic safsety in selecting effective, evidence-based countermeasures for traffic safety problem areas. The 10th Edition, which was published in FY2021, includes an effectiveness star-rating system that ranges from 5 stars (demonstrated to be effective by high-quality evaluations with consistent results) to 1 star (limited or no high-quality evaluations). Over the first years of its existence, CMTW was only available in print as a 600+ page book, or as a very large .pdf that contained the full document. In early FY2022, NHTSA began pilot testing an online version that was searchable based on topic, effectiveness rating, cost, time to implement, or by user-defined keywords. The online resource made it easier for State and local users to quickly identify proven safety countermeasures that could be deployed to save lives and prevent injuries. Throughout FY2022 and FY2023, NHTSA identified improvements and refinements that would be released with the 11th Edition of CMTW. These include harmonizing the content structure but also has a feature that allows users to build their own books by selecting the topics and countermeasures that they need. The improved electronic version of CMTW is available at www.nhtsa.gov/book/countermeasures/countermeasures-that-work. While the 11th Edition was prepared with both paper and electronic versions in mind, the electronic version makes broad distribution feasible and more useful to those who need help in selecting proven safety countermeasures.

### 5.8.4 27th International Technical Conference on the Enhanced Safety of Vehicles

NHTSA led the execution of the 27th International Technical Conference for the Enhanced Safety of Vehicles in Yokohama, Japan in April 2023. This conference brought together government and industry representatives to discuss research and progress in automotive safety. This conference was held in partnership with the Japanese the Ministry of Land, Infrastructure, Transport and Tourism and the Ministry of Economy, Trade and Industry. The conference was attended by 701 participants representing 22 countries. The conference included 173 technical presentations on a wide range of auto safety topics. Additionally, the conference drew 33 exhibitors from 7 countries. The International Technical Conference for the Enhanced Safety of Vehicles has held biannual meetings since 1970. It is the premier conference for government researchers to gather and coordinate on vehicle safety research issues. The conference proceedings are assembled and made available on NHTSA's website: https://www.nhtsa.gov/research-data/enhanced-safety-vehicles


**Figure 17. International Technical Conference. (Source: NHTSA)**

## *5.9 Pipeline and Hazardous Materials Safety Administration [PHMSA]*

### 5.9.1 Improved Tools to Locate Buried Pipelines in a Congested Underground[14]

The installation of utilities such as electrical, natural gas, water, cable, and sewer lines underground is a common practice that provides protection from surface activities, vehicles, and the weather. Gas Technology Institute (GTI) developed and commercialized a geospatial probe to locate and map existing buried pipelines that are not locatable. The probe, which can be inserted in a live gas pipeline, is able to accurately map underground pipeline locations to allow safe excavate around these facilities. The probe can be used to locate 2-inch and larger diameter pipes. PHMSA registered this technology transfer in FY

[14] https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=734.

2022 for this project awarded to Gas Technology Institute (GTI).

**Figure 18. EMAT Line inspection tool. (Source: PHMSA)**

### *5.9.2* Electromagnetic Acoustic Transducer (EMAT) Sensor for Small Diameter and Unpiggable Pipes; Prototype and Testing[15]

In the area of integrity assessment, PHMSA registered a technology transfer project in FY 2022 for the project completed by Physical Sciences, Inc. The project demonstrated the ability of the EMAT crack tool to detect tight/closed cracks down to 2 millimeters deep for 8-inch diameter pipes in traditionally difficult to inspect pipelines. The EMAT Crack In-Line Inspection tool is now being offered for operators' use.

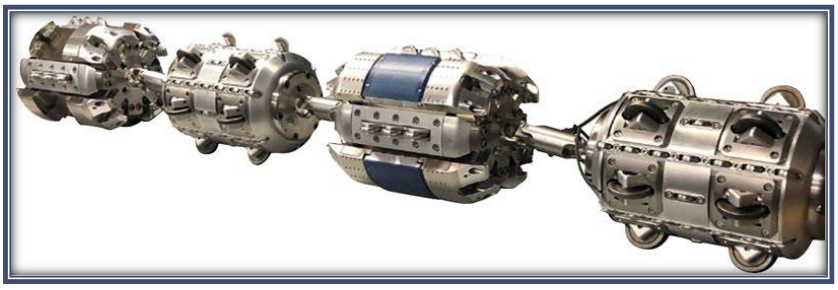


**Figure 19. Picture of a Pipeline Pig. (Source: PHMSA)**

[15] https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=653