

**United States Department of Transportation  
FY 2019 NHTSA Annual Modal Research Plan**

*Office of Vehicle Safety Research  
Acting Associate Administrator, Tim Johnson*

*Office of Behavioral Safety Research  
Acting Associate Administrator, Jon Krohmer*

*April 6, 2019*

**Executive Summary**

NHTSA research efforts are primarily comprised of programs within the Office of Vehicle Safety Research and Office of Behavioral Research and support U.S. DOT's and NHTSA's safety goals by conducting research and safety testing of motor vehicles and motor vehicle equipment as well as research supporting behavioral countermeasures to reduce the occurrence of traffic crashes.

The Office of Vehicle Safety Research (VSR) performs testing and research related to vehicle electronics and emerging technologies, with a major focus in this area on automated driving system technologies. Other key areas include: advanced driver assistance systems for crash avoidance, human factors, and crashworthiness/human injury research. Research efforts in these areas include technologies that aim to address common crash problems on U.S. roadways such as intersection collisions, pedestrian impacts, lane change/merge impacts (blind spot), and rear end crashes as well as research addressing unsafe driver behavior including distracted and impaired driving. In addition, VSR conducts testing and research on the reliability of complex safety-critical electronic control systems, vehicle cybersecurity, and develops new test tools and countermeasures to improve vehicle crashworthiness.

VSR conducts research to facilitate the development and deployment of cost-effective, life-saving technologies by industry. When new vehicle designs and technologies are introduced, the VSR program ensures that those technologies will indeed enhance safety and mitigate any unintended consequences. When a safety need exists for a Federal Motor Vehicle Safety Standard (FMVSS), VSR conducts research to understand the safety need in detail, to develop and evaluate safety countermeasures, and to establish and validate repeatable performance tests that respond to the safety need. For safety problems that occur with high frequency and severity in the crash statistics, VSR uses research to evaluate new safety countermeasures that can prevent these issues, and/or develop new crash tests that can drive better occupant protection in vehicle designs.

The VSR program assures a fair and competitive market, fostering a level playing field while supporting consistency in the safety performance of new and innovative technologies when they are brought to market such as automated driving systems. Overall, because of the program, the introduction of safe new vehicles and technologies into the U.S. fleet is accelerated.

The Office of Behavioral Safety Research directly supports the Department and Agency goals of reducing traffic crashes, fatalities, and injuries by providing the scientific basis for the development of effective behavioral countermeasures to reduce the occurrence of traffic crashes. The Office focuses on unsafe driving behaviors that contribute significantly to death and injury from crashes on the Nation's highways. Evaluation research documents the relative effectiveness of programs to reduce highway fatalities and injuries, and is critical to achieving further progress toward meeting national goals and performance targets. The Behavioral Safety Research program assesses existing and emerging highway safety problems. Results are distributed to the States to use in identifying effective traffic safety countermeasures for implementation through the highway safety formula grant (Section 402) funds and incentive grant funds (Section 405). NHTSA partners with other DOT modal agencies, such as the Federal Highway Administration, Federal Motor Carrier Safety Administration, universities, research contractors, safety advocates, automotive manufacturers and other industry entities.

## Issues required to be addressed by the Annual Modal Research Plan:

- **Economic impact of regulatory reform (critical priority)**

Regulatory reform is a critical Departmental priority and a key element in this process is measuring the economic impacts of reform proposals. These measurements help assess the impacts of existing regulations and the potential savings that could result from reform efforts. Executive Order 12291, issued in February 1981 first required reviews of existing regulations. The Government Performance and Results Act of 1993 and Executive Order 12866, "Regulatory Planning and Review," issued in October 1993, obliged all Federal agencies to evaluate their existing programs and regulations. The Government Performance and Results Modernization Act of 2010 reiterated Agency program evaluation requirements.

NHTSA supports these efforts through a formal Regulatory Review program established in its National Center for Statistics and Analysis (NCSA), Office of Regulatory Analysis and Evaluation. Research participates in these efforts but the funding for the program is separate from research program dollars. Here, the Agency has rigorously evaluated its major programs as a matter of policy since 1970, with evaluations of the effectiveness of the FMVSS beginning in 1975. The NHTSA regulatory evaluation and analysis program includes retrospective statistical analyses of the safety impacts of FMVSS as well as formal engineering teardown studies to determine the cost and weight impacts of vehicle design changes made to meet FMVSS. It also includes engineering reviews of technologies required by FMVSS to determine whether regulations reflect current technology and whether they are prohibiting new technologies.

NHTSA's evaluation program supports DOT's regulatory review process in accordance with the Department's 1979 Regulatory Policies and Procedures (44 FR 11034, Feb. 26, 1979), Executive Order (E.O.) 12866, E.O. 13563, and section 610 of the Regulatory Flexibility Act. Results of all cost and benefit analyses inform future Agency regulatory efforts. NHTSA regularly invites public participation in proposed regulatory and reform actions, seeking data, research, and other information pertinent to the agencies establishment, revision, or revocation of regulations governing motor vehicle and motor vehicle equipment safety.

- **Economic impact of permitting reform (critical priority)**

While critical for the Department, NHTSA's mission and research programs do not support this DOT research priority. The Agency does not require or issue transportation project permits.

- **Performance based regulations and safety**

Safety is NHTSA's mission and number one priority. The Agency is directed by Congress to protect the driving public against unreasonable risks of harm that may arise because of the design, construction, or performance of a motor vehicle or motor vehicle piece of equipment, and to mitigate risks of harm. It does this through non-prescriptive, performance and risk-based regulatory actions to enhance safety, while remaining technology neutral. It does not pick one approach among the developers of existing and emerging technologies. Instead, it strives to foster innovation and remove unnecessary and unintended regulatory barriers. However, companies are still responsible for compliance with established FMVSS. When necessary, NHTSA has broad enforcement authority to address existing and new automotive technologies and equipment. As the NHTSA has always done, when evaluating new automotive technologies, it will be guided by its statutory mission, the laws it is obligated to enforce, and the benefits of the technology.

NHTSA's research programs directly support the agency's mission, continuously assessing ways to seek alternative approaches (e.g., guidance, best practices, generic performance tests and criteria) that hasten the maturation and deployment of cost-effective, life-saving technologies by industry and the States. For example, when new vehicle designs and technologies are introduced, the VSR program evaluates those technologies to understand whether they would enhance safety or if they might present new unintended consequences. When a safety need exists for a FMVSS, NHTSA conducts research to understand the safety need in detail, to develop and evaluate safety countermeasures, and to establish and validate repeatable performance tests that respond to the safety need. For safety problems that occur with high frequency and severity in the crash statistics, the agency uses research to evaluate new safety countermeasures that can address these issues, and/or new crash tests that can drive better occupant protection vehicle designs.

NHTSA's research programs develop findings and data to help assure both market access and a fair competitive market. The program facilitates the acceleration and introduction of new vehicles and safety technologies into the U.S. fleet. Further in this document, more detailed descriptions are provided for NHTSA research programs (Vehicle Electronics and Emerging Technologies, Advanced Safety Technologies, Crashworthiness, Alternative Fuel Vehicle Safety, Vehicle Research and Test Center, and Highway Safety Research.

- **Potential impact of asset recycling**

NHTSA's mission and research programs do not support this DOT research priority. The Agency does not have fixed public assets that it sells or leases to the private sector.

- **Potential impact of value capture**

NHTSA's mission and research programs do not support this DOT research priority. The Agency's programs do not provide for public investments that would generate unearned profits for private landowners.
- **Improving the mobility of freight**

NHTSA's mission and research programs do not support this DOT research priority. The Agency has regulatory oversight of motor vehicles and motor vehicle equipment. Its programs do not improve the mobility of freight.
- **Feasibility of micro-transit**

NHTSA's mission and research programs do not support this DOT research priority. The Agency has regulatory oversight of motor vehicles and motor vehicle equipment. It has no authority or responsibility for micro- or demand responsive transit services.
- **Improving mobility for underserved communities**

The research program supports this DOT research priority through its work on Automated Driving Systems (ADS). Driving automation will provide mobility options not previously afforded to people with disabilities, regardless of cognitive, physical, or even the degree of condition. ADS equipped vehicles with technology making them accessible to persons with disabilities will be expected to provide information through appropriate modes to interact with occupants with disabilities, and finally to ensure that the vehicle has the proper equipment and technology that is accessible to users boarding and exiting the vehicle safely. Agency research is exploring the information needs of persons with disabilities and how these needs will likely be implemented within a human machine interface (HMI). For more information on FY '19 activities in the ADS area, see the program description for Vehicle Electronics and Emerging Technologies, which includes ADS research, further in the document.
- **Cybersecurity**

NHTSA has a well-established research program on vehicle cybersecurity that leverages public-private partnerships. Cybersecurity is a dynamic area requiring a flexible approach to address emerging risks and a strong risk management culture. NHTSA advocates a risk management culture built upon the following themes: Tone at the Top, Awareness, Constructive Challenge, and Continuous Improvement. Within the Agency, this culture permeates throughout our cybersecurity activities across vehicle safety research, enforcement defect investigations, rulemaking considerations, statistics and analysis efforts, and cyber incident response. For more information on FY '19 activities, see the program description for Vehicle Electronics and Emerging Technologies, which includes cybersecurity research, further in the document.

## ***Five High-Priority Projects for FY 2019***

### **1. Functional Safety of Automated Driving Systems (ADSs)**

- ❖ ***Why should we pursue (or invest in) this research?*** This research should be pursued because it has the potential to significantly mitigate the vehicle crash problem on our nation's roadways. In 2016, motor vehicle crashes on U.S. highways claimed 37,461 lives. This is a 5.6% increase from 2015 and a 14.4% increase from 2014. Analysis of crash causation factors imply that a large majority of serious crashes are due to dangerous choices or errors people make behind the wheel. In addition to the historical contributors to these statistics such as impaired driving and failing to use seat belts, we are now faced with increased distracted driving, resulting in further deaths and injuries. Driving automation systems, especially those that have the capability to replace the driver and perform the entire driving task, have a great potential to mitigate, if not remove, these errors and save lives. Researching the functional safety of Automated Driving Systems (ADS—SAE International automation levels 3-5) is essential for the safety assurance of this new technology, and hence, for attaining public acceptance.
  
- ❖ ***Who else is researching this issue?*** ADS technology is being developed by various industry automakers, suppliers, and other new entrant technology companies. Functional safety methods (e.g., ISO 26262) are utilized in the design process for critical subsystems and within product development testing. This research will explore existing system safety and functional safety methodologies in the context of ADS functionality and identify possible gaps that industry may consider addressing in future additions to associated standards. This project differs from those efforts in that there is a need to understand methods and tools and their effectiveness to assess the functional safety of ADS subsystems and the building block components as part of a safety assurance process.
  
- ❖ ***Have we invested in this topic in the past and what have we learned to date?*** To develop a baseline knowledge of functional safety methods, NHTSA has invested in several projects to address the functional safety of electronics systems used in conventional vehicles. As a part of past research, the agency initiated systematic hazard analyses on select safety-critical automotive control systems to better understand the vehicle-level safety risks. Key findings from past research include hazards that could emerge in failure cases, identifying what could lead to such circumstances, and determining what level of system integrity may be needed to ensure safe operations of the item in cases of electrical and electronic failures. However, NHTSA has not specifically researched methodologies to conduct functional safety of ADS vehicles nor plausible failure modes stemming from the introduction of ADS functionality.

- ❖ **Objectives, activities, and the problem being addressed:** The objective of this research area is to establish the capability to assess the functional safety of components and subsystems of ADSs, which can augment system-level safety assessments. The safe operation and reliable performance of ADSs are critical to public acceptance and successful deployment of future ADSs. As the dynamic driving tasks are transferred from the human driver to the driving system, human sensing and cognition functions are essentially being relegated to the machine through a collection of integrated hardware and software subsystems. Accordingly, methods and tools are necessary to assess the functional safety of ADS subsystems and their building block components. In addition, it can be predicted that a collection of new failure modes will surface through the introduction of these subsystems into the automotive architecture. Robust methods will be needed by stakeholders to identify the causality of failures rooted in these software-intensive subsystems. This process would also assess the utility of the 2<sup>nd</sup> edition of the industry standard ISO 26262, which also considers automated driving technologies.
- ❖ **Alignment with DOT Strategic goals:** This research directly supports the DOT and NHTSA goals to improve safety and save lives. In 2016, motor vehicle crashes on U.S. Highways claimed 37,461 lives. This is a 5.6% increase from 2015 and a 14.4% increase from 2014. In addition, the Secretary has a priority goal to prepare for the future and adapt to new technologies, and this project directly aligns with that goal as well.
- ❖ **Expected total project cost and expected funding for FY 2019:** \$750,000
- ❖ **Is there a non-Federal financial contribution? If so, how much?** No

## 2. Crashworthiness Research for Automated Driving Systems (ADS) Vehicles

- ❖ **Why should we pursue (or invest in) this research?** NHTSA has developed a long-range plan to develop safety tools, performance measures, and test procedures to support the design and development of Automated Driving System (ADS – SAE International automation levels 3-5) equipped vehicles with enhanced safety for the widest possible range of occupants. In FY2018, NHTSA initiated a series of postmortem human subject tests to evaluate occupant kinematics for non-standard driving postures anticipated in automated vehicles. In FY2019, a new task will utilize this test data to update human body models to better reflect the kinematics of humans in reclined and rotated seating postures. This topic is extremely important to the safety of ADSs.

- ❖ **Who else is researching this issue?** Others in industry/academia are considering the issue of alternative seating arrangements associated with automated driving systems and the need for the development/modification of existing test tools (dummies) and simulation models (human body models). However, to our knowledge, no research efforts have specifically targeted the development of new biofidelity targets for the test/simulation tools that will be used in these non-standard seating configurations. The crashworthiness research program at NHTSA is initiating this work because it is a vital component in the assessment and possible refinement of the tools (dummies and computer models) that will be used to assess the safety of and countermeasures for alternative seating arrangements in ADSs. Where possible, NHTSA will work closely with related industry groups to make sure research efforts are not duplicated and to ensure that the research focuses on the highest-priority (i.e., most widely anticipated) new seating configurations.
- ❖ **Have we invested in this topic in the past and what have we learned to date?** In FY2018, NHTSA initiated a series of postmortem human subject tests to evaluate occupant kinematics for non-standard driving postures anticipated in automated vehicles.
- ❖ **Objectives, activities, and the problem being addressed:** The objective of this research is to update human body models to better reflect the kinematics of humans in reclined and rotated seating postures. The human body models developed by this research will be used by all automobile manufacturers and other industry entities to design vehicle restraints for these vehicles.
- ❖ **Alignment with DOT strategic goals:** NHTSA has only recently initiated efforts in this area, and while we have shown that the current crash simulation tools cannot fully support future vehicle designs, we believe that additional development can enhance their capabilities in line with the DOT strategic goal for enhancing safety. NHTSA has had broad discussions on this research area with most of the major automotive manufacturers, and the need for this research has been raised in several public meetings.
- ❖ **Expected total project cost and expected funding for FY 2019:** This research effort is anticipated to cost about \$2M in FY 2019.
- ❖ **Is there a non-Federal financial contribution? If so, how much?** No direct non-Federal contributions are anticipated, but it is expected that several auto manufacturers, suppliers, and other industry entities will utilize the resulting simulation tools.

### 3. Title: Development of On-Road Safety Assessment Methods for ADS Vehicles



❖ ***Why should we pursue (or invest in) this research?***

The focus of this project is to prototype and test a non-intrusive “ground truth” trip recorder that can be fitted on a vehicle under test (VUT) to continuously monitor driving performance in real-world driving environments. The data collected by the on-board data acquisition system (OBDAS) would be leveraged (in a parallel project) to develop safety performance metrics. For example, raw data collected could be used to assess: the VUT’s ability to adhere to the lane centerline; hard-braking events; following distance profiles; lane-change behavior; yaw rates during turning events; etc. The research would focus on exploring how such metrics could be collected for a variety of conditions and operational scenarios (relevant to the ODD for the VUT), and then used to assess the ability of the vehicle to complete its intended mission (going from point A to B) in safe manner while adhering to local laws and regulations.

The data collected could also be used to verify that the VUT successfully completed (or experienced) a variety of pre-defined driving scenarios (also called behavioral competencies) expected to be encountered by an ADS vehicle within its Operational Design domain (ODD), such as an automated urban shuttle.

It is anticipated that the OBDAS to be developed under this project would be equipped with very high accuracy sensor systems (e.g. radar, camera, lidar, GPS) to support reliable and accurate recording of: the driving environment; the movement of the VUT; and actions of other roadway users within the driving environment. Additional examples of the data to be collected to support on-road safety performance analyses would include:

- movements of the VUT and surrounding vehicles, pedestrians, cyclists (or other moving objects) that impact the scenario (including speeds, accelerations, headings, trajectories, etc.);
- all relevant roadway infrastructure and signage;
- road surface conditions, including markings (e.g., lane lines, road edge, other markings);
- environmental (weather) conditions; and
- other relevant situational data to be determined as part of the project.

If successful, the OBDAS, along with appropriate data reduction and analyses, would provide the foundational elements for a type of data-driven, objective driving test for an ADS-equipped vehicle.

❖ ***Who else is researching this issue?***

SAE International has established a Working Group to explore variable testing methods—potentially including on-road methods. We are not aware of other entities focused on this type of research.

❖ ***Have we invested in this topic in the past and what have we learned to date?***

NHTSA's VRTC has developed a variety of advanced on-board data acquisition packages to support other testing activities. These include systems that measure the relative range/range-rate of the VUT with surrounding vehicles; accelerometer instrumentation to measure longitudinal and lateral accelerations and yaw rates; high-accuracy GPS systems to measure absolute positioning; and other instrumentation. This project would focus on integrating and augmenting this prior work to develop a robust, transferrable and highly accurate ground truth trip recorder to support the project's objectives. Included would be designs for appropriate on-board data storage and/or wireless downloading provisions.

❖ ***Objectives, activities, and the problem being addressed:***

Safety and performance data on ADS vehicles has only been available from the suppliers/OEMs themselves (self-reported). This project provides tools for independent third-party assessment of performance of a vehicle during driving scenarios that would be experienced (or accumulated) in naturalistic settings.

❖ ***Alignment with DOT Strategic goals:*** This research directly supports the DOT and NHTSA strategic goals to improve safety and save lives.

❖ ***Expected total project cost and expected funding for FY 2019:*** \$2,000,000

#### 4. Driver Engagement Strategies for Vehicles with L3 and Dual-Use L4 ADSs

❖ ***Why should we pursue (or invest in) this research?*** NHTSA wants to understand the implications of driving automation technologies with respect to new safety challenges they may introduce during driving control handoff. Level 3 (L3) and dual-use Level 4 (L4) ADS-equipped vehicles can be both manually operated and ADS controlled, and introduce instances where there may be driver- or system-initiated transfer of control. The objective of this research is to understand the basic human factor issues at hand in these circumstances. System concepts that include strategies to overcome these challenges have been suggested by researchers and designers, and assessment of factors that could evaluate their efficacies will also be part of the study.

❖ ***Who else is researching this issue?*** Many manufacturers, researchers, and foreign government agencies are interested in exploring this topic since it is very difficult to study and understand completely. However, they all focus on a very specific design and implementation approach of their own and do not particularly focus on overarching performance metrics and goals.

❖ ***Have we invested in this topic in the past and what have we learned to date?*** NHTSA performed an initial human factors study with L2 and L3 systems using prototype concept vehicles in partnership with industry and published that report in 2015. Initial research and a

literature review show that people, in general, will adjust their behavior in response to new technologies, and when the driver is out of the loop, it takes time and effort to regain situational awareness. This research will focus on newer concepts introduced since then, as well as risk-mitigation techniques being considered to address driver disengagement risks.

- ❖ **Objectives, activities, and the problem being addressed:** The objectives of this research are to understand the effectiveness of various proposed strategies and how well they overcome the issues related to a driver out of the loop. Activities will include literature and state-of-the-art reviews to learn what is currently known on the topic as well as research metrics, methods, and tools to assess the effectiveness of various engagement strategies. The fundamental problem being addressed by this project is drivers' tendency to become disengaged when not directly involved in the driving task, including the increase of secondary (non-driving) task involvement.
- ❖ **Alignment with DOT Strategic goals:** This project aligns with the Department's Safety and Innovation strategic goals. The results from this project will provide information and knowledge on human factor issues surrounding the driver re-engagement challenges in the L3/L4 ADS context. This knowledge will help the stakeholder community in addressing potential safety risks associated with this concern. In addition, the Secretary has a priority goal to prepare for the future and adapt to new technologies, and this project directly aligns with that goal as well.
- ❖ **Expected total project cost and expected funding for FY 2019:** \$750,000
- ❖ **Is there a non-Federal financial contribution? If so, how much?** Possibly partnerships with manufacturers or technology companies with emerging L3 and dual-use L4 ADS human machine interface concepts and engagement strategies.

## 5. Reducing Fatigue in Emergency Medical Services (EMS) Systems

- ❖ **Objectives and activities:** In Fiscal Year 2018, NHTSA completed the first phase of the "Fatigue in Emergency Medical Services (EMS) Systems." The overall goal of this project was to develop, test, and disseminate evidence-based guidelines for fatigue risk management tailored to the EMS setting. In 2016, there were over 1.3 million EMS activations for traffic crashes. Unfortunately, many EMS personnel report severe fatigue at work and less than six hours of sleep per day, which can lead to personnel injury and patient-care error.

The second phase of this project will experimentally test the effectiveness of the recommendations from Phase 1. These recommendations will be translated into guidelines

for effectively managing fatigue in EMS systems. In selected EMS system that volunteer to participate, they will implement the guidelines and an educational intervention Take 10 for Sleep Health with all employees to determine the effect on fatigue, sleep quality and safety performance. Phase 2 is employing a case cross-over design, with 30 participating agencies randomly assigned to intervention (15) or wait-list control group (15). Approximately 1,200 personnel will participate among the 30 agencies. Some participants will wear an actigraph wristwatch, keep a paper sleep diary and complete psychomotor vigilance testing (PVT). Repeated measures will be taken before and after the intervention to determine changes in sleep quality, fatigue and safety performance.

- ❖ **Alignment with DOT Strategic goals:** Reducing fatigue among EMS personnel supports the DOT's strategic goals related to safety.
- ❖ **What was learned:** More than two dozen investigators reviewed evidence from more than 38,000 pieces of literature. A panel comprised of experts in sleep medicine, fatigue science, emergency medicine, prehospital emergency care, risk administration, and public safety evaluated a summary of the evidence connected to seven research questions and six fatigue-mitigation strategies.
- ❖ **What were the research outputs/outcomes?** The panel of experts used this information to form five recommendations. The project resulted in 11 peer-reviewed articles published in a special edition of *Prehospital Emergency Care*. As of March 2018, the article with the recommendations is eighth on the top-ten list of most read articles for the journal, which is the predominant research publication for the EMS community. Phase 2 has not been completed yet.
- ❖ **Does further research need to be done? If yes, for what purpose:** The next phases of the project involve transferring the findings into practical applications. One task will examine the effectiveness of a training program, which is one of the evidence-based recommendations for reducing fatigue among EMS personnel. Another task will develop, and make freely available, a biomathematical model tailored to EMS shift scheduling.
- ❖ **Will non-Federal stakeholders contribute to further research?** NHTSA does not expect non-Federal stakeholders to contribute funds towards these tasks. However, our non-Federal partners will be involved in implementing and evaluating the recommendations for reducing fatigue in the EMS community.
- ❖ **What was the total cost?** NHTSA accomplished this task through a contract with the National Association of State EMS Officials (NASEMSO). The total cost was \$1,070,000 for development and dissemination of the guidelines, and for the evaluation of the effectiveness

of the guidelines and educational intervention. NHTSA did not use non-Federal funds for the project, though the Phase 2 test of the intervention will result in the 30 participating agencies incurring some undetermined expense in implementing the program.

### ***Two high-priority projects that were completed in FY 2017 or FY 2018***

#### **1. Pedestrian Automatic Emergency Braking (PAEB) Systems.**

Research on PAEB systems was completed to estimate potential safety benefits (FY 2017) and develop a safety performance test that enables evaluation of the technology (FY 2018). PAEB is an advanced driver-assistance system that helps drivers avoid deadly collisions with pedestrians. The technology relies on forward-looking sensing technologies such as radar and video cameras to actively assist the driver by automatically applying brakes to avoid or mitigate a potential impact between the equipped vehicle and pedestrians.

- ❖ ***Objectives and activities:*** The main objectives of the project were to develop a thorough understanding of the potential safety benefits of the technology as well as to develop a safety performance test that can be used to evaluate PAEB systems. Several key activities were conducted that included an industry partnership to complete test track research, estimate potential safety benefits, and develop a safety performance test/procedure and criteria.
- ❖ ***Alignment with DOT Strategic goals:*** This research directly supports the DOT and NHTSA strategic goals to improve safety and save lives. Pedestrian fatalities have risen significantly over the last few years, and the PAEB system represents a potentially significant new vehicle safety countermeasure. Estimates show PAEB systems have the potential to assist drivers in potentially preventing crashes that account for about 3,500 fatalities annually. PAEB research focused on identifying the crash problem, estimating potential benefits, evaluating the current state of technology, and developing test procedures to evaluate PAEB performance in critical scenarios. The project included collaborations with industry (automotive manufacturers), universities, as well as international groups (EuroNCAP), with a focus on optimizing and harmonizing test methods.
- ❖ ***What was learned?*** Analysis of data indicates that there are four scenarios that reflect the most commonly occurring situations during pedestrian crashes. Two pre-crash scenarios with the highest fatalities involved a light vehicle moving forward and striking a pedestrian with the front of the vehicle. The pedestrian was crossing the roadway or adjacent to the roadway moving with or against traffic. Test track work has demonstrated that PAEB technology in certain situations can mitigate, or in some cases completely avoid, a collision with a pedestrian. For detection of pedestrians by a PAEB system, it was found that a pedestrian's

pose is a dominate feature. In terms of potential areas for improvement for PAEB systems, it was found that, with current systems, performance degrades in low-light situations.

❖ **Research Outputs and Outcomes:**

- Completion of preliminary test methods via an industry partnership—Collision Avoidance Metric Partnership (DOT HS 812 040). *FY 2014 completion*
- Completing test track research documenting results of different test mannequins, motion systems, test procedure approaches, potential measures of performance, and vehicle evaluations. *FY 2015-16 completion*
- Estimation of potential safety benefits (DOT HS 812 400). *FY 2017 completion*
- Development of a safety performance test/procedure and criteria. *FY 2018 completion*

❖ **Need for further research:** The research is essentially done; however, the PAEB draft test procedure will be published, and based on any comments received, there may be the need for test procedure refinement.

❖ **Will non-Federal stakeholders contribute to further research?** After the Draft procedure is published, there could be comments received which require some follow-on activities and collaboration with stakeholders. However, since industry has participated significantly and provided expertise and input to the PAEB research program, it is not envisioned there will be a need for significant additional research by either Federal or non-Federal entities.

❖ **Total cost?** \$4,400,000 (for the entire project—all 2014-2018 activities cited above)

❖ **Non-Federal dollars leveraged:** In the industry work with the Collision Avoidance Metrics Partnership, an industry cost share amount of \$570,000 was provided.

## 2. THOR 50<sup>th</sup> Percentile Male Anthropomorphic Test Device (ATD)

❖ **Objectives and activities:** The main objective was to complete research in support of finalizing documentation for the THOR 50th percentile male (THOR-50M) frontal anthropomorphic test dummy (ATD).

❖ **Alignment with DOT Strategic goals:** The research associated with THOR directly supports the Department's safety strategic goal in that it involves the development of a new frontal crash test dummy that can be applied towards developing safer vehicles.

- ❖ **What was learned?** The research demonstrates both the utility of the dummy (new instrumentation, new injury measures) and improved biofidelity (i.e., humanlike response) of the THOR-50M ATD.
- ❖ **What were the research outputs/outcomes?** The research has/will produce by the end of FY 2018 documentation that includes the following:
  - Biofidelity, repeatability & reproducibility (R&R); durability; procedures for assembly, disassembly and inspection (PADI); rationale and methodology for qualification procedures and corridors (R&M); injury criteria
  - Qualification manual, drawing package, 3-D model, seating procedure
  - Publicly available finite element model for computer simulation applications
- ❖ **Does further research need to be done? If yes, for what purpose?** Additional research is planned, which is documenting the potential incorporation of an onboard data acquisition system for THOR to improve its usability. Alternatives to instrumentation and considerations for design updates to support ADS (e.g., reclined posture) are also planned.
- ❖ **Will non-Federal stakeholders contribute to further research? If yes, how much?** Non-Federal stakeholders are not contributing to further research.
- ❖ **What was the total cost?** Over the last ten years, NHTSA has contributed significant funding towards the completion of the THOR-50M ATD. This includes much of the R&R and durability and injury criteria related testing to support the documentation listed above. Costs have also included the upgrade of four THOR dummies as well as the purchasing of four new THOR ATDs. The total costs including the maintenance (calibration, qualification, part replacement) is approximately \$9M.
- ❖ **Were non-Federal dollars leveraged? If so, how much?** The THOR dummies have been loaned out to test labs where OEMs were given the opportunity to run crash tests that utilized our NHTSA-owned THORs. In return, as part of loan agreements between NHTSA and the associated test labs, NHTSA received the data from these tests. These crash tests supported our overall program to assess the performance of THOR in frontal crash testing. Approximately 85 such OEM tests have been completed to date. The typical cost of a crash test of this nature is roughly \$20K plus the cost of the vehicle. The only cost to NHTSA was the shipment of the dummy to the associated test labs.
  - NHTSA loaned a THOR dummy to JARI for completion of sled-test data that were used for biofidelity assessments of the THOR-50M.

- Humanetics Innovative Solutions completed their own in-house revisions to the THOR-50M that we partially incorporated into the final design of THOR.
- Other European-led efforts (e.g., EU-THORAX) contributed to improvements in shoulder biofidelity.



**Section 1—Program Descriptions, FY 2019**

**FY 2019 RD&T Program Funding Details**

<b>RD&amp;T Program Name</b>	<b>FY 2019 Enacted Budget (\$000)</b>	<b>FY 2019 Basic (\$000)</b>	<b>FY 2019 Applied (\$000)</b>	<b>FY 2019 Development (\$000)</b>	<b>FY 2019 Technology (\$000)</b>
Vehicle Electronics and Emerging Technologies	25,000,000		\$25,000,000		
Advance Safety Technologies	\$9,215,800		\$9,215,800		
Crashworthiness	\$13,110,200		\$13,110,200		
Alternative Fuel Vehicle Safety	\$674,000		\$674,000		
Vehicle Research & Test Center	\$500,000		\$500,000		
Highway Safety Research	\$11,748,000		\$6,254,000		\$5,494,000
<b>Totals</b>	<b>\$60,248,000</b>		<b>\$54,754,000</b>		<b>\$5,494,000</b>

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

<b>RD&amp;T Program Name</b>	<b>FY 2019 Enacted Budget (\$000)</b>	<b>SAFETY (\$000)</b>	<b>INFRA-STRUCTURE (\$000)</b>	<b>INNOVATION (\$000)</b>	<b>ACCOUNT-ABILITY (\$000)</b>
Vehicle Electronics and Emerging Technologies	\$25,000,000	\$25,000,000			
Advanced Safety Technologies	\$9,215,800	\$9,215,800			
Crashworthiness	\$13,110,200	\$13,110,200			
Alternative Fuel Vehicle Safety	\$674,000	\$674,000			
Vehicle Research & Test Center	\$500,000	\$500,000			
Highway Safety Research	\$11,748,000	\$6,254,000		5,494,000	
<b>Totals</b>	<b>\$60,248,000</b>	<b>\$54,754,000</b>		<b>\$5,494,000</b>	

## *Office of Vehicle Safety Research*

### **Vehicle Electronics and Emerging Technologies \$25,000,000**

**Program Description/Activities:** The primary focus of this program is on automated driving systems (SAE Levels 3-5 as defined in SAE J3016) as well as electronics systems safety for all vehicles (automated and non-automated), including a strong emphasis on cybersecurity and electronics reliability research. In automated driving systems, the program will address several important areas that are critical to building a strong safety assurance approach for automated vehicles, namely: continuing to develop and define testable scenarios for automated driving concepts expected to emerge over the next several years, i.e. defining what needs to be tested; continuing to develop physical and virtual test methods for ADS systems (i.e. given a set of scenarios, what test methods are available to use); developing performance criteria (i.e. once a physical or virtual test is run and data is collected, what safety metrics should be used such that an evaluation can be done on how well the ADS system performed from a safety perspective). Other key ADS research areas include: Supporting the adaptation and modification of existing FMVSSs to facilitate continued ADS technology innovation; crashworthiness/occupant protection research to address anticipated future designs that do not have conventional seating, including the development of advanced occupant protection test tools and simulation methods; human factors research to address driver engagement strategies for L3 and dual-use L4 vehicles, address driver transitioning in L3 vehicles, research issues related to telltales and HMI concepts needed for ADS systems so they properly communicate to passenger as well as vehicle, pedestrian, bicyclists, etc. external to the vehicle, and address the needs of vulnerable road users such as the disabled community by researching what design elements are needed on vehicles used as part of future mobility services.

In the electronics areas, the research will address both cybersecurity as well as electronics reliability. For cybersecurity, the program includes: application of the NIST cybersecurity framework to automotive architectures, work to enhance the agency's incident tracking and response readiness, applied research to develop vehicle software testing capabilities, an evaluation of wireless interface vulnerabilities, and initial research to explore potential cybersecurity performance metrics. In the area of electronics reliability, the program includes research on the functional safety of ADS vehicles as well as initial research focused on evaluating the safety implications and potential for sensor degradation over a vehicle lifetime (sensors used in advanced technology safety systems).

This program is not a statutory mandate. We will continue to collaborate with internal agencies on funding and other research programs. The program meets the annual funding appropriations act's requirement to conduct safety research.

**Program Alignment with Strategic Goals:** In support of NHTSA's Strategic Goals and Objectives 2016-2020, the NHTSA's Vehicle Electronics and Emerging Technologies program conducts testing, research, and data collection and analysis to support its safety mission in addressing system safety performance,

and driver behavior. It further develops methods, tools, and procedures, as well as conduct engineering analysis and testing of possible safety concerns and countermeasures across the full spectrum of prevention, mitigation, and response.

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

**How does this program support DOT’s Strategic Goals and/or the Strategic Objectives under each of these goals?** All VSR’s program efforts are directed at DOT’s priority in "building upon DOT's legacy of safety" and the strategic goal of “improving public health and safety by reducing transportation-related fatalities and injuries for all users, working toward no fatalities across all modes of travel." This aligns with NHTSA's mission to "save lives, prevent injuries, and reduce economic costs due to road traffic crashes through education, research, safety standards, and enforcement activity." This program does not have any impact on rural communities.

**Program Objectives:** NHTSA will continue to carry out needed research in coordination with other offices and organizations and will also be closely coordinated with the Advanced Safety Technologies Program (focused on SAE Level 0-2 technologies) as described further in this document. Preliminary research indicates that there is the potential for significant safety enhancement associated with ADS-equipped vehicles. This program area is focused on building the knowledge to support agency decisions with respect to regulatory updates needed to enable innovative concepts, develop the necessary tools and knowledge to evaluate the safety of these systems, and perform the research necessary to determine if current tools can properly evaluate the safety of new vehicle designs from passenger vehicles to commercial motor vehicles. NHTSA is also addressing other core research associated with these systems such as software safety, vehicle cybersecurity, and human factors needs. The program is performing research into methods and performance metrics that can provide appropriate measure to assess the quality of risk management effectiveness for ADS-equipped vehicles. Research collaboration is performed to leverage resources, knowledge, and best practices. Collaboration also includes other governmental entities including the Department of Homeland Security (DHS), National Institute of Standards and Technology (NIST), Department of Defense (DOD), and the National Science Foundation (NSF). NHTSA will pursue the following activities:

- Perform research to support development of a safety assurance framework, testing capabilities, and safety metrics for ADS systems;
- Perform research to support modification of the FMVSS to facilitate continued technology innovation for ADS;
- Develop test tools to support the development of capabilities for testing crashworthiness aspects of future vehicle designs that use alternative seating arrangements;

- Perform human factors research to address key issues such as driver engagement and transitioning in L3/dual use L4 systems, HMI and telltale needs to ADS-equipped vehicles, and address vulnerable and disabled road user needs – both inside and outside the vehicle;
- Perform electronics reliability research to evaluate the impacts over a vehicle’s lifetime on advanced sensors (i.e. calibration, maintenance, reliability, and potential for performance degradation);
- Assess, from a functional safety perspective, safety critical subsystems for ADS including perception, decision-support software, and on-board communication systems; and
- Perform cybersecurity research to:
  - Determine feasibility and utility of applying the NIST framework to automotive architectures;
  - Enhance cybersecurity assessment, incident tracking and response capabilities; and
  - Perform applied laboratory research in the areas of software testing, wireless interface vulnerability assessment, and cybersecurity performance metric development.

Manufacturers continue to introduce new features into modern vehicles at a record pace. What enables many of the new features is software and other advanced technologies. As vehicles become more and more complex, in an already complex supply chain structure, the amount of necessary time and effort to exhaustively test complex interactions of subsystems for safety and cybersecurity put pressure on time-to-market urgency exerted on the developers from a business side. This program enhances NHTSA’s ability to understand the vehicle platform as it evolves from a primarily mechanical tool to a highly complex computerized and automated consumer product, as well as its impact on the safety outcomes to carry out its mission in the new era of emergent technologies and vehicle electronics. The Vehicle Electronic and Emerging Technologies program supports the Department’s critical research priority to address performance-based regulations and safety. In addition, it also supports two other DOT research priorities - improving mobility for underserved communities and cybersecurity.

**Research Collaboration Partners:** NHTSA collaborates with Intelligent Transportation Systems Joint Program Office (ITS JPO), FMCSA, Federal Highway Administration (FHWA), and Federal Transit Administration (FTA) on studies related to light vehicle, heavy truck, and motorcoach electronics, functional safety, and cybersecurity. NHTSA collaborates with other government agencies as well, including the DHS, DOD, DOE, and FCC in sharing research being conducted with emerging technology, their testing, assessment and cyber resiliency. NHTSA also collaborates with research institutions and private sector to access cutting-edge technologies to be scientifically and objectively studied without the need to exchange proprietary intellectual property.

NHTSA’s VSR office regularly meets with the public and other stakeholders (industry, safety advocates) to seek feedback, prioritize, and to communicate status of projects aimed at improving vehicle safety and projects are often set up to partner directly with stakeholders to conduct the research. We also publish reports and data to seek feedback from all interested parties. Additionally, we host public

meetings and submit research reports for public comment such that the targeted customer has an opportunity to review and comment on the research products. The output or results are then published at the top conference venues in which the targeted end users participate. The input NHTSA receives from these exchanges are considered when executing current research and in planning future research priority areas.

**Acquisition/Assistance:** This program utilizes the competitive procurement process. Projects' contractual documents specify research for the intended purpose and are reviewed and approved by senior management and acquisition personnel. Federal personnel and contractors are accountable for performing work on schedule. Most NHTSA research is conducted using performance-based contracts. Contractor performance is monitored for current/past performance and is considered in the award process. Additionally, annual performance plans for Federal project managers contain milestones and deliverables used to assess performance.

NHTSA's VSR program mostly allocates funding using a broadly competitive process based on merit. Project contract documents are prepared by experienced engineers with significant technical expertise. Contract officers review and approve from a contractual perspective and senior managers review technical approaches, progress, and results. Some program needs can only be met by one source, so a very limited number of sole-source acquisitions are necessary. In such cases, the processes used to distribute funds with sole-source justification are thoroughly described and documented. Regular internal and external peer reviews of NHTSA VSR projects is a standard practice to maintain program quality and integrity. NHTSA's Research budget is broken up into two budgets of 1- and 2-year funds. This program does not leverage non-Federal funds.

### **Technology Transfer (T2):**

- ❖ **T2 stakeholders:** NHTSA's vehicle safety research program has a long history of working collaboratively with academia, industry, and other Federal and public partners to develop tools that can help mitigate the injuries and fatalities that result from motor vehicle crashes.
- ❖ **Intended audience and outreach:** The program's research, reports, and products are communicated on an ongoing basis to the public through public meetings, requests for comment, conferences, through publication on the agency's website and National Transportation Library (NTL). Electronic test data are available to the public through online databases, which are accessible through the agency's website.
- ❖ **Measuring the performance of T2 activities:** Timeliness of research completion is one measure—schedules with milestones for the projects deliverables are established and closely tracked. For public notices, the agency can assess this in part through the number of public

comments received. For reports and data on NHTSA's website, the number of downloads and web logins are measured. For example, in 2017, NHTSA's data, videos, photos, and reports were downloaded an average of 278 k per month, totaling 3.3 million downloads for the year.

- ❖ **Funding or other resources for T2 activities:** There is no specific allocation for T2 activities, but NHTSA spends approximately \$500k for updates and maintenance to its electronic test data web site.
- ❖ **Represented in the US DOT Research Hub and NTL Digital Library:** Yes, NHTSA's research program, particularly the VSR program, has within the last year completely revamped its process for research products including dedicated personnel to ensure work products are placed into the Research Hub and NTL library. Although, work products are not yet completely up-to-date on the US DOT Research Hub and NTL Digital Library, the VSR program expects to make significant progress this year in doing so. The programs target is to start with VSR's most recent products and work backwards, until fully updated. In the end, links to final reports (and to the data in some cases) will all be added to the Research Hub entry. Currently, our metric is the number of NHTSA vehicle safety web site research report downloads and electronic test data web logins and downloads.
- ❖ **T2 process, the roles they play, the activities they undertake, the results of such activities, and how you measure T2 performance (e.g. adoption/implementation rates):** This section was reviewed to ensure it outlines the information listed above. NHTSA is a regulatory oversight agency and directly aligns with the objectives of Technology Transfer, when applicable. For example, NHTSA performs research on crash test dummies which are developed in coordination with the regulation community and other stakeholders. The VSR program supports agency decision making and advances the state of the knowledge in the agency and in the field. See Technology Transfer sections throughout Annual Modal Research Plan for additional details.

**Evaluation / Performance Measurement: Does it establish performance baselines (tailored to given research areas), analyze emergent trends, and evaluate benefits created through DOT-sponsored research?** Within the VSR program, deliverables, dates, and performance measures are set for each specific internal and contract research project, which are reviewed throughout the lifecycle of the project. These deliverable items are carefully monitored and contractor performance is recorded in the Contractor Performance Assessment Reporting System (CPARS). Project long-term goals align with all Departmental and Agency Strategic Planning and Performance Management initiatives under the GPRA Modernization Act towards achievement of NHTSA's mission. VSR works with NHTSA's Offices of Government Affairs and Strategic Planning and Budget to set its performance goals and indicators. Given these are living documents updated on a set schedule, targets are usually set for the next 3-5 years and revisited and revised as necessary given performance data and trends, which are documented

as part of the explanation for changes. These are then reflected in all Agency planning and reporting documents (e.g., budget submissions, strategic and performance plans, etc.). Longer term (5-10 years) performance measures are usually set as Department/Agency visionary goals (e.g., Vision Zero). Annually, NHTSA reviews and updates its metrics as part of the Office of the Secretary of Transportation's Performance Management Review process. See DOT FY2015 Annual Performance Report and FY2017 Annual Performance Plan. See <https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

Likewise, when new vehicle safety countermeasures are encouraged by NHTSA, either through voluntary agreements, the New Car Assessment Program (NCAP), and/or regulation, NHTSA's NCSA typically does a review of the efficacy of NHTSA's actions at some point after implementation to determine effectiveness in reducing injuries/fatalities due to motor vehicle crashes which correlate to DOT's and NHTSA performance metrics, both short and long term. On a routine basis, the Office of the Secretary of Transportation also meets with the modal administrations to review its progress towards meeting performance targets and indicators, as mentioned, under its internal Performance Management Review Process. Currently, the Agency is able to discuss trends which may impact meeting strategic goals and its planned approaches to get back on track or otherwise. Additionally, as an agency, NHTSA completes estimates for the effectiveness of new programs in reducing injuries and fatalities for the associated crash/road user types. Long-term, NHTSA also completes a regulatory analysis to evaluate the actual effectiveness of a program (generally ~10 years after introduction to allow fleet coverage to increase and for collection of sufficient field data to support analysis).

Additionally, annual performance plans for leadership and Federal projects manage certain milestones and deliverables used to assess performance. See NHTSA Annual Budget request submissions: <https://www.nhtsa.gov/about-nhtsa/nhtsa-budget-information>.

**Do any of the measures/metrics in the DOT Strategic Plan, Annual Performance Plan, or Program Evaluation (OST CFO initiative) apply to this program?** At the Departmental level, surface transportation safety is measured through its annual overall outcome performance measures of reducing the fatality rates of passenger vehicle occupants; non-occupants (pedestrians and bicyclists); motorcycle riders; and large truck and bus occupants. NHTSA tracks and reports on these outcome measures for the Agency through data collected by its NCSA. The VSR Office does not individually track such performance measures. Tracking and reporting is in coordination with OST guidance. In addition, NHTSA has agency-specific strategic goals with specific performance indicators it tracks, monitors, and reports on surrounding Safety; Proactive Vehicle Safety; Automated Vehicles; Human Choices; and Organizational Excellence.

NHTSA's VSR program directly aligns with its Annual Modal Research Plan and NHTSA's Research and Rulemaking Priority Plan for Vehicle Safety, 2015 to 2017 (update in development). In addition, like past practice, the Agency is currently preparing an updated agency research portfolio, and it hosted a public

meeting where it presented the plan and sought stakeholder feedback for consideration prior to finalization.

Likewise, NHTSA supports DOT's Accountability strategic goal to "serve the nation with reduced regulatory burden and greater efficiency, effectiveness, and accountability" with its work to remove unnecessary barriers to allow for innovation and emerging technologies.

See Evaluation and Performance Measurement sections throughout Annual Modal Research Plan for additional details.

**What measures/metrics do you use to track program performance?** See Appendix A

**Trend data and target for the coming fiscal year:** See Appendix A and DOT FY 2015 Annual Performance Report/FY2017 Annual Performance Plan:

<https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

**Program performance:** See Appendix A and DOT FY 2015 Annual Performance Report and FY2017 Annual Performance Plan: <https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>



## Advanced Safety Technologies

\$9,215,800

**Program Description/Activities:** The Advanced Safety Technologies program includes both light and heavy vehicle research and is primarily focused on technology innovations that map to SAE Levels 0-2 (as defined SAE J3016). These types of systems play a primary role in assisting drivers to avoiding crashes.

NHTSA data shows that 37,461 lives were lost on U.S. roads in 2016, an increase of 5.6 percent from calendar year 2015. The number of fatalities between 2014 (32,744) and 2015 (35,485) increased at an even greater level, 8.4 percent. These statistics support the need for an increased emphasis on crash avoidance and driver assistance technologies with significant potential to reduce fatalities and injuries by preventing the crash from occurring, or significantly reducing the severity of crashes by providing timely warnings to the driver to take appropriate action. Such technologies also may support automatic braking or steering interventions to provide additional safety benefits. Further, active safety systems that assist drivers to avoid crashes (SAE Level 0 systems) are precursors and necessary building blocks for driving automation systems (SAE Automation Levels 1-5), which are beginning to appear in vehicle manufacturers' product development plans and are even emerging in the marketplace today in early forms at the lower levels of automation. In addition to systems that actively assist the driver to avoid a crash, there are also other passive automotive technology innovations that the agency needs to address through research. Examples include advanced lighting systems such as adaptive driving beam headlighting systems and camera monitoring systems that have potential to replace side view mirrors. For these and other innovations not yet allowed by current FMVSS standards, the agency needs research data to facilitate next steps policy decisions. This program is not statutorily mandated.

**Program Alignment with Strategic Goals:** In support of NHTSA's Strategic Goals and Objectives 2016-2020, the crash avoidance program conducts testing, research, and crash data analysis to support its safety oversight mission in addressing crash avoidance and driver behavior impacting safety outcomes through technology, developing necessary methods, guidance, tools, and procedures, as well as conducting engineering analysis and testing of possible safety concerns and countermeasures across the full spectrum of prevention, mitigation, and response in crash scenarios.

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

**How does this program support DOT's Strategic Goals and/or the Strategic Objectives under each of these goals?** All VSR's program efforts are directed at DOT's priority of "building upon DOT's legacy of safety" and the strategic goal of "improving public health and safety by reducing transportation-related fatalities and injuries for all users and working toward no fatalities across all modes of travel." This aligns with NHTSA's mission to "save lives, prevent injuries, and reduce economic costs due to road

traffic crashes through education, research, safety standards, and enforcement activity." Advanced Safety Technologies research that focuses on active and passive driver assistance technologies directly supports safety and innovation and has an impact on all communities.

**Program Objectives:** NHTSA continues to fulfill its mission of saving lives, preventing injuries, and reducing traffic-related health care and other economic costs by facilitating the development, deployment, and evaluation of active and passive safety systems that help drivers avoid crashes. Among other activities, this involves research into both the science of, and human interaction with, driver assistance technologies to enable the development and evaluation of safety-enhancing products. The Advanced Safety Technologies program supports the Department's critical research priority to address performance based regulations and safety.

The program's main goal is to prevent crashes and reduce automotive-related fatalities through innovative vehicle technologies. The research contributes to this goal by developing publicly available data, tools, performance measures, and procedures that both NHTSA and industry uses to understand how crashes can be avoided or mitigated.

Advanced Safety Technologies research in the light vehicle area will: develop objective test procedures and performance evaluation methods; evaluate system reliability, unintended consequences, and potential safety benefits of discrete technologies; understand performance characteristics and operational envelope of crash avoidance technology and systems; and assist the agency in developing approaches to addressing potential regulatory barriers for emerging driver assistance systems.

The human factors portion of this program area will help develop the community's understanding around the safety impacts of human-machine interface approaches as well as potential longer term behavioral changes related to driver assistance systems and how they might impact safety outcomes. This research provides the basis for manufacturers to make incremental improvements in their next generation systems and would improve the societal safety benefits achieved with deployed technology.

The heavy vehicle portion of the program will focus on new passive technology innovations (camera monitoring systems) and evaluation of crash data in the medium duty segment (class 3-6) to identify potential new safety countermeasures.

This program supports the entire private sector and does not benefit a single entity. Research on evolving advanced technologies and the development of safety assessment tools is intended for widespread use in automotive design that would lead to high societal benefits.

**Research Collaboration Partners:** NHTSA collaborates and reviews FHWA, FMCSA, FTA, and PHMSA studies on light vehicle, heavy truck, and motorcoach safety. NHTSA collaborates with other government agencies as well including the DHS, DOD, DOE, and FCC in sharing research being conducted

with emerging technology. NHTSA also collaborates with research institutions and the private sector to access cutting-edge technologies to be scientifically and objectively studied without the need to exchange proprietary intellectual property.

NHTSA VSR regularly meets with the public and other stakeholders (industry, safety advocates) to seek feedback, prioritize, and to communicate status of projects aimed at improving vehicle safety and projects are often set up to partner directly with stakeholders to conduct the research. We also publish reports and data to seek feedback from all interested parties. Additionally, NHTSA VSR frequently hosts public meetings and submits research reports for public comment such that the targeted customer has an opportunity to review and comment on the research products. The output or results are then published at the top conference venues in which the targeted end users participate. The input NHTSA receives from these exchanges are considered when executing current research and in planning future research priority areas.

**Acquisition/Assistance:** This program utilizes the competitive procurement process. Projects' contractual documents specify research for the intended purpose and are reviewed and approved by senior management and acquisition personnel. Federal personnel and contractors are accountable for performing work on schedule. Most NHTSA research is conducted using performance-based contracts. Contractor performance is monitored for current/past performance and is considered in the award process. Additionally, annual performance plans for Federal project managers contain milestones and deliverables used to assess performance.

NHTSA's VSR program mostly allocates funding using a broadly competitive process based on merit. Project contract documents are prepared by experienced engineers with significant technical expertise. Contract officers review and approve from a contractual perspective and senior managers review technical approaches, progress, and results. Some program needs can only be met by one source, so a very limited number of sole-source acquisitions are necessary. In such cases, the processes used to distribute funds with sole-source justification are thoroughly described and documented. Regular internal and external peer reviews of VSR projects are a standard practice to maintain program quality and integrity. The NHTSA research budget is broken up into two budgets of 1- and 2-year funds. This program does not leverage non-Federal funds.

### **Technology Transfer (T2):**

- ❖ **T2 stakeholders:** NHTSA's VSR program has a long history of working collaboratively with academia, industry, and other Federal and public partners to develop tools that can help mitigate the injuries and fatalities that result from motor vehicle crashes.
- ❖ **Intended audience and outreach:** The program's research, reports, and products are communicated on an ongoing basis to the public through public meetings, requests for

comment, conferences, and through publication on the agency's website. Electronic test data are available to the public through online databases, which are accessible through the agency's website.

- ❖ ***Measuring the performance of T2 activities:*** Timeliness of research completion is one measure—schedules with milestones for the projects deliverables are established and closely tracked. For public notices, the agency can assess this in part through the number of public comments received. For reports and data on NHTSA's website, the number of downloads and web logins are measured. For example, in 2017, NHTSA's data, videos, photos, and reports were downloaded an average of 278 k per month, totaling 3.3 million downloads for the year.
- ❖ ***Funding or other resources for T2 activities:*** There is no specific allocation for T2 activities, but the Agency spends \$496k for updates and maintenance to its electronic test data web site.
- ❖ ***Represented in the US DOT Research Hub and NTL Digital Library:*** Yes, but now, NHTSA's VSR products are not current on the US DOT Research Hub and NTL Digital Library. NHTSA's VSR Office is working to get the hub and library back up to date so that when research projects are completed, a link to the final report (and to the data in some cases) is added to the Research Hub entry. Currently, our metric is the number of NHTSA vehicle safety web site research report downloads and electronic test data web logins and downloads.
- ❖ ***Method of reporting T2 Annual Performance activities:*** Yes, but currently NHTSA's vehicle safety research products are not up-to-date on the US DOT Research Hub and NTL Digital Library. NHTSA's VSR Office is currently in the planning stages to begin work internally to re-establish its process which will define the people and organizations involved in the T2 process, the roles they play, the activities they undertake, the results of such activities, and how the office will measure T2 performance (e.g. adoption/implementation rates). The target is to start with VSR's most recent products and work backwards, until fully updated. In the end, links to final reports (and to the data in some cases) will all be added to the Research Hub entry. Currently, our metric is the number of NHTSA vehicle safety web site research report downloads and electronic test data web logins and downloads.
- ❖ ***T2 process, the roles they play, the activities they undertake, the results of such activities, and how you measure T2 performance (e.g. adoption/implementation rates):*** This section was reviewed to ensure it outlines the information listed above. NHTSA is a regulatory oversight agency and directly aligns with the objectives of Technology Transfer, when applicable. For example, NHTSA performs research on crash test, dummies which are developed in coordination with the regulation community and other stakeholders. The VSR program supports agency decision making and advances the state of the knowledge in the

agency and in the field. See Technology Transfer sections throughout Annual Modal Research Plan for additional details.

**Evaluation / Performance Measurement:** Within the VSR program, deliverables, dates, and performance measures are set for each specific internal and contract research project, which are reviewed throughout the lifecycle of the project. These deliverable items are carefully monitored and contractor performance is recorded in the Contractor Performance Assessment Reporting System (CPARS). Project long-term goals align with all Departmental and Agency Strategic Planning and Performance Management initiatives under the GPRA Modernization Act towards achievement of NHTSA's mission. VSR works with NHTSA's Offices of Government Affairs and Strategic Planning and Budget to set its performance goals and indicators. Given these are living documents updated on a set schedule, targets are usually set for the next 3-5 years and revisited and revised as necessary given performance data and trends, which are documented as part of the explanation for changes. These are then reflected in all Agency planning and reporting documents (e.g., budget submissions, strategic and performance plans, etc.). Longer term (5-10 years) performance measures are usually set as Department/Agency visionary goals (e.g., Vision Zero). Annually, NHTSA reviews and updates its metrics as part of the Office of the Secretary of Transportation's Performance Management Review process. See DOT FY2015 Annual Performance Report and FY2017 Annual Performance Plan. See <https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

Likewise, when new vehicle safety countermeasures are encouraged by NHTSA, either through voluntary agreements, the New Car Assessment Program (NCAP), and/or regulation, NHTSA's NCSA typically does a review of the efficacy of NHTSA's actions at some point after implementation to determine effectiveness in reducing injuries/fatalities due to motor vehicle crashes which correlate to DOT's and NHTSA performance metrics, both short and long term. On a routine basis, the Office of the Secretary of Transportation also meets with the modal administrations to review its progress towards meeting performance targets and indicators, as mentioned, under its internal Performance Management Review Process. Currently, the Agency is able to discuss trends which may impact meeting strategic goals and its planned approaches to get back on track or otherwise. Additionally, as an agency, NHTSA completes estimates for the effectiveness of new programs in reducing injuries and fatalities for the associated crash/road user types. Long-term, NHTSA also completes a regulatory analysis to evaluate the actual effectiveness of a program (generally ~10 years after introduction to allow fleet coverage to increase and for collection of sufficient field data to support analysis).

Additionally, annual performance plans for leadership and Federal projects manage certain milestones and deliverables used to assess performance. See NHTSA Annual Budget request submissions: <https://www.nhtsa.gov/about-nhtsa/nhtsa-budget-information>.

**What measures/metrics do you use to track program performance?** See Appendix A

**Do any of the measures/metrics in the DOT Strategic Plan, Annual Performance Plan, or Program Evaluation (OST CFO initiative) apply to this program?** At the Departmental level, surface transportation safety is measured through its annual overall outcome performance measures of reducing the fatality rates of passenger vehicle occupants; non-occupants (pedestrians and bicyclists); motorcycle riders; and large truck and bus occupants. NHTSA tracks and reports on these outcome measures for the Agency through data collected by its NCSA. The VSR Office does not individually track such performance measures. Tracking and reporting is in coordination with OST guidance. In addition, NHTSA has agency-specific strategic goals with specific performance indicators it tracks, monitors, and reports on surrounding Safety; Proactive Vehicle Safety; Automated Vehicles; Human Choices; and Organizational Excellence.

NHTSA's VSR program directly aligns with its Annual Modal Research Plan and NHTSA's Research and Rulemaking Priority Plan for Vehicle Safety, 2015 to 2017 (update in development). In addition, like past practice, the Agency is currently preparing an updated agency research portfolio, and it hosted a public meeting where it presented the plan and sought stakeholder feedback for consideration prior to finalization.

Likewise, NHTSA supports DOT's Accountability strategic goal to "serve the nation with reduced regulatory burden and greater efficiency, effectiveness, and accountability" with its work to remove unnecessary barriers to allow for innovation and emerging technologies.

See Evaluation and Performance Measurement sections throughout Annual Modal Research Plan for additional details.

**What measures/metrics do you use to track program performance?** See Appendix A

**Trend data and target for the coming fiscal year:** See Appendix A and DOT FY 2015 Annual Performance Report/FY2017 Annual Performance Plan:

<https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

**Program performance:** See Appendix A and DOT FY 2015 Annual Performance Report and FY2017 Annual Performance Plan: <https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

## Crashworthiness

\$13,110,200

**Program Description/Activities:** Crashworthiness research focuses on vehicle safety countermeasures to reduce the number of serious injuries and fatalities that occur from motor vehicle crashes in the United States each year. This research program is responsible for developing and upgrading test procedures for evaluating motor vehicle safety and developing the test devices, such as crash test dummies, and appropriate injury metrics. Crashworthiness research encompasses new and improved vehicle design, biomechanics, injury causation, field data collection, and analysis of serious injury cases, safety countermeasures, and vehicle equipment to enhance occupant safety. This program is not statutorily mandated.

**Program Alignment with Strategic Goals:** In support of NHTSA's Strategic Goals and Objectives 2016-2020, the Crashworthiness Program conducts testing, research, and crash data collection and analysis to support its safety oversight mission in addressing occupant protection; developing necessary FMVSSs, guidance, tools, and procedures; and conducting engineering analysis and testing of possible safety concerns and countermeasures across the full spectrum of prevention, mitigation, and response.

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

**How does this program support DOT's Strategic Goals and/or the Strategic Objectives under each of these goals?** All VSR's program efforts are directed at DOT's priority of "building upon DOT's legacy of safety" and the strategic goal of "improving public health and safety by reducing transportation-related fatalities and injuries for all users [and] working toward no fatalities across all modes of travel." This aligns with NHTSA's mission to "save lives, prevent injuries, and reduce economic costs due to road traffic crashes through education, research, safety standards, and enforcement activity." NHTSA supports the FHWA on the crash safety evaluation of roadside infrastructure. Vehicle crash safety research has impacts for all communities.

**Program Objectives:** The purpose of this research program is to investigate the problems of vehicle crash safety and associated factors (e.g., vehicle design, human response/injury tolerance) that contribute to serious injuries and fatalities. The near-term goal is to identify fatality and injury trends and to enhance safety requirements and best practices to improve crash occupant outcomes. The NHTSA VSR, Crashworthiness program supports the Department's critical research priority to address performance based regulations and safety.

The Biomechanics research program makes significant contributions to safety by developing publicly available data, tools, performance measures, and procedures that NHTSA and industry use, both to understand how occupants are injured in crashes and for assessment of vehicle safety countermeasures. The Biomechanics research program also works with trauma centers to understand the detailed nature of occupant injuries. The causes of these injuries are evaluated through laboratory test programs and used to refine the design of crash test dummies and injury measures. These tools are then utilized to support vehicle safety development. In 2019, Biomechanics research will focus on completing biofidelity testing and development of associated requirements for tools (ATDs, computer models) resulting in tools that will increase both agency and industry's ability to test occupant protection safety in frontal, side, oblique, and rear impact crash modes. This includes the ability to test occupant protection for small stature females (5<sup>th</sup> percentile). In addition, the program focuses significantly on vulnerable populations (pedestrians, children, and older occupants). Pedestrian research will focus on completing and evaluating test tools to assess vehicle countermeasures addressing pedestrian safety. Older occupant research focuses on evaluate leading injury mechanisms for older occupants - brain injuries (subdural hematoma) and thorax injuries. Child research will include research to develop an advanced frontal child dummy, current test tools lack the ability to assess risk in the most commonly injured body regions for children (head, thorax, and abdomen).

The Safety Systems division conducts research to support agency actions aimed at reducing the number of fatal and serious injuries to occupants in motor vehicles that occur in the United States each year from crashes. This research program is responsible for evaluating new crash safety concerns and for developing safety concepts, test procedures, and performance measures. Safety Systems research examines existing designs, new and improved vehicle designs, safety countermeasures, and equipment to enhance safety for all occupants in the event of a crash. In 2019, Safety Systems research will utilize the tools developed through the Biomechanics program and start to develop strategies for enhancing occupant safety. Areas of focus include vehicle crash compatibility, side impact safety (evaluating new side impact crash test dummies), assessing far side occupant protection, developing test procedures to evaluate safety countermeasures that have potential to reduce roof ejection, frontal impact safety, and child safety to improve usability of child seat attachments in vehicles.

Crashworthiness research supports the entire private sector, but does not benefit a single company. Research on evolving crash injury mechanisms and the development of safety assessment tools is intended for widespread use in automotive design.

**Research Collaboration Partners:** Public Sector—NHTSA reviews and uses FMCSA studies on motorcoach and heavy-truck crashes and fires. NHTSA collaborates with FHWA on developing and conducting crash simulation models. NHTSA works with the Federal Aviation Administration's (FAA) Civil Aerospace Medical Institute on human injury crash tolerance.

Private Sector—NHTSA's VSR Office regularly meets with the public and other stakeholders (industry, safety advocates) to seek feedback, prioritize, and to communicate status of projects aimed at improving



vehicle safety, and projects are often set up to partner directly with stakeholders to conduct the research. We also publish reports and data to seek feedback from all interested parties. Additionally, VSR frequently hosts public meetings and submits research reports for public comment so that the targeted customer has an opportunity to review and comment on the research products. The output or results are then published at the top conference venues in which the targeted end users participate. The input NHTSA receives from these exchanges are considered when executing current research and in planning future research. NHTSA frequently conducts broad-based research meetings with automotive manufacturers, suppliers, safety advocates, and other stakeholders.

**Acquisition/Assistance:** Projects' contractual documents specify research for the intended purpose and are reviewed and approved by senior management and acquisition personnel. Federal personnel and contractors are accountable for performing work on schedule. Most NHTSA research is conducted using performance-based contracts. Contractor performance is monitored for current/past performance and is considered in the award process. Additionally, annual performance plans for Federal project managers contain milestones and deliverables used to assess performance.

NHTSA's VSR program mostly allocates funding using a broadly competitive process based on merit. Project contract documents are prepared by experienced engineers with significant technical expertise. Contract officers review and approve from a contractual perspective and senior managers review technical approaches, progress, and results. Some program needs can only be met by one source, so a very limited number of sole-source acquisitions are necessary. In such cases, the processes used to distribute funds with sole-source justification are thoroughly described and documented. Regular internal and external peer reviews of NHTSA VSR projects is a standard practice to maintain program quality and integrity. NHTSA research budget is broken up into two budgets of 1 and 2 year funds. This program does not leverage non-Federal funds.

### **Technology Transfer (T2):**

- ❖ **T2 stakeholders:** NHTSA's VSR program has a long history of working collaboratively with academia, industry, and other Federal and public partners to develop tools that can help mitigate the injuries and fatalities that result from motor vehicle crashes.
  
- ❖ **Intended audience and outreach:** The program's research, reports, and products are communicated on an ongoing basis to the public through public meetings, requests for comment, conferences, and through publication on the agency's website. Electronic test data are available to the public through online databases, which are accessible through the agency's website.

- ❖ **Measuring the performance of T2 activities:** Timeliness of research completion is one measure—schedules with milestones for the projects deliverables are established and closely tracked. For public notices, the agency can assess this in part through the number of public comments received. For reports and data on NHTSA’s website, the number of downloads and web logins are measured. For example, in 2017, NHTSA’s data, videos, photos, and reports were downloaded an average of 278 k per month, totaling 3.3 million downloads for the year.
  
- ❖ **Funding or other resources for T2 activities:** There is no specific allocation for T2 activities, but the Agency spends \$496k for updates and maintenance to its electronic test data web site.
  
- ❖ **Represented in the US DOT Research Hub and NTL Digital Library:** Yes, but now, NHTSA’s vehicle safety research products are not current on the US DOT Research Hub and NTL Digital Library. NHTSA’s VSR Office is working to get the hub and library back up-to-date so that when research projects are completed, a link to the final report (and to the data in some cases) is added to the Research Hub entry. Currently, our metric is the number of NHTSA vehicle safety web site research report downloads and electronic test data web logins and downloads.
  
- ❖ **Method of reporting T2 Annual Performance activities:** Yes, but currently NHTSA’s vehicle safety research products are not up-to-date on the US DOT Research Hub and NTL Digital Library. NHTSA’s VSR Office is currently in the planning stages to begin work internally to re-establish its process which will define the people and organizations involved in the T2 process, the roles they play, the activities they undertake, the results of such activities, and how the Office will measure T2 performance (e.g. adoption/implementation rates). The target is to start with VSR’s most recent products and work backwards, until fully updated. In the end, links to final reports (and to the data in some cases) will all be added to the Research Hub entry. Currently, our metric is the number of NHTSA vehicle safety web site research report downloads and electronic test data web logins and downloads.
  
- ❖ **T2 process, the roles they play, the activities they undertake, the results of such activities, and how you measure T2 performance (e.g. adoption/implementation rates).** NHTSA is a regulatory oversight agency and directly aligns with the objectives of Technology Transfer, when applicable. For example, NHTSA performs research on crash test, dummies which are developed in coordination with the regulation community and other stakeholders. The VSR program supports agency decision making and advances the state of the knowledge in the agency and in the field. See Technology Transfer sections throughout Annual Modal Research Plan for additional details.

**Evaluation / Performance Measurement:** Within the VSR program, deliverables, dates, and performance measures are set for each specific internal and contract research project, which are reviewed throughout the lifecycle of the project. These deliverable items are carefully monitored and contractor performance is recorded in the Contractor Performance Assessment Reporting System (CPARS). Project long-term goals align with all Departmental and Agency Strategic Planning and Performance Management initiatives under the GPRM Modernization Act towards achievement of NHTSA's mission. VSR works with NHTSA's Offices of Government Affairs and Strategic Planning and Budget to set its performance goals and indicators. Given these are living documents updated on a set schedule, targets are usually set for the next 3-5 years and revisited and revised as necessary given performance data and trends, which are documented as part of the explanation for changes. These are then reflected in all Agency planning and reporting documents (e.g., budget submissions, strategic and performance plans, etc.). Longer term (5-10 years) performance measures are usually set as Department/Agency visionary goals (e.g., Vision Zero). Annually, NHTSA reviews and updates its metrics as part of the Office of the Secretary of Transportation's Performance Management Review process. See DOT FY2015 Annual Performance Report and FY2017 Annual Performance Plan. See <https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

Likewise, when new vehicle safety countermeasures are encouraged by NHTSA, either through voluntary agreements, the New Car Assessment Program (NCAP), and/or regulation, NHTSA's NCSA typically does a review of the efficacy of NHTSA's actions at some point after implementation to determine effectiveness in reducing injuries/fatalities due to motor vehicle crashes which correlate to DOT's and NHTSA performance metrics, both short and long term. On a routine basis, the Office of the Secretary of Transportation also meets with the modal administrations to review its progress towards meeting performance targets and indicators, as mentioned, under its internal Performance Management Review Process. Currently, the Agency is able to discuss trends which may impact meeting strategic goals and its planned approaches to get back on track or otherwise. Additionally, as an agency, NHTSA completes estimates for the effectiveness of new programs in reducing injuries and fatalities for the associated crash/road user types. Long-term, NHTSA also completes a regulatory analysis to evaluate the actual effectiveness of a program (generally ~10 years after introduction to allow fleet coverage to increase and for collection of sufficient field data to support analysis).

Additionally, annual performance plans for leadership and Federal projects manage certain milestones and deliverables used to assess performance. See NHTSA Annual Budget request submissions: <https://www.nhtsa.gov/about-nhtsa/nhtsa-budget-information>.

**Do any of the measures/metrics in the DOT Strategic Plan, Annual Performance Plan, or Program Evaluation (OST CFO initiative) apply to this program?** At the Departmental level, surface transportation safety is measured through its annual overall outcome performance measures of reducing the fatality rates of passenger vehicle occupants; non-occupants (pedestrians and bicyclists);

motorcycle riders; and large truck and bus occupants. NHTSA tracks and reports on these outcome measures for the Agency through data collected by its NCSA. The VSR Office does not individually track such performance measures. Tracking and reporting is in coordination with OST guidance. In addition, NHTSA has agency-specific strategic goals with specific performance indicators it tracks, monitors, and reports on surrounding Safety; Proactive Vehicle Safety; Automated Vehicles; Human Choices; and Organizational Excellence.

NHTSA's VSR program directly aligns with its Annual Modal Research Plan and NHTSA's Research and Rulemaking Priority Plan for Vehicle Safety, 2015 to 2017 (update in development). In addition, like past practice, the Agency is currently preparing an updated agency research portfolio, and it hosted a public meeting where it presented the plan and sought stakeholder feedback for consideration prior to finalization.

Likewise, NHTSA supports DOT's Accountability strategic goal to "serve the nation with reduced regulatory burden and greater efficiency, effectiveness, and accountability" with its work to remove unnecessary barriers to allow for innovation and emerging technologies.

See Evaluation and Performance Measurement sections throughout Annual Modal Research Plan for additional details.

**What measures/metrics do you use to track program performance?** See Appendix A

**Trend data and target for the coming fiscal year:** See Appendix A and DOT FY 2015 Annual Performance Report/FY2017 Annual Performance Plan:

<https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

**Program performance:** See Appendix A and DOT FY 2015 Annual Performance Report and FY2017 Annual Performance Plan: <https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

## Alternative Fuel Vehicle Safety

**\$674,000**

**Program Description/Activities:** Recently introduced vehicle engine technologies, including hydrogen and advanced lithium ion battery vehicles, are being introduced to the market at a fast rate. Additionally, the recent increase in Compressed Natural Gas (CNG)-fueled heavy trucks has introduced new concerns regarding the safety of these vehicle systems. This research will examine the safety issues and promote research to enhance industry best practices. Test procedures and assessment methods will be developed to standardize safety assessment methods. This program is not statutorily mandated. We will continue to collaborate with internal agencies on funding and other research programs. The program meets the annual funding appropriations act's requirement to conduct alternate fuel vehicle safety research.

**Program Alignment with Strategic Goals:** All VSR's program efforts are directed at DOT's priority of "building upon DOT's legacy of safety" and the strategic goal of "improv[ing] public health and safety by reducing transportation-related fatalities and injuries for all users [and] working toward no fatalities across all modes of travel." This aligns with NHTSA's mission to "save lives, prevent injuries, and reduce economic costs due to road traffic crashes through education, research, safety standards, and enforcement activity."

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

**How does this program support DOT's Strategic Goals and/or the Strategic Objectives under each of these goals?** All VSR's program efforts are directed at DOT's priority of "building upon DOT's legacy of safety" and the strategic goal of "improving public health and safety by reducing transportation-related fatalities and injuries for all users [and] working toward no fatalities across all modes of travel." This aligns with NHTSA's mission to "save lives, prevent injuries, and reduce economic costs due to road traffic crashes through education, research, safety standards, and enforcement activity."

**Program Objectives:** Fleet safety testing of lithium ion electric vehicles and charging stations is ongoing to ensure a safe introduction of these vehicles. Test procedures are being developed to better assess the potential for, and the vehicle response to, thermal propagation. NHTSA is working with local jurisdictions to improve response and handling of electric vehicle fires. NHTSA is also evaluating diagnostic methods that can evaluate the health of battery traction motors prior to fire or smoke initiation. The introduction of hydrogen fuel cell vehicles underscores the need to understand the real-world safety of automotive pressure vessels. NHTSA will continue to perform research activities such as

- continuing fleet safety validation testing of high voltage traction battery systems.
- conducting Thermal Propagation testing at the pack- and full-vehicle level to assess test procedure suitability and evaluate performance criteria.
- assessing Battery Management System functionality including all levels of charging.
- developing and evaluating lithium ion battery diagnostics that can detect damage prior to battery fire initiation.
- evaluating the safety of the fiber wrapped pressure vessels used for storing high pressure hydrogen and compressed natural gas in vehicle systems. Refine, demonstrate, and document safety best practices for laboratory testing. This program does not directly benefit rural communities beyond enhancing the safety of alternate fuel vehicles.

NHTSA will assist in the safe introduction of new vehicle fuel systems in the U.S. fleet. Field safety incidents will be investigated and, where appropriate, best practices will be developed to enhance fleet safety. NHTSA will continue to partner with industry, standards organizations, and other Federal agencies to develop appropriate safety performance for new alternative fuel vehicles.

**Research Collaboration Partners:** NHTSA coordinates our alternative fuel safety research with FMCSA and FTA researchers who also study fleet safety of these systems. NHTSA reviews PHMSA standards on lithium ion battery safety and high pressure carbon fiber overwrapped pressure vessels. NHTSA collaborates with FHWA on developing and conducting crash simulation models for electric vehicles and battery packs. NHTSA Research public meetings were used to describe ongoing and planned research and so solicit feedback on future safety concerns. NHTSA participated in the DOT liquefied natural gas safety research meeting.

**Acquisition/Assistance:** This program utilizes the competitive procurement process. Projects' contractual documents specify research for the intended purpose and are reviewed and approved by senior management and acquisition personnel. Federal personnel and contractors are accountable for performing work on schedule. Most NHTSA research is conducted using performance-based contracts. Contractor performance is monitored for current/past performance and is considered in the award process. Additionally, annual performance plans for Federal project managers contain milestones and deliverables used to assess performance.

NHTSA's VSR program mostly allocates funding using a broadly competitive process based on merit. Project contract documents are prepared by experienced engineers with significant technical expertise. Contract officers review and approve from a contractual perspective and senior managers review technical approaches, progress, and results. Some program needs can only be met by one source, so a very limited number of sole-source acquisitions are necessary. In such cases, the processes used to distribute funds with sole-source justification are thoroughly described and documented. Regular internal and external peer reviews of NHTSA VSR projects is a standard practice to maintain program

quality and integrity. NHTSA Research Budget is broken up into two budgets of 1 and 2 year funds. This program does not leverage non-Federal funds.

### Technology Transfer (T2):

- ❖ **T2 stakeholders:** NHTSA's Vehicle Safety Research program has a long history of working collaboratively with academia, industry, and other Federal and public partners to develop tools that can help mitigate the injuries and fatalities that result from motor vehicle crashes.
- ❖ **Intended audience and outreach:** The program's research, reports and products are communicated on an ongoing basis to the public through public meetings, requests for comment, conferences, and through publication on the agency's website. Electronic test data are available to the public through online databases, which are accessible through the agency's website.
- ❖ **Measuring the performance of T2 activities:** Timeliness of research completion is one measure—schedules with milestones for the projects deliverables are established and closely tracked. For public notices, the agency can assess this in part through the number of public comments received. For reports and data on NHTSA's website, the number of downloads and web logins are measured. For example, in 2017, NHTSA's data, videos, photos, and reports were downloaded an average of 278 k per month, totaling 3.3 million downloads for the year.
- ❖ **Funding or other resources for T2 activities:** There is no specific allocation for T2 activities, but the Agency spends \$496k for updates and maintenance to its electronic test data website.
- ❖ **Represented in the US DOT Research Hub and NTL Digital Library:** Yes, but currently NHTSA's vehicle safety research products are not up-to-date on the US DOT Research Hub and NTL Digital Library. NHTSA's VSR Office is currently in the planning stages to begin work internally to re-establish its process which will define the people and organizations involved in the T2 process, the roles they play, the activities they undertake, the results of such activities, and how the Office will measure T2 performance (e.g. adoption/implementation rates). The target is to start with VSR's most recent products and work backwards, until fully updated. In the end, links to final reports (and to the data in some cases) will all be added to the Research Hub entry. Currently, our metric is the number of NHTSA vehicle safety web site research report downloads and electronic test data web logins and downloads.
- ❖ **T2 process, the roles they play, the activities they undertake, the results of such activities, and how you measure T2 performance (e.g. adoption/implementation rates):** This section was reviewed to ensure it outlines the information listed above. NHTSA is a regulatory

oversight agency and directly aligns with the objectives of Technology Transfer, when applicable. For example, NHTSA performs research on crash test, dummies which are developed in coordination with the regulation community and other stakeholders. The VSR program supports agency decision making and advances the state of the knowledge in the agency and in the field. See Technology Transfer sections throughout Annual Modal Research Plan for additional details.

**Evaluation / Performance Measurement:** Within the VSR program, deliverables, dates, and performance measures are set for each specific internal and contract research project, which are reviewed throughout the lifecycle of the project. These deliverable items are carefully monitored and contractor performance is recorded in the Contractor Performance Assessment Reporting System (CPARS). Project long-term goals align with all Departmental and Agency Strategic Planning and Performance Management initiatives under the GPRA Modernization Act towards achievement of NHTSA's mission. VSR works with NHTSA's Offices of Government Affairs and Strategic Planning and Budget to set its performance goals and indicators. Given these are living documents updated on a set schedule, targets are usually set for the next 3-5 years and revisited and revised as necessary given performance data and trends, which are documented as part of the explanation for changes. These are then reflected in all Agency planning and reporting documents (e.g., budget submissions, strategic and performance plans, etc.). Longer term (5-10 years) performance measures are usually set as Department/Agency visionary goals (e.g., Vision Zero). Annually, NHTSA reviews and updates its metrics as part of the Office of the Secretary of Transportation's Performance Management Review process. See DOT FY2015 Annual Performance Report and FY2017 Annual Performance Plan. See <https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

Likewise, when new vehicle safety countermeasures are encouraged by NHTSA, either through voluntary agreements, the New Car Assessment Program (NCAP), and/or regulation, NHTSA's NCSA typically does a review of the efficacy of NHTSA's actions at some point after implementation to determine effectiveness in reducing injuries/fatalities due to motor vehicle crashes which correlate to DOT's and NHTSA performance metrics, both short and long term. On a routine basis, the Office of the Secretary of Transportation also meets with the modal administrations to review its progress towards meeting performance targets and indicators, as mentioned, under its internal Performance Management Review Process. Currently, the Agency is able to discuss trends which may impact meeting strategic goals and its planned approaches to get back on track or otherwise. Additionally, as an agency, NHTSA completes estimates for the effectiveness of new programs in reducing injuries and fatalities for the associated crash/road user types. Long-term, NHTSA also completes a regulatory analysis to evaluate the actual effectiveness of a program (generally ~10 years after introduction to allow fleet coverage to increase and for collection of sufficient field data to support analysis).



Additionally, annual performance plans for leadership and Federal projects manage certain milestones and deliverables used to assess performance. See NHTSA Annual Budget request submissions: <https://www.nhtsa.gov/about-nhtsa/nhtsa-budget-information>.

**Do any of the measures/metrics in the DOT Strategic Plan, Annual Performance Plan, or Program Evaluation (OST CFO initiative) apply to this program?** At the Departmental level, surface transportation safety is measured through its annual overall outcome performance measures of reducing the fatality rates of passenger vehicle occupants; non-occupants (pedestrians and bicyclists); motorcycle riders; and large truck and bus occupants. NHTSA tracks and reports on these outcome measures for the Agency through data collected by its NCSA. The VSR Office does not individually track such performance measures. Tracking and reporting is in coordination with OST guidance. In addition, NHTSA has agency-specific strategic goals with specific performance indicators it tracks, monitors, and reports on surrounding Safety; Proactive Vehicle Safety; Automated Vehicles; Human Choices; and Organizational Excellence.

NHTSA's VSR program directly aligns with its Annual Modal Research Plan and NHTSA's Research and Rulemaking Priority Plan for Vehicle Safety, 2015 to 2017 (update in development). In addition, like past practice, the Agency is currently preparing an updated agency research portfolio, and it hosted a public meeting where it presented the plan and sought stakeholder feedback for consideration prior to finalization.

Likewise, NHTSA supports DOT's Accountability strategic goal to "serve the nation with reduced regulatory burden and greater efficiency, effectiveness, and accountability" with its work to remove unnecessary barriers to allow for innovation and emerging technologies.

See Evaluation and Performance Measurement sections throughout Annual Modal Research Plan for additional details.

**What measures/metrics do you use to track program performance?** See Appendix A

**Trend data and target for the coming fiscal year:** See Appendix A and DOT FY 2015 Annual Performance Report/FY2017 Annual Performance Plan:

<https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

**Program performance:** See Appendix A and DOT FY 2015 Annual Performance Report and FY2017 Annual Performance Plan: <https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

## Vehicle Research and Test Center (VRTC) - Ohio

**\$500,000**

**Program Description/Activities:** The Vehicle Research and Test Center (VRTC) is NHTSA's in-house research, development, test and evaluation facility located in East Liberty, Ohio. VRTC has access to world-class testing facilities like those used by automotive suppliers and manufacturers. Research and testing activities conducted at the VRTC support agency decisions and actions with respect to new vehicle systems and issues; agency consumer information programs; test dummy development; injury criteria development; advanced research into cutting edge technologies; and safety issues that require quick reaction or are sensitive in nature, including defect investigations. The full range of testing and research capabilities available to NHTSA at VRTC allows the agency to maximize its testing capabilities to more rapidly study emerging safety issues and more quickly provide benefits to the American public.

VRTC will continue to collaborate with internal agencies and offices on funding and other research programs. The VRTC program meets the annual funding appropriations act's requirement to conduct research that supports the agency's mission in the program areas cited above (crashworthiness, crash avoidance, vehicle electronics, and automated driving). This program is not statutorily mandated.

**Program Alignment with Strategic Goals:** In support of NHTSA's Strategic Goals and Objectives 2016-2020, VRTC conducts research, testing, data collection and analysis to support the departmental and agency safety mission. VRTC supports a broad range of critical safety areas including Crash Avoidance research to evaluate new technologies that help drivers prevent crashes; Crashworthiness research to improve occupant protection in crashes; Biomechanics research to develop, evaluate, maintain, and improve the agency's vehicle crash test dummies; lab and in-field support for safety defects investigations; and research into complex new areas such as automated vehicles and cybersecurity.

<b>DOT Strategic Goal</b>	<b>DOT RD&amp;T Critical Transportation Topic</b>
Safety	Promoting safety
Innovation	Improving mobility

**How does this program support DOT's Strategic Goals and/or the Strategic Objectives under each of these goals?** VRTC contributes to DOT's innovation goal by developing new cutting edge test tools and methods used to test advanced technologies and improve occupant protect. Recent examples of innovative test tools developed at VRTC and through partnerships with other organizations are (1) development and refinement of a surrogate vehicle (Guided Soft Target) that can be used to dynamically test advanced crash avoidance systems in a test track setting, (2) development of a new 10-year-old test dummy called the Large Omnidirectional Child (LODC) Anthropomorphic Test Device (ATD) which seeks to improve biofidelity in several key areas and ultimately facilitate safety improvements for children.

**Program Objectives:** The FY 2019 funding will be used to procure equipment needed to conduct research and analysis of automated vehicles, cybersecurity, other advanced technologies, or other research and defects analysis efforts to support agency actions to improve safety on our nation's roadways. With new sophisticated electronic control systems emerging in the market, NHTSA needs to maintain a well-equipped and dedicated center to test, monitor, and investigate these and other emerging safety issues. NOTE: the \$500K in direct funding to VRTC is in addition to research funding to support the program areas cited above (vehicle electronics and emerging technologies (automated driving systems), advanced safety technologies, and crashworthiness) and is in addition to support research done in collaboration with other offices within NHTSA (e.g., NHTSA enforcement and rulemaking) as well as offices within the Department (e.g., ITS Joint Program Office).

Considerations for upgrading testing capabilities include instrumentation, hardware, software, and equipment for the following:

- Material and component composition/failure analysis;
- Advanced technology and controls;
- Driving automation systems (specifically ADSs);
- Cybersecurity;
- Electronics reliability; and
- Crashworthiness/Biomechanics.

VRTC conducts testing, research and development necessary to support FMVSSs, recall of defective vehicles, and other safety-engineering objectives to address the crash safety problem. Through efforts in these areas, VRTC directly addresses the vehicle crash problem on our nations roadways. Analysis of crash causation factors imply that a large majority of serious crashes are due to dangerous choices or errors people make behind the wheel. VRTC's research supporting improved crash avoidance, improved occupant protection in a crash, and emerging technology areas (e.g. vehicle automation) are addressing the driver error issue and other crash causation factors such as vehicle defects. The program has as a primary goal evaluating how new technologies and other vehicle safety innovations can potentially improve vehicle safety.

Research conducted at VRTC supports agency vehicle safety programs that include sensitive activities such as safety defects investigations and standards development, compliance testing, and support for policy decisions with respect to advanced cutting edge technologies and support for safety issues that require quick agency response. By their very nature these are not areas that private industry (the market) can address.

Other basic research on new and emerging issues (topics not part of confidential agency matters) is collaborative in nature such as automated vehicle testing, cybersecurity, biomechanics research on new test dummies, and new approaches to occupant protection. This research often involves automotive manufacturers and suppliers.

**Research Collaboration Partners:** Research collaboration partners include vehicle automakers (e.g., GM, Ford, Honda, Toyota, etc.), automotive suppliers (e.g., Bosch, Delphi, Continental), academia (e.g., Virginia Tech Transportation Institute, University of Michigan Transportation Research Institute), other government agencies (Department of Homeland Security, Department of Defense, Department of Justice) as well as safety advocacy groups and the public.

VRTC participates in meetings throughout the year with these key stakeholders and collaboration partners. For example, as part of research exchange meetings with automotive manufacturers, VRTC participates along with many other offices within NHTSA and DOT to discuss the latest vehicle safety innovations and technologies. Collaborative meetings with research collaboration partners occur almost on a weekly basis as NHTSA has discussions on research topics involving outside project partners and contractors. Some of these meetings are hosted directly on-site at VRTC while many others are held at DOT headquarters. For meetings held at DOT headquarters, VRTC participates via videoconference.

As part of the broader vehicle safety research organization, VRTC participates in several public meetings, listening sessions, and workshops throughout the year to gather input on the key topics within the research programs areas, i.e., crashworthiness, crash avoidance, vehicle electronics, and automated driving. These outreach efforts are described in the program area writeups above.

Program partners for VRTC are like those described above for the vehicle safety research programs. These include

- NHTSA offices, including Rulemaking, Enforcement, Office of Chief Counsel, NCSA, and Communications.
- Other DOT agencies: FHWA, FMCSA, FTA, ITS Joint Program Office.
- Industry: automakers, vehicle equipment suppliers.
- Academia (mainly university research institutes).

These programs are intended to share research results and coordinate research plans. VRTC partners with other research centers and academic institutions to carry out its research programs. For VRTC, this includes the Transportation Research Center and The Ohio State University.

**Acquisition/Assistance:** VRTC follows all required processes per Federal Acquisition Regulations (FAR). VRTC uses a sole source approach only if another source can't be found to supply the requirement. For example, warranties for software packages are usually only held by the manufacturer of supply, so therefore you must use the one source available - the software manufacturer. Other times only one source is found to supply the services that are required. In all cases, FAR procedures are followed. VRTC uses both. A multi-year approach is used when the procurement consists of a known requirement that spans a multiple-year time period. Most procurements are done on a single-year or multiple-year basis with optional periods to be exercised. This program does not leverage non-Federal funds.

### **Technology Transfer (T2):**

- ❖ **T2 stakeholders:** NHTSA's Vehicle Safety Research program has a long history of working collaboratively with academia, industry, and other Federal and public partners to develop tools that can help mitigate the injuries and fatalities that result from motor vehicle crashes.
- ❖ **Intended audience and outreach:** The program's research, reports and products are communicated on an ongoing basis to the public through public meetings, requests for comment, conferences, and through publication on the agency's website. Electronic test data are available to the public through online databases, which are accessible through the agency's website.
- ❖ **Measuring the performance of T2 activities:** Timeliness of research completion is one measure – schedules with milestones for the projects deliverables are established and closely tracked. For public notices, the agency can assess this in part through the number of public comments received. For reports and data on NHTSA's website, the number of downloads and web logins are measured. For example, in 2017, NHTSA's data, videos, photos, and reports were downloaded an average of 278 k per month, totaling 3.3 million downloads for the year.
- ❖ **Funding or other resources for T2 activities:** There is no specific allocation for T2 activities, but the Agency spends \$496k for updates and maintenance to its electronic Service Level Agreement data base.
- ❖ **Represented in the US DOT Research Hub and NTL Digital Library:** Yes, but currently NHTSA's vehicle safety research products are not up-to-date on the US DOT Research Hub and NTL Digital Library. NHTSA's VSR Office is currently in the planning stages to begin work internally to re-establish its process which will define the people and organizations involved in the T2 process, the roles they play, the activities they undertake, the results of such activities, and how the Office will measure T2 performance (e.g. adoption/implementation rates). The target is to start with VSR's most recent products and work backwards, until fully

updated. In the end, links to final reports (and to the data in some cases) will all be added to the Research Hub entry. Currently, our metric is the number of NHTSA vehicle safety web site research report downloads and electronic test data web logins and downloads.

- ❖ **T2 process, the roles they play, the activities they undertake, the results of such activities, and how you measure T2 performance (e.g. adoption/implementation rates):** This section was reviewed to ensure it outlines the information listed above. NHTSA is a regulatory oversight agency and directly aligns with the objectives of Technology Transfer, when applicable. For example, NHTSA performs research on crash test, dummies which are developed in coordination with the regulation community and other stakeholders. The VSR program supports agency decision making and advances the state of the knowledge in the agency and in the field. See Technology Transfer sections throughout Annual Modal Research Plan for additional details.

**Evaluation / Performance Measurement:** Within the VSR program, deliverables, dates, and performance measures are set for each specific internal and contract research project, which are reviewed throughout the lifecycle of the project. These deliverable items are carefully monitored and contractor performance is recorded in the Contractor Performance Assessment Reporting System (CPARS). Project long-term goals align with all Departmental and Agency Strategic Planning and Performance Management initiatives under the GPRA Modernization Act towards achievement of NHTSA's mission. VSR works with NHTSA's Offices of Government Affairs and Strategic Planning and Budget to set its performance goals and indicators. Given these are living documents updated on a set schedule, targets are usually set for the next 3-5 years and revisited and revised as necessary given performance data and trends, which are documented as part of the explanation for changes. These are then reflected in all Agency planning and reporting documents (e.g., budget submissions, strategic and performance plans, etc.). Longer term (5-10 years) performance measures are usually set as Department/Agency visionary goals (e.g., Vision Zero). Annually, NHTSA reviews and updates its metrics as part of the Office of the Secretary of Transportation's Performance Management Review process. See DOT FY2015 Annual Performance Report and FY2017 Annual Performance Plan. See <https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

Likewise, when new vehicle safety countermeasures are encouraged by NHTSA, either through voluntary agreements, the New Car Assessment Program (NCAP), and/or regulation, NHTSA's NCSA typically does a review of the efficacy of NHTSA's actions at some point after implementation to determine effectiveness in reducing injuries/fatalities due to motor vehicle crashes which correlate to DOT's and NHTSA performance metrics, both short and long term. On a routine basis, the Office of the Secretary of Transportation also meets with the modal administrations to review its progress towards meeting performance targets and indicators, as mentioned, under its internal Performance Management Review Process. Currently, the Agency is able to discuss trends which may impact meeting strategic goals and its planned approaches to get back on track or otherwise. Additionally, as an agency, NHTSA completes

estimates for the effectiveness of new programs in reducing injuries and fatalities for the associated crash/road user types. Long-term, NHTSA also completes a regulatory analysis to evaluate the actual effectiveness of a program (generally ~10 years after introduction to allow fleet coverage to increase and for collection of sufficient field data to support analysis).

Additionally, annual performance plans for leadership and Federal projects manage certain milestones and deliverables used to assess performance. See NHTSA Annual Budget request submissions: <https://www.nhtsa.gov/about-nhtsa/nhtsa-budget-information>.

**Do any of the measures/metrics in the DOT Strategic Plan, Annual Performance Plan, or Program Evaluation (OST CFO initiative) apply to this program?** At the Departmental level, surface transportation safety is measured through its annual overall outcome performance measures of reducing the fatality rates of passenger vehicle occupants; non-occupants (pedestrians and bicyclists); motorcycle riders; and large truck and bus occupants. NHTSA tracks and reports on these outcome measures for the Agency through data collected by its NCSA. The VSR Office does not individually track such performance measures. Tracking and reporting is in coordination with OST guidance. In addition, NHTSA has agency-specific strategic goals with specific performance indicators it tracks, monitors, and reports on surrounding Safety; Proactive Vehicle Safety; Automated Vehicles; Human Choices; and Organizational Excellence.

NHTSA's VSR program directly aligns with its Annual Modal Research Plan and NHTSA's Research and Rulemaking Priority Plan for Vehicle Safety, 2015 to 2017 (update in development). In addition, like past practice, the Agency is currently preparing an updated agency research portfolio, and it hosted a public meeting where it presented the plan and sought stakeholder feedback for consideration prior to finalization.

Likewise, NHTSA supports DOT's Accountability strategic goal to "serve the nation with reduced regulatory burden and greater efficiency, effectiveness, and accountability" with its work to remove unnecessary barriers to allow for innovation and emerging technologies.

See Evaluation and Performance Measurement sections throughout Annual Modal Research Plan for additional details.

**Trend data and target for the coming fiscal year:** See Appendix A and DOT FY 2015 Annual Performance Report/FY2017 Annual Performance Plan:

<https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

**Program performance:** See Appendix A and DOT FY 2015 Annual Performance Report and FY2017 Annual Performance Plan: <https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

## Highway Safety Research

**\$11,748,000**

**Program Description:** Highway Safety Research directly supports the Department and agency goals of reducing traffic crashes, fatalities and injuries by providing the scientific basis for the development of effective behavioral countermeasures to reduce the occurrence of traffic crashes. Recent estimates of the causes of crashes suggest that 94 percent of crashes are due to driver behavior rather than vehicle defects, roadway defects, or environmental factors. Highway Safety Research focuses on unsafe driving behaviors that contribute significantly to death and injury from crashes on our highways. These include such things as alcohol and drug impaired driving, speeding and speed management, occupant protection (seat belt use and child safety seats), pedestrian and bicyclist safety, school bus safety, distraction, drowsiness and fatigue, motorcycle safety, older drivers, young drivers, driver licensing, graduated driver licensing, driver education, and emergency medical services.

Evaluation research documents the relative effectiveness of programs to reduce fatalities and injuries on our highways, and is critical to achieving further progress toward meeting national goals and performance targets. The results of the Highway Safety Research program assess existing and emerging highway safety problems and are disseminated to the States to use to identify effective traffic safety countermeasures for implementation through the highway safety formula grant (Section 402) funds and incentive grant funds (Section 405). Our highway safety research studies can be found at:

[www.nhtsa.gov/Driving+Safety/Research+&+Evaluation](http://www.nhtsa.gov/Driving+Safety/Research+&+Evaluation)

Highway Safety Research also funds the Driver Alcohol Detection System for Safety (DADSS) program which is a collaborative research partnership between the Automotive Coalition for Traffic Safety (ACTS), representing 17 automobile manufacturers in the United States, and NHTSA to assess and develop alcohol-detection technologies to prevent vehicles from being driven when a driver's blood alcohol concentration (BAC) exceeds the illegal per se limit of .08 grams per deciliter (g/dL). From its inception, the DADSS program has been, and continues to be, a voluntary, non-regulatory effort. The purpose is to develop cutting edge technology that can be integrated voluntarily into the vehicle fleet to prevent alcohol-impaired driving.

In FY 2019, Highway Safety Research will identify more effective and efficient countermeasures for existing traffic risks such as alcohol-impaired driving, drug-impaired driving, speeding, nonuse of seat belts, and to develop new solutions for emerging and resurgent problems such as pedestrian and bicyclist safety, motorcycle safety, driver fatigue and distracted driving.

### **Statutory Requirements:**

Is this program statutorily mandated (Y/N): Yes, the highway safety research program is required by the Highway Safety Act, Title 23, United States Code, Chapter 4 and related Highway Safety Provisions administered by the National Highway Traffic Safety Administration. Specific guidance is often provided through the appropriation process in funding bills and associated reports.



**Program Alignment with Strategic Goals:**

<b>DOT Strategic Goal</b>	<b>DOT RD&amp;T Critical Transportation Topic</b>
<b>Safety</b>	<b>Promoting Safety</b>

Highway safety research directly supports the department safety goal by showing how states and communities can alter driver, pedestrian and bicyclist behavior to reduce crashes, deaths and injuries. The highway safety research program recognizes that in many cases different approaches and programs are required for urban/suburban versus rural areas. Programs that are effective in urban communities often are less effective in rural communities (due to the large distances and lower density). Thus, some highway safety projects directly target rural communities.

**Program Objectives:** This research program is designed to find ways to change the behavior of drivers and other roadway users to increase safe behavior (seat belt use, child seat use, protective gear use by motorcycle riders, etc.) and reduce unsafe behaviors (alcohol- and drug-impaired driving, texting, speeding, etc.) that are critical to achieving further reductions in motor vehicle crashes, deaths and injuries. Behavioral research provides an evidence-based foundation for State and community traffic safety programs.

The objective of the DADSS program is to develop a system that can accurately and reliably detect when a driver is above the legal alcohol limit and that could be offered as original equipment in new cars on a voluntary, market-driven basis. The automatic system would be enabled every time the car starts, but unobtrusive so it would not pose an inconvenience to the non-intoxicated driver.

**What market failure is addressed by the research program:** There is relatively little research conducted at the state and community level. To make further progress in reducing the crashes, deaths and injuries it is necessary that new and more effective programs be developed and demonstrated to be effective. Without question, NHTSA funds a large portion of the highway safety research that has resulted in much of the progress in changing behavior and reducing crashes over the last few decades. NHTSA research funding has supported university research centers and other non-governmental research institutes and allowed them to develop necessary expertise to make a difference.

**Research Collaboration Partners:**

**How has public and stakeholder input been utilized in the development of this research program?**

The Highway Safety Research program receives input from our program offices, regional offices, State highway safety offices, non-governmental organizations, the Transportation Research Board Standing Committees that pertain to operator behavior, and a variety of other sources that factor into our research planning process.

**List all program partners:** NHTSA collaborates with OST, FHWA and FMCSA on specific topics of driver behavior. Specifically, FHWA's Advanced Exploratory Research Program has been helpful to NHTSA. NHTSA is an active participant in the intermodal human factors coordinating committee. NHTSA also collaborates with FHWA and FMCSA on speed-related issues (the three agencies have an intermodal speed team that meets periodically to share project information and occasionally to more formally collaborate on joint projects). NHTSA shares responsibility for pedestrian and bicyclist safety in partnership with FHWA. We have recently funded some focus city grants (along with OST and FHWA) to address pedestrian and bicyclist safety. NHTSA works with the OST Office of Drug and Alcohol Policy and Compliance to ensure the accuracy of alcohol testing performed for the 60,000+ employees who work in safety sensitive positions, and to provide expert information on drug use by vehicle operators.

Highway Safety Research also collaborates with other Federal agencies like ONDCP (Office of National Drug Control Policy), NIDA (National Institute on Drug Abuse), NIAAA (National Institute on Alcoholism and Alcohol Abuse), SAMHSA (substance Abuse and Mental Health Services Administration), CDC (Centers for Disease Control), among others to leverage our resources and involve the public health community in our efforts to change behavior.

**Do non-government groups partner with this program?** We also work with a variety of Non-Governmental Organizations (NGOs), including IACP (International Association of Chiefs of Police), NSA (National Sheriffs Association), NOBLE (National Organization of Black Law Enforcement officers), Safe Kids (child safety seats), NSC (the National Safety Council), MADD (Mothers Against Drunk and Drugged Driving), SADD (Students Against Dangerous Driving), NETS (Network of Employers for Traffic Safety), ACTS (Automotive Coalition for Traffic Safety), among others.

**Acquisition/Assistance:**

**Does this program utilize competitive procurement processes? (Yes /N).** Yes. We primarily use competitive procurement processes. We use open competitive procurements and Task Order contracts that were awarded as a result of an open competitive procurement process.

**Please provide a description of the acquisition methods used by this program.** As stated above Highway Safety Research primarily uses competitive contracts. Only on rare occasions do we limit competition. When advantageous, Highway Safety Research will employ a cooperative agreement, if it can accomplish the project objective at a reduced cost. For example, if a non-governmental entity has collected data that would be useful, we may collaborate with them to avoid duplication of effort.

**If this program uses sole source acquisitions, please explain why this non-competitive approach is used.** Highway Safety Research almost never uses sole source procurements.

**Does this program utilize single year or multi-year acquisitions, or both?** Highway Safety Research uses both single year and multi-year acquisitions. If a contract can be completed within a year, then a single year contract is used. However, research often takes time, especially if field data collection is required, resulting in multi-year contracts. For example, a contract to perform a program evaluation will often

entail a period of planning, site selection, program implementation, followed by a year to collect data to determine the program's effectiveness.

**Does this program leverage non-Federal funds? (Y/N) If yes, please provide details (cost sharing, match funding, etc.)** Sometimes Highway Safety Research partners with non-governmental organizations to implement and evaluate and new program. For example, we have developed training programs for law enforcement use like the SFST (Standardized Field Sobriety Test), that provides an officer with probable cause to make an alcohol-impaired driving arrest and request a BAC test. When we took this test into the field, cooperating law enforcement agencies agreed to have their officers trained and to collect data (cost sharing) so we could conduct an evaluation of the use of the SFST.

### **Technology Transfer (T2):**

Provide descriptions of at least a paragraph for each FY 2019 RD&T Program, including:

- **Describe at a program level your technology transfer activities:**
- ❖ **T2 Stakeholders: Who is involved, who are the beneficiaries, what are their roles, and how will they benefit?** Highway Safety Research primarily produces information and programs for use by States, Communities, and non-governmental organizations who have a direct role in implementing programs. We provide information to these users on emerging highway safety problems and disseminate programs we develop and evaluate to the States to use to identify effective traffic safety countermeasures for implementation through the highway safety formula grant (Section 402) funds and incentive grant funds (Section 405). Our highway safety research studies can be found at: [www.nhtsa.gov/Driving+Safety/Research+&+Evaluation](http://www.nhtsa.gov/Driving+Safety/Research+&+Evaluation)  
Behavioral safety research has contributed significantly to the widespread adoption of numerous programs proven to reduce crashes. Examples include the national Click It or Ticket (CIOT) program, the adoption of Standardized Field Sobriety Tests (SFST) by law enforcement officers investigating potential impaired driving cases, passage of primary seat belt and distracted-driving laws, the national .08 BAC limit, advancement of Graduated Driver Licensing laws, greater understanding of older-driver issues, and development and testing of effective pedestrian and bicyclist safety programs. Proposed efforts in FY 2019 will continue to add evidence-based countermeasures.

Behavioral safety research often result in the development of training programs for use by a variety of state and local governments and non-governmental safety organizations. Examples include the development of the Standardized Field Sobriety Test (SFST) now in use by the vast majority of law enforcement agencies through the country and the Drug Evaluation and Classification (DEC) program for identifying drug-impaired drivers now in use by law enforcement agencies in every State. Other examples include pedestrian and bicyclist crash typing in use by many state and local governments. Also, Child Safety Seat inspection program, currently managed by Safe Kids International was developed and made available by NHTSA.

- ❖ **What is the intended audience for the program’s research output(s)? How and when will this research be distributed to the broader public and other stakeholders? Metric: products developed for outreach, times participated in outreach.** We make all our research findings public. We use the DOT Research Hub to list ongoing research and provide links to published reports and publicly available data sets for others to use. Highway Safety Research puts out email newsletter almost every month of the year providing a description of new products (with the link to the product online) by topic area (e.g., occupant protection, impaired driving, older drivers, etc.). The number of recipients has been growing every month for a number of years.

The results of NHTSA’s Highway Safety Research program are used to develop guidance for State and local highway safety programs. The research develops the data that help States and others prioritize their efforts toward the larger contributors to traffic crashes and identifies new trends they should be aware of, while the results of our research and program evaluations help guide them toward spending scarce resources on programs with demonstrated effectiveness at reducing crashes, deaths and injuries and the cost of traffic crashes. While we make publicly available at no charge research reports for most individual research and program evaluation projects, this information is summarized biannually in a guidance document: Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, [www.nhtsa.gov/staticfiles/nti/pdf/812202-CountermeasuresThatWork8th.pdf](http://www.nhtsa.gov/staticfiles/nti/pdf/812202-CountermeasuresThatWork8th.pdf).

For a more extensive list of research and program evaluation reports (with hyperlinks) we periodically put out a compendium of NHTSA’s traffic safety research and evaluation project reports that covers hundreds of studies. The latest version of this compendium can be accessed by following this link: [www.nhtsa.gov/staticfiles/nti/pdf/811847.pdf](http://www.nhtsa.gov/staticfiles/nti/pdf/811847.pdf)

- ❖ **How do you measure the performance of this program’s T2 activities? Metric: effectiveness.** There are several ways to measure the impact of the Highway Safety Research program. These include adoption of programs developed in the Highway Safety Research program, the number of times our reports are download downloaded from the NHTSA web site or TRL, or the use of training programs.
- ❖ **Is funding or other resources allocated to T2 activities for this program? If so, please describe.** There is no specific allocation for T2 activities.
- ❖ **Is this program represented in the US DOT Research Hub and NTL Digital Library, including project descriptions, funding amounts, links to final reports, datasets, and summary descriptions of research outputs, outcomes, and impacts? (Y/N). Metric: downloads (NTL).** Yes, all recent Highway Safety Research projects are listed in the US DOT Research Hub and NTL Digital Library. When research projects are completed a link to the final report (and to the data in some cases) is added to the Research Hub entry.

- ❖ **How are you reporting T2 Annual Performance (Intellectual Property) activities? Metric: See T2 Reports.**

**Evaluation / Performance Measurement:**

**Provide descriptions of at least a paragraph for each FY 2019 RD&T Program, including:**

- **How does this program track/evaluate its progress towards its objectives/outcome goals?** Yes, Highway Safety Research looks to see if State's and communities adopting our programs are showing the desired outcomes.
- **What measures/metrics do you use to track program performance?** It depends on the nature of the project or program. Some programs are designed to change behavior, in which case we will often conduct observations to see if there is behavioral change (e.g., seat belt use, correct child safety seat use, reduced speeding, hand-held cell phone use, etc.). In other cases, our measure is the number of crashes that occur after a program is implemented. Two recent examples are 1) a hazard awareness training program implemented in California (in cooperation with the California DMV) showed a significant reduction in crashes for novice drivers who were trained, and 2) a four-year follow-up of the effect of High-Visibility Enforcement on Driver Compliance with Pedestrian Right-of-Way Laws that showed that the decline in failure to yield to pedestrians not only had been sustained but had increased.
- **Does it establish performance baselines (tailored to given research areas), analyze emergent trends, and evaluate benefits created through DOT-sponsored research?** Yes, the Highway Safety Research program is continually monitoring for emerging issues, working to develop or modify current programs and practices to increase efficiency and effectiveness, and to develop new, effective tools for emerging issues.
- **Do any of the measures/metrics in the DOT Strategic Plan, Annual Performance Plan, or Program Evaluation (OST CFO initiative) apply to this program? If yes, identify the metric(s) and describe the impact of this program on all relevant metric(s).** All of Highway Safety Research program efforts are designed to "save lives, prevent injuries, and reduce economic costs due to road crashes through education, research, and enforcement activity."
- **Please provide trend data (e.g.: for 5 years or as appropriate) for each metric and indicate the target for the coming fiscal year.** See Appendix A and DOT FY 2015 Annual Performance Report and FY 2017 Annual Performance Plan - <https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

**How is this program performing based on assigned performance measures/metrics? See:**

<https://www.transportation.gov/sites/dot.gov/files/docs/FY15-PerformanceReport-FY17-PerformancePlan-508.pdf>

**What measures/metrics do you use to track program performance? See Appendix A**

## Appendix A – Program Performance Measures

Program Performance Measures				
<i>Term</i>	<i>Measure Type</i>	<i>Measure Name</i>	<i>Description</i>	<i>Calculation Methodology</i>
Annual	Output	Roadway Safety: Safety - Proactive Vehicle Safety	Improve EWR reporting and analysis fatalities.	Establish an Agency/industry EWR working group.
Annual	Output	Roadway Safety: Safety - Proactive Vehicle Safety	Improve cybersecurity threat information sharing across the automotive industry.	Support continuous updates, through the Auto-ISAC, of industry-wide cybersecurity best practices.
Annual	Output	Roadway Safety: Safety - Retool Recalls	Increase recall completion rates.	Operate an effective vehicle safety research program to support recall efforts.
Annual	Output	Roadway Safety: Safety - Inform and Empower Consumers	Improve NCAP.	Operate an effective vehicle safety research program to support NCAP efforts.
Annual	Output	Roadway Safety: Safety - Coordinate Global Road Safety	Through global harmonization, improve safety of motor vehicles and promote the deployment of proven safety technologies.	Operate an effective vehicle safety research program to support global road safety efforts.
Annual	Output	Roadway Safety: Automated Vehicles - Safely Deploy Automated Driving Systems (ADS)	Provide Federal leadership for the safe deployment of automated vehicle for any entity testing, operating, and deploying ADSs.	Establish work plan to enhance specific safety areas of the Vehicle Performance Guidance.
Annual	Output	Roadway Safety: Automated Vehicles - Safely Deploy Automated Driving Systems (ADS)	Identify new tools and authorities to enable the safe deployment of automated vehicles.	Explore new tools and authorities by operating and effective vehicle

**Program Performance Measures**

<i>Term</i>	<i>Measure Type</i>	<i>Measure Name</i>	<i>Description</i>	<i>Calculation Methodology</i>
				safety research program.
Annual	Output	Roadway Safety: Automated Vehicles - Enable a Robust, Layered Framework for Vehicle Cybersecurity	Improve threat and incident intelligence sharing to handle cyber incidents effectively.	Develop internal reference processes for handling future vehicle cyber incidents, develop and promote best practices.
Annual	Output	Roadway Safety: Automated Vehicles - Democratize Safety Technologies	Make AEB standard in all vehicles by 2022.	Percentage of the fleet with AEB.
Annual	Output	Roadway Safety: Automated Vehicles - Democratize Safety Technologies	Develop DADSS.	Conduct multi-vehicle field operational trial beginning in FY 2017.
Annual	Output	Roadway Safety: Human Choices - Promote Innovative Solutions for Behavioral Safety	Reduce distracted driving	Finalize the Phase II Guidelines; Update Phase I Guidelines

## Section 2 - Program Descriptions, FY 2020

### Vehicle Electronics and Emerging Technologies

**Program Description/Activities:** Provide research findings and data to address the increased use of electronic controls and connectivity and emerging technologies such as automated vehicles to enhance transportation safety and efficiency. This program advances NHTSA's expertise in vehicle electronics and engineering to address the safety and security of emerging electronics and software technologies, and their implications to the safety of motorists and other vehicle occupants. This program area's research focuses on challenges related to the technical, human factors, safety assurance, testing and validation of road vehicles and their automation in addition to activities that support agency decisions on safety and cybersecurity requirements for vehicle control systems.

**Program Alignment with Strategic Goals:** In support of NHTSA's Strategic Goals and Objectives 2016-2020, the Agency's VSR Program conducts testing, research, and crash data collection and analysis to support its safety oversight mission in addressing driver behavior; developing necessary FMVSS standards, guidance, tools, and procedures, as well as conducting engineering analysis and testing of possible safety concerns and countermeasures across the full spectrum of prevention, mitigation, and response.

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

#### PROGRAM SUMMARY

This program supports the safety strategic goal by exploring emerging vehicle technologies that are built on electronics and software architectures. The automotive industry has made significant progress in the development of advanced technologies intended to prevent and/or mitigate crashes. Today's vehicle systems rely on sensors such as radar, lidar, camera, ultrasonic and others to detect potential collisions with other vehicles, pedestrians or objects and then warn the driver to take appropriate action. More advanced systems may also automatically apply brakes or provide steering inputs to avoid or mitigate the crash if the driver's actions (in response to an alert) are delayed or insufficient. While these systems are promising to enhance safety of the motoring public, introduction of complex software and connectivity raise new challenges in terms of safety assurance, product reliability and cybersecurity which may not be easy to address through traditional mechanics-based knowledge.

- What problem will be addressed? While these systems are promising to enhance safety of the motoring public, introduction of complex software and connectivity raise new challenges in terms of



safety assurance, product reliability and cybersecurity which may not be easy to address through traditional mechanics-based knowledge. This research program researches methods, topics, designs, and contemporary approaches to testing, assessing, understanding the safety performance of electronic subsystems of vehicular architecture, such that potential safety risks and concerns are identified early and appropriately mitigated.

- Why should we pursue (or invest in) this research? As the safety oversight agency over motor vehicles and motor vehicle equipment, NHTSA needs to build capabilities, knowledge and necessary tools to understand, and assess the performance of safety-critical electronic vehicle equipment, and the software that resides on those modules. As vehicles become more electrified and software-base, trends in defects and issues are shifting towards electronic equipment failures and software bugs from the traditional mechanical failures.
- Who else is researching this issue? Manufacturers, suppliers, standards setting organizations, academia also perform related research and NHTSA leverages them and performs research that fills the gaps.
- Have we invested in this topic in the past and what have we learned to date? NHTSA has researched several topics on electronics reliability, functional safety, vehicle cybersecurity, vehicular software area. We have accumulated knowledge on effectiveness and applicability of industry performance standards on safety-critical system performance; numerous approaches to protecting vehicular systems against cybersecurity risks; software update mechanisms and their role in cybersecurity; and potential effects of vehicle software architectures on electronics reliability and cyber resiliency.
- *What is the projected time of completion for a tangible outcome?* The Vehicle Electronics and Emerging Technologies program anticipates completing projects that result in research reports on key topics within 12-18 months from award.

### **FY 2020 - Advanced Safety Technologies**

**Program Description/Activities:** U.S. traffic crash fatalities have increased in recent years. NHTSA data shows that 37,461 lives were lost on U.S. roads in 2016, an increase of 5.6 percent from calendar year 2015. The number of fatalities between 2014 (32,744) and 2015 (35,485) increased at an even greater level, 8.4 percent. These statistics support the need for an increased emphasis on crash avoidance and driver assistance technologies with significant potential to reduce fatalities and injuries by preventing the crash from occurring, or significantly reducing the severity of crashes by providing timely warnings to the driver to take appropriate action. Such technologies also may support automatic braking or steering interventions to provide additional safety benefits. Further, crash avoidance systems are precursors, and necessary building blocks, for driving automation systems (SAE Automation Levels 1-5) which are

beginning to appear in vehicle manufacturers’ product development plans—and are even emerging in the marketplace today in early forms at the lower levels of automation.

**Program Alignment with Strategic Goals:** In support of NHTSA's Strategic Goals and Objectives 2016-2020, the Agency's VSR Program conducts testing, research, and crash data collection and analysis to support its safety oversight mission in addressing driver behavior; developing necessary FMVSS standards, guidance, tools, and procedures, as well as conducting engineering analysis and testing of possible safety concerns and countermeasures across the full spectrum of prevention, mitigation, and response.

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

**PROGRAM SUMMARY**

All VSR’s program efforts are directed at DOT's priority in "Building Upon DOT's Legacy of Safety" and Strategic Goal - "Safety – Improve public health and safety by reducing transportation-related fatalities and injuries for all users, working toward no fatalities across all modes of travel." This aligns with NHTSA's mission to "Save lives, prevent injuries, and reduce economic costs due to road traffic crashes through education, research, safety standards, and enforcement activity." NHTSA supports FHWA on the crash safety evaluation of roadside infrastructure. Research supporting autonomous vehicle safety directly supports innovation. Crashworthiness also supports the safety evaluation of new lightweight vehicle designs encouraged by improvements fuel economy.

- **What problem will be addressed?** In 2020, the crash avoidance program will continue to focus on test and evaluation projects involved advanced driver assistance systems (ADAS). Like the 2019 program, the main goal remains to test cutting edge technologies that have potential to prevent crashes and reduce automotive related fatalities. The research contributes to this goal by developing publicly available data, tools, performance measures, and procedures that both NHTSA and industry uses to understand how crashes can be avoided or mitigated.

ADAS research results will develop objective test procedures and performance evaluation methods; evaluate real world performance and potential safety benefits of discrete technologies; understand performance characteristics and operational envelopes of crash avoidance technology and systems; and assist the agency in developing approaches to addressing potential regulatory barriers for emerging driver assistance systems.

Human factors research is also envisioned to be a part of the 2020 program and will help develop the safety community's understanding around the safety impacts of human-machine interface approaches as well as potential longer term behavioral changes related to ADAS uses and how they might impact safety outcomes. These learnings provide a basis for manufacturers to make incremental improvements in their next generation systems and would improve the societal safety benefits achieved with deployed technology.

- **Why should we pursue (or invest in) this research?** Crash Avoidance research should be pursued because it supports policy decisions on the part of NHTSA and the Department on what next steps are needed to facilitate deployment of ADAS systems that are found (through this research program) to perform well, have good driver acceptance, and have significant lifesaving potential. This research also benefits a wide range of stakeholders, including automotive OEM who typically do not do as much research purely focused on determining crash problems addressed, how effective they are at addressing them, and human factors issues a driver feedback – these issues are expected to be addressed in this program. Research on evolving crash avoidance technology and the development of safety assessment tools is intended for widespread use in automotive design that would lead to high societal benefits
- **Who else is researching this issue?** In terms of performing the day-to-day research, portions of this research program involve work somewhat unique to NHTSA such as developing objective test procedures and associated safety performance criteria to support agency policy decisions. However, as part of these efforts, there is significant collaboration, meetings (public meetings, with industry, safety groups etc.) to discuss our results and seek feedback on tests, test procedures, and safety criteria. Other portions of the program will have strong collaboration with industry and other partners to carry out the projects – a good example would be field studies to assess safety benefits, driver feedback, and general system performance in the real world.
- **Have we invested in this topic in the past and what have we learned to date?** Yes, NHTSA has invested in crash avoidance research for several years and valuable information has resulted to support agency decision on a wide variety of safety technologies such as electronic stability control, forward crash warning systems, lane departure warning systems, automatic emergency braking systems, vehicle braking performance, tire testing and safety, tire pressure monitoring systems, new headlighting technology among many others. Safety data to inform agency decision, self-certification standards, consumer information, support voluntary agreements with industry, have all resulted from this program.
- **What is the projected time of completion for a tangible outcome?** The advance safety technologies program anticipates completing projects that result in research data, test

procedures, and reports (tangible outcomes) on key topics for projects funded in 2020. This is consistent with previous years' research in the crash avoidance program area.

### **FY 2020 - Crashworthiness**

**Program Description/Activities:** Crashworthiness research focuses on vehicle safety countermeasures to reduce the number of fatal and serious injuries that occur from motor vehicle crashes in the United States each year. This research program is responsible for developing and upgrading test procedures for evaluating motor vehicle safety and developing the test devices, such as crash test dummies, and appropriate injury metrics. Crashworthiness research encompasses new and improved vehicle design, biomechanics and injury causation, field data collection and analysis of serious injury cases, safety countermeasures and vehicle equipment to enhance occupant safety.

**Program Alignment with Strategic Goals:** In support of NHTSA's Strategic Goals and Objectives 2016-2020, the Agency's VSR Program conducts testing, research, and crash data collection and analysis to support its safety oversight mission in addressing driver behavior; developing necessary FMVSS standards, guidance, tools, and procedures, as well as conducting engineering analysis and testing of possible safety concerns and countermeasures across the full spectrum of prevention, mitigation, and response.

<b>DOT Strategic Goal</b>	<b>DOT RD&amp;T Critical Transportation Topic</b>
Safety	Promoting safety
Innovation	Improving Mobility

### **PROGRAM SUMMARY**

All VSR's program efforts are directed at DOT's priority in "Building Upon DOT's Legacy of Safety" and Strategic Goal - "Safety – Improve public health and safety by reducing transportation-related fatalities and injuries for all users, working toward no fatalities across all modes of travel." This aligns with NHTSA's mission to "Save lives, prevent injuries, and reduce economic costs due to road traffic crashes through education, research, safety standards, and enforcement activity." NHTSA supports FHWA on the crash safety evaluation of roadside infrastructure. Research supporting autonomous vehicle safety directly supports innovation. Crashworthiness also supports the safety evaluation of new lightweight vehicle designs encouraged by improvements fuel economy.

- What problem will be addressed? Crashworthiness research will complete a full evaluation of potential ATDs to be used in alternative seating evaluations associated with automated driving systems. This research will include biofidelity, repeatability, reproducibility, and durability assessments for ATDs being considered for use in ADS

seating/restraint system evaluations. Pending the results of initial assessments in FY 2019, some of the tools may require significant updates that could continue into FY 2020. Like the FY 2018 accomplishment described earlier regarding the completion of technical documentation for the THOR 50<sup>th</sup> percentile male ATD, it is anticipated that NHTSA will be completing similar technical documentation for additional ATDs in the 2020 timeframe. This includes documentation for the World Side Impact Dummy (WorldSID) 5<sup>th</sup> percentile female, the Large Omnidirectional 10-year-old child ATD and the BioRID rear impact ATD. Rear Seat Safety will be addressed by full vehicle and sled testing using the 5<sup>th</sup> female THOR and Large Omnidirectional 10-year-old ATDs. Using these newly developed ATDs and their enhanced injury prediction capabilities will allow better evaluation of restraint performance for rear seat occupants. Evaluation of restraint countermeasures for rear facing and reclined occupants. NHTSA has been developing enhanced tools for evaluating the crash safety of occupants in anticipated ADS vehicle designs. These new analytical tools will be further developed through their use in evaluation prototype restraint designs.

- Why should we pursue (or invest in) this research? These research topics support the development and demonstration of analytical tools to be used in enhancing the safety for the next generation of vehicle systems.
- Who else is researching this issue? NHTSA is coordinating these research efforts with numerous OEMs, suppliers, and safety research groups.
- Have we invested in this topic in the past and what have we learned to date? NHTSA is continually developing enhanced safety tools to improve the safety of vehicle designs used on U.S. roads. This research has led to reduced injury and fatality through a more comprehensive understanding of crash injury protection.
- What is the projected time of completion for a tangible outcome? Two years.

### **FY 2020 - Alternative Fuel Vehicle Safety**

**Program Description/Activities:** Recently introduced vehicle engine technologies including hydrogen and advanced lithium ion battery vehicles are being introduced to the market at a fast rate. Additionally, the recent increase in Compressed Natural Gas (CNG) fueled heavy trucks has introduced new concerns regarding the safety of these vehicle systems. This research will examine the safety issues and promote research to enhance industry best practices. Test procedures and assessment methods will be developed to standardize safety assessment methods.

#### **Program Alignment with Strategic Goals:**

Each program must be allocated to DOT Strategic Goal areas AND DOT RD&T Critical Transportation Topic Areas. These areas are provided below:

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

**PROGRAM SUMMARY**

NHTSA’s 2020 alternate fuel research will focus on next generation systems for electric vehicles. These technologies include 350 kW extreme fast charging systems and evaluating the safety of wireless charging systems for commercial and residential applications. NHTSA will also initiate research to define the failure modes for solid state battery systems and begin consideration of the need for safety performance testing. These technologies should all involve research between the DOE national laboratories, the automotive OEMs and their suppliers. NHTSA has invested extensively in developing test procedures for charging safety of lithium ion battery systems and the planned research would extend past research into new charging methods and battery types. This research should take 2 to 3 years to complete.

**FY 2020 - Vehicle Research and Test Center - Ohio**

**Program Description/Activities:** The Vehicle Research and Test Center (VRTC) is NHTSA’s in-house research, development, test and evaluation facility located in East Liberty, Ohio. VRTC has access to world class testing facilities like those used by automotive suppliers and manufacturers. Research and testing activities conducted at the VRTC support agency decisions and actions with respect to new vehicle systems and issues; agency consumer information programs; test dummy development; injury criteria development; advanced research into cutting edge technologies; and safety issues that require quick reaction, including defect investigations. The full range of testing and research capabilities available to NHTSA at VRTC allows the agency to maximize its testing capabilities to more rapidly study emerging safety issues and more quickly provide benefits to the American public.

**Program Alignment with Strategic Goals:** VRTC, along with all VSR’s program efforts are directed at DOT's priority in "Building Upon DOT's Legacy of Safety" and Strategic Goal - "Safety – Improve public health and safety by reducing transportation-related fatalities and injuries for all users, working toward no fatalities across all modes of travel." This aligns with NHTSA's mission to "Save lives, prevent injuries, and reduce economic costs due to road traffic crashes through education, research, safety standards, and enforcement activity."

DOT Strategic Goal	DOT RD&T Critical
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	<b>Transportation Topic</b>
Safety	Promoting safety
Innovation	Improving Mobility

## **PROGRAM SUMMARY**

In 2020, VRTC plans to support a broad range of critical safety areas including: Crash avoidance research to evaluate new technologies that help drivers prevent crashes; Crashworthiness research to improve occupant protection in crashes; Biomechanics research to develop, evaluate, maintain, improve the agency’s vehicle crash test dummies; Lab and in-field support for safety defects investigations; and research into complex new areas such as automated vehicles and cybersecurity.

- **What problem will be addressed?** VRTC conducts testing, research and development necessary to support FMVSSs, recall of defective vehicles, and other safety-engineering objectives to address the crash safety problem. Through efforts in these areas, VRTC directly addresses the vehicle crash problem on our nations roadways. In 2016, motor vehicle crashes on U.S. Highways claimed 37,461 lives. This is a 5.6% increase from 2015 and 14.4% increase from 2014. Analysis of crash causation factors imply that a large majority of serious crashes are due to dangerous choices or errors people make behind the wheel. VRTC’s research supporting improved crash avoidance, improved occupant protection in a crash, and emerging technology areas (e.g. vehicle automation) are addressing the driver error issue and other crash causation factors such as vehicle defects. The program has as a primary goal evaluating how new technologies and other vehicle safety innovations can potentially improve vehicle safety.
- **Why should we pursue (or invest in) this research?** VRTC supports a broad range of critical safety areas including: Crash avoidance research to evaluate new technologies that help drivers prevent crashes; Crashworthiness and Biomechanics research to improve occupant protection in crashes; Lab and in-field support for safety defects investigations; and research into complex new areas such as automated vehicles and cybersecurity.
- **Who else is researching this issue?** A portion of VRTC’s research portfolio supports agency vehicle safety programs that include sensitive activities such as safety defects investigations and standards development, compliance testing, and support for policy decisions with respect to advanced cutting edge technologies and support for safety issues that require quick agency response. No one else is doing this research given its inherently Federal nature.

Other basic research on new and emerging issues (topics not part of confidential agency matters) is collaborative in nature such as automated vehicle testing, cybersecurity, biomechanics

research on new test dummies, and new approaches to occupant protection. This research often involves automotive manufacturers and suppliers.

Research to develop and bring to market new innovative safety countermeasures is being conducted by industry (automotive manufacturers, suppliers, and other entities) and it is these industry efforts and investment that result in the new innovative safety systems often involved in VRTC research and test programs.

- **Have we invested in this topic in the past and what have we learned to date?** Since it was formed in 1978, VRTC research efforts have resulted in most of the objective test procedures and associated safety criteria for industry self-certification standards (FMVSS) promulgated since that time. Other outputs have been used for safety performance test procedures for the agency's NCAP. Other VRTC outputs like technical reports and scientific papers have increased the general body of knowledge in the field of automotive safety in the areas of crash avoidance, crashworthiness and biomechanics.
- **What is the projected time of completion for a tangible outcome?** VRTC completes projects that result in research data, test procedures, and reports (tangible outcomes) on key topics each year in the areas of crash avoidance, crashworthiness, and biomechanics research.

### **FY 2020 - Highway Safety Research**

**Program Description:** Highway Safety Research directly supports the Department and agency goals of reducing traffic crashes, fatalities and injuries by providing the scientific basis for the development of effective behavioral countermeasures to reduce the occurrence of traffic crashes. Recent estimates of the causes of crashes suggest that 94 percent of crashes are due to driver behavior rather than vehicle defects, roadway defects, or environmental factors. Highway Safety Research focuses on unsafe driving behaviors that contribute significantly to death and injury from crashes on our highways. These include such things as alcohol and drug impaired driving, speeding and speed management, occupant protection (seat belt use and child safety seats), pedestrian and bicyclist safety, school bus safety, distraction, drowsiness and fatigue, motorcycle safety, older drivers, young drivers, driver licensing, graduated driver licensing, driver education, and emergency medical services.

Evaluation research documents the relative effectiveness of programs to reduce fatalities and injuries on our highways, and is critical to achieving further progress toward meeting national goals and performance targets. The results of the Highway Safety Research program assess existing and emerging highway safety problems and are disseminated to the States to use to identify effective traffic safety countermeasures for implementation through the highway safety formula grant (Section 402) funds and incentive grant funds (Section 405). Our highway safety research studies can be found at:

[www.nhtsa.gov/Driving+Safety/Research+&+Evaluation](http://www.nhtsa.gov/Driving+Safety/Research+&+Evaluation)



Highway Safety Research also funds the Driver Alcohol Detection System for Safety (DADSS) program which is a collaborative research partnership between the Automotive Coalition for Traffic Safety (ACTS), representing 17 automobile manufacturers in the United States, and NHTSA to assess and develop alcohol-detection technologies to prevent vehicles from being driven when a driver’s blood alcohol concentration (BAC) exceeds the illegal per se limit of .08 grams per deciliter (g/dL). From its inception, the DADSS program has been, and continues to be, a voluntary, non-regulatory effort. The purpose is to develop cutting edge technology that can be integrated voluntarily into the vehicle fleet to prevent alcohol-impaired driving.

**Program Alignment with Strategic Goals:**

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

**How does this program support DOT’s Strategic Goals and/or the Strategic Objectives under each of these goals?** Highway safety research directly supports the department safety goal by showing how states and communities can alter driver, pedestrian and bicyclist behavior to reduce crashes, deaths and injuries. The highway safety research program recognizes that in many cases different approaches and programs are required for urban/suburban versus rural areas. Programs that are effective in urban communities often are less effective in rural communities (due to the large distances and lower density). Thus, some highway safety projects directly target rural communities.

**What problems will be addressed?** In FY 2020, Highway Safety Research will focus on high priority issues to identify more effective and efficient countermeasures for alcohol-impaired driving, drug-impaired driving, speeding, nonuse of seat belts, and to develop new solutions for emerging and resurgent problems such as pedestrian and bicyclist safety, motorcycle safety, and distracted driving.

**Why should we pursue (or invest in) this research?** The results of the Highway Safety Research program help to drive down the numbers of crashes, fatalities, injuries and economic cost of crashes. In the past Highway Safety Research has been at the forefront in developing programs that have been widely implemented across the U.S. and have helped to lower the number of crashes, deaths and injuries on our nation’s roads. Examples include programs like annual *Click It or Ticket* program, encouraging use of Sobriety Checkpoints, development of the SFST (Standardized Field Sobriety Test), Zero Tolerance Laws, demonstrating the effectiveness of high visibility enforcement programs with media focusing on the enforcement activities and research and evaluation supporting the use of Graduated Driver Licensing for novice drivers. We are currently working on several research programs with the potential to have widespread impact, when completed.

One of these areas is a program to develop a field test for cannabis impairment. This test would be designed for law enforcement use with suspected cannabis impaired drivers. It would help provide probable cause for a body fluid test for cannabis. Another research area we will be working on in FY 2020 is developing exposure measures for motorcycles and pedestrians. Currently changes in motorcycle and pedestrian deaths are difficult to explain as we do not have an exposure measure for either motorcycles or pedestrians. Thus, separating out the role of increased exposure is not possible.

**Who else is researching this issue?** There is one group in San Diego also working on developing a field test for cannabis (funded by the State of California) that is taking a somewhat different, but complimentary approach to the one we are taking. In terms of developing an exposure measure for motorcycling or pedestrian vehicle conflicts, we are not aware of any other group currently working on this issue.

Regarding the Driver Alcohol Detection System for Safety (DADSS) project. A considerable amount of funding for the project has come from the Automotive Coalition for Traffic Safety (ACTS), representing 17 automobile manufacturers in the United States, and more recently the State of Virginia where a field operational test is underway.

**Have we invested in this topic in the past and what have we learned to date?** We have been working on developing a field test for cannabis impairment for a couple of years. Prior work included a systematic review of previous research in to identify ways in which cannabis use impairs behavior. Where we found consistent results showing impairment in several studies, we then turned to analyze the issue of whether the impairment could be measured outside of a laboratory, without expensive equipment, with no prior knowledge about the individual to be tested under real world conditions (i.e. suitable for law enforcement use). This allowed us to focus on the most promising potential measures that are currently being tested on dosed subjects. Assuming some of these measures appear promising, the next step will be to refine the measures so that the administration and scoring of the tests is simple and standardized. Additional testing will be required so that effectiveness of the measures is demonstrated for both genders, a range of ages, and experience using cannabis.

The development of exposure measures has not seen much prior work. We have successfully looked at using mileage (odometer) readings in states that require an annual safety inspection as a way estimate motorcycle vehicle miles traveled. At this point it appears promising, but further investigation and more data needs to be collected before a determination of its utility can be made. In the case of developing a pedestrian exposure measure we hope to leverage current and future technology to accomplish something not possible just a few years ago.

For DADSS project considerable progress has been made in developing two systems for detecting driver BACs in a surprisingly quick and accurate fashion. One approach uses a touch based sensor (when the driver pushes the vehicle start button, the other is breath based and can distinguish between the driver and any passengers.

**What is the projected time of completion for a tangible outcome?** We anticipate being able to know whether it is feasible to develop a field test for cannabis within a couple of years. Several challenges

must be overcome for a successful outcome. In the criminal justice system, there is a need to keep false positives to an absolute minimum. While false negatives are not desirable, a small number are acceptable. There is no data yet to indicate whether any of the measures will accurately and reliably detect cannabis impairment in all users without suggesting non-users are impaired by cannabis. It is relatively easy to detect impairment in an individual when you know their normal performance level. A general scoring criterion is much more difficult given the range of performance in the general population.

It should be possible, if all goes well, to know whether an exposure measure for motorcycle vehicle miles traveled can be developed within the next 3-4 years. The development of a pedestrian exposure measure will probably take several more years.

The DADSS project should have some tangible results from the current field operational test within a couple of years.