United States Department of Transportation FY 2020
NHTSA Annual Modal Research Plan

Office of Vehicle Safety Research
Associate Administrator, Cem Hatipoglu

Office of Research and Program Development
Associate Administrator, Nanda Srinivasan

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Executive Summary

The National Highway Traffic Safety Administration (NHTSA) is grounded in sound science, based on sufficient data and research, and robust real-world engineering, to fulfill its mission to save lives, prevent injuries, and reduce economic costs due to road traffic crashes. NHTSA's work is deliberative and considers potential unintended consequences and harm that might be caused if the Agency acts in haste in the development of policy, programs, or regulations, and in issuing information to the public. Safety is its number one priority, and with rigorous engineering and a thoughtful data- and science-driven approach, NHTSA strives to build public trust and confidence in every action taken because lives depend on it.

Much of this work is done through its research efforts, which are primarily comprised of programs within the Office of Vehicle Safety Research (VSR) and Office of Research and Program Development, Behavioral Safety Research (BSR). Both support the U.S. Department of Transportation (USDOT) and NHTSA safety goals. VSR conducts research on new technologies and countermeasures that could impact the safety of motor vehicles and motor vehicle equipment. Research results support agency safety oversight policy decisions with respect to a range of critical agency functions, including guidance to industry, consumer information, rulemaking, and enforcement efforts. The Office performs testing and research related to crashworthiness, human injury/biomechanics, advanced safety technologies, human factors, automation, cybersecurity, and electronic systems safety. Other research areas include developing enhanced computer modeling tools; identifying vehicle fleet changes with potential safety ramifications quickly and efficiently, particularly in areas related to alternative fuels vehicles; modeling and analysis of advanced battery control; assessing crash notification technology and emergency response, while supporting NHTSA's other cross-cutting initiatives.

The Vehicle Research and Test Center (VRTC), located in East Liberty, OH, is NHTSA's in-house applied research test facility. Consistent with the overall mission of the VSR Office, VRTC conducts the testing, research, and development necessary for Federal motor vehicle safety standards (FMVSS), recall of defective vehicles, and other safety-engineering objectives in support of NHTSA's programs.

VSR has a long history of working collaboratively with academia, industry, States, and other

Federal partners to develop tools that can help mitigate the injuries and fatalities that result from motor vehicle crashes. The Agency's research and products are communicated on an ongoing basis to the public through public meetings, requests for comment, website publication, and conferences. NHTSA research publications are also published by others such as the Transportation Research Board (TRB), which reaches a more diverse set of researchers.

The Office participates in numerous industry and academic working groups, and effectively and frequently communicates progress of research efforts through these working groups, public meetings, publications, and conference presentations (SAE, ISO, ASME, UL, and other academic/industry standards groups), as well as its International Technical Conference on the Enhanced Safety of Vehicles (ESV). NHTSA also regularly meets with original equipment manufacturers (OEMs), technology companies, trade associations, safety advocates, and other private research organizations.

In fiscal year (FY) 2020, major VSR research areas include Vehicle Electronics and Emerging Technologies (including Automated Driving Systems, SAE level 3-5 technologies, and Cybersecurity); Advanced Safety Technologies (focusing on SAE Level 0-2 Advanced Driver Assistance Systems (ADAS) and Heavy Vehicle Technologies); Crashworthiness research to improve crash survivability; and Alternative Fuels Vehicle Safety to examine the safety issues and promote research to enhance industry best practices for new engine technologies. Research funding in these areas will improve vehicle safety in a variety of areas including enhancing vehicle electronics safety (including software), hardening vehicles against cybersecurity attacks, removing potential regulatory barriers to ADS and other advanced technology innovations, development of ADS safety assurance frameworks and methods, enhancing occupant protection for current and future vehicle designs, addressing critical human factors issues for both ADS and other advanced technologies, and addressing the safety of alternative fuel technologies that will be used in conventional and future ADSs. Funding will also allow NHTSA to undertake further activities to enhance and expand testing capabilities of advanced technologies at VRTC. For FY2021, VSR's major research areas will remain relatively unchanged. New projects will be proposed to address research results, trends, priorities, industry learnings, and real-world events.

The primary objective of BSR is to improve the return on investment from the Congressionally mandated Highway Safety Grant program. The 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. In addition to these activities, BSR also works with VSR to coordinate human factors research with an emphasis on the behavior of drivers, passengers, pedestrians, bicyclists, and other non-motorists.

BSR administers NHTSA's Highway Safety Research program, which directly supports the Department and Agency safety 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 motor vehicle crashes. BSR focuses on unsafe driving behaviors that contribute significantly to death and injury from crashes on the Nation's roadways. BSR assesses existing and emerging highway safety problems and conducts evaluation research to document the relative effectiveness of programs to reduce motor vehicle fatalities and injuries. 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 (FHWA), the Federal Motor Carrier Safety Administration (FMCSA), universities, research contractors, safety advocates, automotive manufacturers, and other industry entities.

In FY 2020, BSR will continue efforts to identify more effective and efficient countermeasures for existing traffic risks such as alcohol-impaired driving, speeding, nonuse of seat belts, nonuse and misuse of child restraints, and to develop new solutions for emerging and resurgent problems such as pedestrian and bicyclist safety, distracted driving, as well as continuing the Driver Alcohol Detection System for Safety (DADSS) program. In addition, it plans to focus on three priority areas: drug-impaired driving, ADS Human Factors Research, and ADAS Driver Adaptation Research. Drug-impaired driving is a growing safety concern because of the increased availability of marijuana products and increased use of opioids, as well as the use of illicit drugs like methamphetamines and pharmaceutical products. NHTSA will continue research into field tests of drug impairment and field test devices that could be used by law enforcement to detect drivers impaired by drugs, with a focus on marijuana, as well as research supporting successful prosecution of drug-impaired drivers, improvements in data collection systems, and more effective messaging and communication strategies.

In FY 2021 BSR will continue to focus on the three high priority issues of drug-impaired driving, ADS human factors research, and ADAS driver adaptation research. BSR also will continue efforts to identify more effective and efficient countermeasures for existing traffic risks such as alcohol- impaired driving, speeding, nonuse of seat belts, nonuse and misuse of child restraints, and to develop new solutions for emerging and resurgent problems such as pedestrian and bicyclist safety and distracted driving.

Chapter 1. Introduction/Agency-Wide Research Approach

Federal Role/Continued Relevance

NHTSA's mission is to save lives, prevent injuries, and reduce economic costs due to road traffic crashes through education, research, safety standards, and enforcement activity. VSR programs support the Department's efforts to improve motor vehicle and motor vehicle equipment safety by strengthening agency knowledge and expertise, developing test procedures to assess the safety impact and risks of new technologies, and developing countermeasures to vehicle safety issues. 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 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.

BSR supports the agency's safety mission by finding 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.

Given the inherently governmental nature and the timeliness of the Agency's research (e.g., to support agency policy decisions and other internal agency deliberative actions such as rulemaking and enforcement actions), the Agency cannot rely solely on research results provided by other Federal, State, local, or private organizations. VSR programs assure 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 ADSs. Overall, because of these programs, the introduction of safe new vehicles and technologies into the U.S. fleet is accelerated.

BSR's objective is to improve the return on investment from the Congressionally Mandated Highway Safety Grant program through research about traffic safety programs conducted at the state and community level. Because there is little nonfederal research in this area, BSR's research is needed to support the development of new countermeasures and to demonstrate their effectiveness in order to make further progress in reducing crashes, deaths, and injuries.

Research Portfolio Information

NHTSA recognizes the importance of providing research outcomes for public consumption in the USDOT 's Research Hub and the Repository and Open Science Access Portal, known as ROSA-P, the National Transportation Library's (NTL) digital repository and full-text archive for the transportation research community. It contains resources from the USDOT, State DOTs, and transportation organizations. Resources available in ROSA-P include full-text

electronic publications, datasets, images, videos, and maps. In recognizing a deficit of Vehicle Safety Research reports in ROSA-P, and subsequently the Research Hub, VSR identified reports going back to 2014, published and available through various other NHTSA resources, to transfer them to ROSA-P.

VSR is working in conjunction with NHTSA's Communications Office to properly format the reports for accessibility and search functions and submitting them for upload into ROSA-P. At the same time, all new reports available for publication from VSR are sent directly to ROSA-P for upload. For ease of search access, a special collection has been established to house VSR reports titled *Vehicle Safety Research*. It will be set up and populated in the same manner that our counterpart the Behavioral Safety Research Office has done with its collection in ROSA-P.

This is a work in progress, so while this effort is underway with ROSA-P, VSR is populating the Research in Progress (RiP) Database to create records in the Research Hub. Due to a deficit in records over the previous years, VSR is back-populating for FY17-FY19 in order to link reports and upload data to the Research Hub. This is a concerted and prioritized effort among contract officer representatives (CORs), analysts, and management to ensure an expedited process.

For Behavioral Safety Research, all recent projects are listed in the US DOT Research Hub as imported from the Transportation Research Board's RiP database. Records are updated at the end of each fiscal year to reflect new awards and contract modifications. As research projects are completed, reports approved by the Agency are provided to the NTL Digital Library, and links to the reports are added to the Research Hub record.

Acquisition/Assistance

NHTSA research programs utilize the competitive procurement process. Projects' contractual documents specify research for the intended purpose and are reviewed and approved by senior management and acquisition personnel. Most of NHTSA's research is conducted using performance-based contracts. Federal personnel and contractors are accountable for performing work on schedule. 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 research programs mostly allocate funding using a broadly competitive process based on merit. Project contract documents are prepared by experienced engineers and program specialists 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. When advantageous, NHTSA research programs may also employ a cooperative agreement if it can accomplish the project objective at a reduced cost.

For example, if a nongovernmental entity has collected data that would be useful, we may

collaborate with them to avoid duplication of effort. Regular internal and external peer reviews of NHTSA research 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. Many projects use multiyear acquisitions since research often takes time, especially if field data collection is required and the product is non-severable, resulting in multiyear contracts. Furthermore, the need for Office of Management and Budget approval of new data collections adds an additional 18 months to project timelines.

This program primarily does not leverage nonfederal funds. However, sometimes the Agency may partner with nongovernmental organizations to implement and evaluate a new program. For example, BSR develops training programs for law enforcement use like the Standardized Field Sobriety Test (SFST), which provides an officer with probable cause to make an alcohol-impaired driving arrest and request a blood alcohol concentration (BAC) test. When NHTSA deployed this test in 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)

Many NHTSA offices participate in Technology Transfer (T2) activities and produce T2 output, and these are strategized and coordinated through a single point of contact in NHTSA. NHTSA's specific efforts for T2 occur in the Offices of Vehicle Safety Research, Research and Program Development, Rulemaking, Enforcement, as well as the National Center for Statistics and Analysis. In addition to coordinating efforts through a centralized resource, NHTSA is actively participating in the Departmental T2 Working Group (T2WG) to improve existing efforts, develop more efficient processes, and identify new methods of technology transfer. The T2WG provides an opportunity to share and gather information across DOT modes for successful and effective methods of T2 strategies (supports USDOT Accountability goal).

Stakeholders

NHTSA's VSR programs primarily produce data, reports, and tools for use by motor vehicle equipment suppliers, motor vehicle manufacturers, the technology industry, test facility operations, test equipment developers, academia, consumer organizations, State and local governments, and other Federal government agencies, among others. NHTSA provides information to manufacturers, suppliers and the technology industry regarding emerging technologies' operation, effectiveness, and safety. With automation on the forefront of the automotive industry, technology companies have become increasingly prominent stakeholders, and the role of safety and the complex manner of incorporating technology into vehicles can be a new environment for them.

NHTSA works closely with academia who use our information to conduct further research or develop new materials, test methods, or test devices. Consumer organizations incorporate agency research into their own programs in order to deliver safety messages, improve information to the public, and incorporate NHTSA research outcomes into stronger strategic

programs. State and local governments may use information to make decisions, such as whether or how to allow for testing of vehicles with ADSs on their roadways. VSR is also used within NHTSA to support continued efforts in rulemaking activities, to drive policy decisions, and in program development. It is similarly used within other agencies for supporting research and implementing policies, practices, and standards development.

VSR often results in the development of test devices and injury criterion used industry-wide for crash testing, as well as standardized performance tests and technology evaluations which lead to improved safety and performance or provide the means to further encourage promising safety advancements.

BSR primarily produces information and programs for use by States, communities, and non-governmental organizations who have a direct role in implementing traffic safety programs. It provides information to these users on emerging highway safety problems and effective and promising traffic safety countermeasures for implementation through the highway safety formula grant (Section 402) funds and incentive grant funds (Section 405). BSR has contributed significantly to the widespread adoption of numerous programs proven to reduce crashes. Examples include the national Click It or Ticket (CIOT) high visibility enforcement program, the adoption of 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 2020 will continue to expand evidence-based countermeasures.

BSR often results in the development of training programs for use by a variety of state and local governments and nongovernmental safety organizations. Examples include the Drug Recognition Expert (DRE) program for identifying drug-impaired drivers now in use by law enforcement agencies in every State and pedestrian and bicyclist crash typing in use by many state and local governments. Also, Highway Safety Research developed the child safety seat inspection station program, which is currently managed by Safe Kids International.

Intended Audience: NHTSA research is intended for many stakeholders, but first and foremost the public at large, along with Congress. NHTSA research is conducted to increase the safety of motor vehicles and the safety of the traveling public. Therefore, it is incumbent upon the agency to share information with the public. Transparency of our research efforts increases trust in developing technology and demonstrates that the government and the motor vehicle industry collaborate on efforts to improve motor vehicle safety, including the safety of individuals both inside and outside of the vehicle.

The output of research programs is available through various means depending on the program objectives. NHTSA provides reports, test data, databases, public presentations, training and enforcement programs, safety countermeasures, and models through the research sections of the NHTSA website. Published reports are also available in the National Transportation Library. Project information is more broadly available on the Research Hub. NHTSA utilizes GitHub to provide developed software in a public environment.

On a regular basis, NHTSA's research programs provide outcomes on a global level at the SAE Government/Industry Meeting as well as its International Technical Conference for the Enhanced Safety of Vehicles (ESV conference). These are two broad research forums that provide technical information to conference attendees, including the general public. NHTSA presents the results of its research during these conferences. While these are two long-standing conferences that NHTSA uses as a means of coordinating and sharing research, information is continually shared at numerous other conferences and meetings throughout the year.

BSR's intended audience is States, communities, and nongovernmental organizations who have a direct role in implementing traffic safety programs. The Office makes all its research findings public. It uses the DOT Research Hub to list ongoing research and provide links to published reports and publicly available data sets for others to use. Ongoing research also is listed in the TRB RiP database, and it frequently shares research updates with the relevant TRB committees. The results of NHTSA's BSR are used to develop guidance for State and local highway safety programs. The research helps States and others prioritize their efforts toward the significant contributors to traffic crashes and identifies new trends of which they should be aware. The results of its research and program evaluations guide it toward spending scarce resources on programs with demonstrated effectiveness at reducing crashes, deaths, injuries, and the cost of traffic crashes. To aid in the selection of programs, Highway Safety Research publishes a basic reference titled, *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices* on a biannual basis. NHTSA published the ninth edition in 2018. BSR is also working on a new companion document called *Countermeasures at Work,* which will feature specific examples of communities implementing countermeasures with higher effectiveness ratings.

Metrics:
There are several ways to measure the impact of NHTSA Research programs. These potential measures include adoption of test tools and procedures and safety countermeasure programs, the number of reports that are downloaded from the NHTSA website or NTL, and the use of training programs. NHTSA research generally does not have IP activities to report.

Funding: There are no specific allocations for T2 activities for VSR or BSR. As research outputs are institutionalized and part of the research project process, the public distribution of the research output is not separately funded. Activities such as the SAE Government/Industry Meeting and the ESV conference receive separate funding, but not specifically as a T2 activity. NHTSA VSR does fund an electronic test data website with the money going towards maintenance and updates.

Evaluation/Performance Measurement
Performance measures are set for each specific project, which are reviewed throughout the lifecycle of the project. NHTSA's research offices work with the agency's Offices of Government Affairs and Strategic Planning and Budget to set performance goals and indicators that align with the Government Performance and *Results* Modernization Act of 2010 (GPRA Modernization Act). These are living documents updated on a set schedule (annually), and 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). The Agency also actively participates in the Departmental Evaluation/ Performance Measurement Working group (supports USDOT Accountability goal) to monitor and evaluate the contribution of research, development and technology activities toward the achievement of DOT strategic goals and objectives. Likewise, its Data Working Group (supports USDOT Accountability goal) to ensure access to high-quality data to support data-driven technologies, operations, and decision making.

When new vehicle safety countermeasures are encouraged by the agency, either through voluntary agreements, the New Car Assessment Program (NCAP), and/or regulation, NHTSA's National Center for Statistics and Analysis (NCSA) typically does a retrospective review of agency actions after implementation to determine the effectiveness in reducing injuries/fatalities due to motor vehicle crashes which are part of DOT and NHTSA's short and long-term performance metrics.

Similarly, for traffic safety countermeasures, NHTSA continuously monitors States and communities adopting its programs and showing the desired outcomes by conducting program evaluations. These program evaluations, as well as evaluations conducted by others, inform the effectiveness ratings in *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices*. *Countermeasures That Work* is a basic reference guide to assist State Highway Safety offices in selecting effective, evidence-based behavioral strategies for traffic safety problem areas. Likewise, the Agency continually monitors traffic safety for emerging issues, which includes seeking input from NHTSA regional offices, State highway safety offices, nongovernmental stakeholder organizations, and Transportation Research Board standing committees. This information is used by the Agency to develop new or modify current programs and practices to increase efficiency and effectiveness, as well as address emerging trends.

Additionally, in assessing behavioral changes, including seat belt use, correct child safety seat use, speeding, hand-held cell phone use, and others, the Agency will often conduct observations to see whether behaviors change from before to after program implementation. In other cases, the measure is the change in the number of crashes that occur after a program is implemented. On a routine basis, the Office of the Secretary of Transportation (OST) also meets with the modal administrations to review its progress towards meeting performance targets and indicators 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 change course. NHTSA completes near-term 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 about 10 years after introduction to allow for fleet penetration and the collection of sufficient field data to support analysis).

The work conducted under NHTSA's research programs support DOT's and NHTSA's top

priority and performance goal of safety. 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 the NCSA. NHTSA's research offices do not individually track such performance measures. Tracking and reporting are conducted in coordination with OST and agency guidance.

NHTSA's internal and contract research includes specific deliverables and dates that must be met for the successful performance of the research task. 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. NHTSA reviews and updates its goals annually as part of the OST Performance Management Review process.

Alignment: All NHTSA research 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." 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. 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 regulatory barriers to allow for innovation and emerging technologies.

These align 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 also has agency-specific strategic goals with specific performance indicators it tracks, monitors, and reports on surrounding safety (i.e., Proactive Vehicle Safety; Automated Vehicles; Human Choices; and Organizational Excellence).

Measures/metrics:
See Appendix A.

Trend Data and Fiscal Year Targets: See Appendix A and the DOT FY 2018-2019 Annual Performance Plan and FY 2017 Annual Performance Report.

Program Performance: ***See the DOT FY 2018-2019 Annual Performance Plan and FY 2017 Annual Performance Report.***

USDOT Research Priorities: *Economic impact of regulatory reform* ***- 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 GPRA 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 Analyses (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 - 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 motoring 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 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. For more information on FY2020 activities, see the program descriptions for Vehicle Electronics and Emerging Technologies, Advanced Safety Technologies, Crashworthiness, Alternative Fuels Vehicle Safety, the Vehicle Research and Test Center, and Highway Safety Research (conducted under the Office of Research and Program Development).

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 safety. 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 safety. It has no authority or responsibility for micro- or demand responsive transit services.

Improving mobility for underserved communities – The VSR program supports this DOT research priority through its work on ADS. Driving automation will provide mobility options not previously afforded to people with disabilities, regardless of cognitive, sensory, physical, or even the degree of condition. ADS equipped vehicles with technology making them accessible to people 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 people with

disabilities and how these needs will likely be implemented within a human machine interface (HMI). For more information on FY 2020 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 2020 activities, see the program description for Vehicle Electronics and Emerging Technologies, which includes cybersecurity research, further in the document.

Chapter 2. High-Priority Project Descriptions

1. Enhancement of testing and simulation tools for occupant protection in alternative vehicle designs enabled by ADS

Why should we pursue (or invest in) this research? In order to provide manufacturers with the ability to protect occupants of ADS-equipped vehicles in the event of a crash, it is necessary to have tools (anthropomorphic test devices (ATDs), human models) that have been developed for use in new or more prevalent seating configurations and/or occupant postures that may be present in ADS-equipped vehicles, which are still in the early development and testing stages.

Who else is researching this issue? While the automotive industry and academia are interested in this issue from the tool development/vehicle design aspect of ADS occupant protection, the use of newly-developed biofidelity requirements (FY 2018 & 2019) related to potential ADS alternative seating arrangements to assess current crashworthiness testing and modeling tools (ATDs, human models) is unique to this NHTSA crashworthiness research project.

Have we invested in this topic in the past and what have we learned to date? NHTSA has completed similar research in the past to assess the suitability of existing tools given the availability of new biofidelity data. However, we have not undertaken research specific to the application of the new biofidelity data that is being collected (FY 2018 and 2019) in support of occupant protection in vehicles with ADS.

Objectives, activities, and what is the problem being addressed? To provide manufacturers with the ability to protect ADS-equipped vehicle occupants in the event of a crash, it is necessary to have tools that have been developed for use in new and/or more prevalent seating configurations that may be present in future vehicles with ADS. In FY 2018 and 2019, NHTSA Crashworthiness Research supported the collection of new human response/biofidelity data associated with these potential seating arrangements/occupant postures. Specifically, the research focused on collection of human response data for occupants seated in reclined postures in frontal impacts as well as those involved in high- speed rear impacts. Current anthropomorphic test devices (ATDs) and computer models of humans were not designed for use in these conditions.

In FY 2020, NHTSA will apply this newly gathered data to assess the performance, suitability, and biofidelity of current tools (ATDs and human models) and initiate research, as needed, to improve the biofidelity of the current tools in these new test conditions.

Alignment with DOT Strategic goals and/or DOT research priorities: The research project directly aligns with the Department's strategic goals related to safety and reducing injuries and fatalities associated with motor vehicle crashes.

Expected total project cost and expected funding for FY 2020: The estimated cost of the research is $2M.

Is there a nonfederal financial contribution? If so, how much? No nonfederal financial contributions are included in this planned research.

2. Cybersecurity Resiliency: Evaluating Emerging Tools and Methods

Why should we pursue (or invest in) this research? This project will conduct research into emerging tools and methods on testing for vehicle cybersecurity resiliency in a systematic and quantifiable manner. Such assessments may be used by industry to enhance public transparency in vehicle cybersecurity protections, improve product design, and to understand how to withstand against and recover from potential cyber-attacks.

Who else is researching this issue? Various independent testing groups, international standards setting bodies, and numerous cybersecurity service and consulting firms are exploring test methods and measures within automotive and in other related industries.

Have we invested in this topic in the past and what have we learned to date? NHTSA currently has an initial scoping project with the Virginia Tech Transportation Institute and Booz Allen Hamilton to conduct initial research into identifying effective methods and strategies that could be beneficial in containment of, response to, and recovery from cyber incidents and evaluating how these could be applied to the automotive sector. NHTSA also has a project with The Ohio State University that is researching test procedures and test measures for cybersecurity that different sectors are implementing. Further, NHTSA is aware that there are industry-developed risk / resiliency assessment tools, and common core test methods being utilized by other sectors to assess cyber-physical systems' cyber-resiliency. More research is needed to understand their applicability to automotive architectures and their performance variability across different implementations.

Objectives, activities, and the problem being addressed: The main objective of this work is to identify and assess some of the emerging testing methods, tools and resiliency measures, that could improve the containment, response, and recovery from potential automotive cyber- attacks. This research will inform how resiliency strategies could guide design choices for cybersecurity (hardware or software), and mitigate the risks associated with automotive cybersecurity incidents.

Alignment with DOT Strategic goals and/or USDOT research priorities: This research directly supports the DOT and NHTSA goals to improve safety and save lives. The research also directly supports the DOT goal, Development of Innovations. One strategy under this goal is for the DOT to develop strategies for the integration of cybersecurity risk management into safety management programs.

Expected total project cost and expected funding for FY 2020: $900,000

Is there a nonfederal financial contribution? If so, how much? No

3. Safety Performance Synthesis Research for Advanced Driver Assistance Systems

Why should we pursue (or invest in) this research? ADAS are being deployed across the automotive market at an increasing rate. ADAS systems assist drivers while they maintain and perform their full-time role to assure the safety of the vehicle they are operating. There are various such ADAS functions, and safety benefits estimates are documented only for a subset of the available features, such as Automatic Emergency Braking (AEB), but not for others, such as Blind-Spot Warning, Lane Departure Warning, etc.

This project will synthesize available research on various ADAS functions through target-crash population identification studies, controlled testing studies, naturalistic testing studies, simulated studies, and identify and close gaps where necessary to estimate projected safety benefits across several common ADAS functions. This information informs what the future of crash safety landscape may look like when broader deployment of ADAS systems happen and facilitates informed decision over what residual safety issues will remain and need priority emphasis.

Who else is researching this issue? Industry performs research and testing on their specific systems in development and deployment, however their research is limited to their particular product offerings, capabilities, and targeted operating environments. In addition, industry research will often be considered proprietary and detailed data will not be made available to the broader stakeholder community and public. Organizations such as Insurance Institute for Highway Safety (IIHS), industry standards setting bodies, and international rating agencies such as Euro NCAP also perform research in this area. NHTSA coordinates with such groups but has an objective and technology-agnostic perspective which may not be required or followed by other entities.

Have we invested in this topic in the past and what have we learned to date? NHTSA has developed preliminary test procedures for a limited set of ADAS capabilities. As part of validating the procedures some performance data was acquired. This work will synthesize all available research and perform gap research in simulation and modeling to estimate safety benefits for various ADAS functions.

Objectives, activities, and the problem being addressed: The principal objective of the project is to estimate safety benefits for mature ADAS functions. This work will involve synthesis of research to date and modeling and simulation of relevant crash scenarios from crash databases to estimate potential safety benefits under realistic circumstances. This knowledge will help data driven prioritization of available ADAS offered safety opportunities and help project what crash problems will likely become top issues when ADAS functions may become wide-spread deployed.

Alignment with USDOT Strategic goals and/or USDOT research priorities: This research is aligned with the DOT strategic goal of Safety to Reduce Transportation-Related Fatalities and Serious Injuries Across the Transportation System by acquiring safety data through assessment of ADAS safety benefits. The project is aligned with the DOT

strategic goal of Innovation by contributing to DOT's leadership in the development and deployment of innovative technologies that improve motor vehicle safety. This research is aligned with DOT research priorities tied to performance-based safety through the use of scientific methods and data- driven processes to guide safety programs and enable innovative approaches to improving safety.

Expected total project cost and expected funding for FY 2020: $750,000

Is there a nonfederal financial contribution? If so, how much? No

4. Driver Monitoring Strategies in Driving Automation Systems

Why should we pursue (or invest in) this research? Vehicle technologies that monitor the driver's level of attentiveness are already being deployed in SAE driving automation Level 2 (L2) systems (e.g., the General Motors (GM) Super Cruise system). Similar eye-gaze monitoring technologies, or other driver's physical state monitoring technologies are likely to be introduced with SAE Level 3 (L3) automation as well. NHTSA will explore the efficacy of different approaches in successfully mitigating against the risk of inattentive, impaired, and drowsy drivers that may be called on to resume control of the vehicle by SAE L2 or SAE L3 systems. The objective of this research is to examine the driver monitoring/mitigation strategies already deployed as well as prototype concepts for their effectiveness in ensuring/improving driver readiness for takeover requests from the driving automation system.

Who else is researching this issue? Many manufacturers, researchers, and foreign government agencies are interested in the role of driver state monitoring in improving driver attentiveness with SAE L2 systems, as well as their utility in SAE L3 systems. However, these groups tend to focus on a specific design and implementation Human-machine interface approaches and do not focus on overarching human performance related to safety.

Have we invested in this topic in the past and what have we learned to date? Whereas driver monitoring strategies, such as eye-gaze tracking, have been discussed by industry for some time, it is only recently that costs have allowed an OEM to deploy such a system in production vehicles. NHTSA's research on current SAE L2 systems has included GM's Super Cruise, but the focus has been on overall performance rather than specific to the driver monitoring capability. NHTSA has conducted research on low-cost driver state monitoring strategies (e.g., algorithms using inputs from steering and throttle data) to detect impairment from alcohol, inattention, and drowsiness in real-time, but that research was conducted prior to more advanced technology approaches were market feasible.

Objectives, activities, and the problem being addressed: The objective of this research is to understand the effectiveness of current and proposed strategies for driver state monitoring and mitigation, and how well they contribute to improved driver readiness for takeover requests when a driver is 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 monitoring 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, and how driver monitoring of these behaviors might pair with engagement strategies investigated in prior research.

Alignment with USDOT Strategic goals and/or USDOT research priorities: This project aligns with the Department's Safety and Innovation strategic goals. The results from this project will provide information and knowledge on human factors issues surrounding the challenges with driver readiness to resume control in SAE L2 and SAE L3 driving automation contexts. This knowledge will help the stakeholder community in addressing potential safety risks using driver state monitoring approaches 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.

Expected total project cost and expected funding for FY 2019: $900,000

Is there a nonfederal financial contribution? If so, how much? Possibly partnerships with manufacturers or technology companies with emerging driver monitoring technology solutions and human machine interface concepts.

5. Maintaining Situational Awareness when Operating Vehicles with Automated Driving Systems: Findings from Other Modes

Why should we pursue (or invest in) this research?
ADS human factors research is important to safe introduction of driving automation. In vehicles equipped with ADSs, the expectations of driver behavior and system behavior could become intertwined and interdependent in their effects on safety. For example, safe control handoff between drivers and ADS depends on the driver's understanding of the functionality and state of ADS as well as the driver's readiness to resume control. The system should clearly communicate its state and intent when it needs the human driver to resume control. Maintaining the driver's situational awareness of the driving context and vehicle state, therefore, is critical for safety. Factors that influence driver engagement with the driving task and the ADS include the human- machine interface, the driver's experience and training with the system, and other situation-specific factors that affect behavioral responses. Historically, these types of research questions were featured in Vehicle Safety programs, but the changes in driving role for vehicles equipped with ADSs mean that near term issues with driver engagement are predominantly behavioral and needs to be closely studied to inform education and training programs that could enable drivers to realize the potential of automated systems to reduce crash risk.

Who else is researching this issue?
ADS human factors research is closely coordinated between NHTSA's VSR and RPD offices due to the need for switching the driving role between a human operator and the ADS under certain circumstances in SAE L3 and dual-mode SAE L4 systems. This research will focus on driver knowledge and behavior. Vehicle manufacturers are beginning to deploy driver

engagement strategies, such as through monitoring of force applied to the steering wheel or eye-glaze behavior at the roadway ahead. In addition to research conducted by vehicle manufacturers and universities, related work on these topics has also been conducted by researchers in other transportation modes, particularly in fields such as rail, aviation, space operations, and pipeline monitoring.

Have we invested in this topic in the past and what have we learned to date?
ADS human factors research with a behavioral focus is proposed to begin in FY 2020. The related research to date conducted by NHTSA's Advanced Safety Technologies and Vehicle Electronics and Emerging Technologies research programs highlights the importance of driver engagement. Vehicles with SAE L3 and dual-mode SAE L4 ADS are designed to be operated by both a driver and an ADS, so they sometimes involve control handoff between driver and ADS. This research complements previous work by focusing on driver knowledge, assumptions, and behavior under different scenarios as opposed to focusing on vehicles' human-machine interface design features.

Objectives, activities, and what is the problem being addressed?
The primary objective of this proposed project is to document the current state of knowledge in driver/operator engagement relevant for motor vehicles including learnings from other transportation modes such as rail and aviation. The planned activities will include a synthesis of the existing research literature regarding methods to enhance driver/operator engagement with an emphasis on research that evaluates the effectiveness of various approaches. This synthesis will identify technologies currently being used as well as near-term solutions under development. Finally, the project will convene an expert panel and conduct interviews with key stakeholders to validate the current state of knowledge. This research will help NHTSA identify research gaps and needs from the behavioral perspective as well as provide interested stakeholders with new and innovative ideas from other transportation modes.

Alignment with USDOT Strategic goals and/or USDOT research priorities: The research project directly aligns with the Department's strategic goal of safety, and it cuts across the critical transportation topics of automation and human factors.

Expected total project cost and expected funding for FY 2020: $600,000

Is there a nonfederal **financial contribution? If so, how much?** No.

Describe two high priority projects that were completed in FY 2018 or FY 2019:

1. **Future of Crash Safety**
   Analysis of crashes, occupants, and injuries in retrospective real-world crash data is used to help define priorities in road safety research. However, given the rapid current pace of change in vehicle safety technology and ongoing shifts in population and transportation trends, the research priorities of the future will be different than those highlighted by analysis of historical, retrospective real-world crash data. The Future of Crash Safety research project developed a projection model to predict the most frequent and harmful

types of crashes and injuries in the future.

- **Objectives and activities**: The objective of the current study was to leverage all available data on recent and developing safety countermeasures, as well as predictions on population and transportation trends, to estimate crash outcomes in the future for passenger vehicle occupants. The projection model utilizes real-world crash data from 2005 to 2015 (from NASS CDS, NASS GES, and FARS) along with the best available forecasts and data on road safety trends and countermeasures (e.g., the aging population, shifts in vehicle types in the fleet, advanced safety technologies, crashworthiness, infrastructure improvements, and policy changes) to establish future projections for crash years 2020-2030. These projections can be searched to identify the most frequent injuries, crash types, and affected occupants expected to still be present in the future, for use in identifying research priorities.

- **Alignment with USDOT Strategic goals:** The development of the Future of Crash Safety projection model directly supports the DOT and NHTSA goals to improve safety and save lives. Prioritization of research goals based on the best estimates of the safety issues of the future focuses research efforts on issues and risks that have not yet been solved and/or will not be addressed by countermeasures that have already been developed. The model will help NHTSA to be more proactive and less reactive with resource allocation.

- **What was learned?** The model results, which suggest lower overall risk of injury in crashes in the future, showed the crash, occupant, and injury types projected to be most frequent and associated with the most harmful outcomes in 2020-2030. Although there are many sources of uncertainty in these projections, the results provide better tools for identifying research priorities than retrospective crash datasets or estimates of the effects of individual trends or safety countermeasures.

- **What were the research outputs/outcomes**? The research has/will produce by the end of FY 2019:

  - Detailed methodology report, including results of an evaluation model that predicts passenger vehicle crash outcomes in 2014, compared to real-world results from 2013-2015 to validate the model methodology.
  - Brief output dataset demonstrating crash outcomes in 2020-2030 under the hypothetical assumption that no new technologies or safety improvements were introduced in the future.
  - Full output dataset showing projected crash and injury outcomes in 2020-2030, under available current assumptions and predictions regarding current and expected future shifts in trends, as well as changes to vehicles, infrastructure, and policies expected to affect passenger vehicle safety.
  - The completed full model can also be used to explore the potential effects of a

broad range of hypothetical passenger vehicle, infrastructure, and policy developments.

- **Does further research need to be done? If yes, for what purpose?** The current version of the model was developed using available information on expected population and transportation trends, and on the expected effectiveness and penetration of a variety of countermeasures and changes in vehicles, infrastructure, and policies. Many of the model parameters were necessarily approximate and can be improved as more current information comes available. Additionally, the model will be useful for exploration of hypothetical future developments in vehicle safety, infrastructure, and policy. Future extensions of the model could incorporate road users other than passenger vehicle occupants (including heavy trucks, pedestrians, cyclists, and motorcyclists). Updates of the model with more recent retrospective data will require incorporation of data from the new Crash Investigation Sampling System (CISS) and Crash Report Sampling System (CRSS) crash datasets.

- **Will nonfederal stakeholders contribute to further research? If yes, how much**? The building of predictive models requires accurate estimates of the future effectiveness and penetration of developing safety countermeasures. If these reports are released to the public, and it is decided to continue to improve the model with better estimates, those best estimates could potentially be obtained/received from nonfederal stakeholders.

- **What was the total cost?** $645,000.

- **Were nonfederal dollars leveraged? If so, how much?** No, nonfederal dollars were not leveraged for this research project.

2. Motor Vehicle Occupant Safety Survey

The Motor Vehicle Occupant Safety Survey, or MVOSS, is a national self-report survey to track changes in public attitudes, knowledge, and behavior related to occupant protection. NHTSA conducted the baseline MVOSS in 1994, and NHTSA is now releasing the seventh administration of the MVOSS. The MVOSS is composed of two questionnaires, one focusing on seat belt use and the other on child passenger safety. Other modules included in the survey address Emergency Medical Services (EMS) and crash injury experience. Each questionnaire is administered to roughly 6,000 respondents. While previous administrations of the MVOSS were conducted by telephone, this MVOSS employed major changes in methodology by emphasizing Web-based responding, with a mail back paper questionnaire as an alternative mode of response. The survey also used an address-based sampling frame instead of a telephone sampling frame to draw the sample.

- **Objectives and activities**: The purpose of the survey is to provide levels and identify changes in attitudes, knowledge and (self-reported) behavior related to seat belt use, child passenger safety, crashes and crash injuries, and EMS. Data from the survey help identify current obstacles to public safety, detect emergent targeting

issues for program activity, and provide an overall status report on where the public stands on key occupant protection matters. The data will help the Office of Behavioral Safety Research to continue efforts to identify more effective and efficient countermeasures for nonuse of seat belts as well as nonuse and misuse of child restraints. The recommendations and programs developed from the survey help provide an evidence-based foundation for State and community traffic safety programs.

- **Alignment with USDOT Strategic goals:** MVOSS supports the DOT strategic goal of safety. Successful efforts to increase occupant protection will decrease the number of crash fatalities and injuries.

- **What was learned?** An estimated 93% of drivers report that they wear their seat belts "all of the time," an increase in reported usage from the previous MVOSS (88% in 2007). The survey found that most people agreed with the utility of wearing seat belts. However, adults differ in their use, beliefs, and attitudes regarding aspects of belt use. NHTSA also found that only 63% of rear seat users reported always wearing their belt when riding in the back. Support for and belief in the existence of rear seat belt laws and front seat belt use were strong predictors for self-reported rear seat belt use, which has important implications for program development based upon state laws. For child passenger safety, adults generally believe that children should be required to wear seat belts. These data also indicate that there is broad support for fines for driving with unrestrained children, but only about half of adults (55%) believe law enforcement regularly ticket drivers with unrestrained children in their vehicles.

- **What were the research outputs/outcomes**?
  The outcomes from this version of MVOSS include the following:

  - A methodology report describing the statistical techniques used in the survey.
  - A report documenting the levels and changes in attitudes, awareness, and experience related to adult belt use.
  - A report documenting the levels and changes in attitudes, awareness, and experience related to child passenger safety.
  - A report documenting the levels and changes in attitudes, awareness, and experience related to EMS and crash experience.
  - Two short summary documents, one for belt use and one child passenger safety, that highlight key findings.
  - Two databases, each containing responses from one of the two versions of the survey.
  - A peer-reviewed journal article exploring self-reported seat belt use in rear seats that was recently accepted for publication in the Journal of Safety Research.

- **Does further research need to be done? If yes, for what purpose?**

NHTSA plans to conduct at least two additional analyses using the MVOSS databases.

One effort will examine rural versus urban differences in attitudes related to occupant protection with the goal of developing programs specifically for rural areas. A second effort is to examine changes in attitudes, beliefs, and experience related to EMS with the goal of identifying any issues that should be addressed in this important part of the transportation system.

- **Will nonfederal stakeholders contribute to further research? If yes, how much**? Nonfederal stakeholders will have the potential to conduct additional research using the two databases once they are made available to the public.

- **What was the total cost?** $1,313,452

Were nonfederal dollars leveraged? If so, how much? No, there were no nonfederal financial contributions.

Chapter 3 – FY 2020 Program Descriptions

FY 2020 RD&T Program Funding Details

RD&T Program Name	FY 2020 Enacted ($000)	FY 2020 Basic ($000)	FY 2020 Applied ($000)	FY 2020 Development ($000)	FY 2020 Technology ($000)
Vehicle Electronics and Emerging Technologies	$27,865		$27,865		
Advanced Safety Technologies	$5,351		$5,351		
Crashworthiness	$13,110		$13,110		
Alternative Fuels Vehicle Safety	$674		$674		
Vehicle Research & Test Center	$500		$500		
Highway Safety Research	$14,073		$9,307		$4,766
Totals	**$61,573**		**$56,807**		**$4,766**

FY 2020 RD&T Program Budget Request by DOT Strategic Goal

RD&T Program Name	FY 2020 Enacted ($000)	SAFETY ($000)	INFRA-STRUCTU RE ($000)	INNOVATIO N ($000)	ACCOUNT-ABILITY ($000)
Vehicle Electronics and Emerging Technologies	$27,865	$27,865			
Advanced Safety Technologies	$5,351	$5,351			
Crashworthiness	$13,110	$13,110			
Alternative Fuels Vehicle Safety	$674	$674			
Vehicle Research & Test Center	$500	$500			
Highway Safety Research	$14,073	$9,307		4,766	
Totals	**$61,573**	**$56,807**		**$4,766**	

Office of Vehicle Safety Research (VSR)

Program: Vehicle Electronics and Emerging Technologies FY2020

$27,865

Program Description/Activities: As the industry moves toward a future of driving automation systems and nearly ubiquitous availability of vehicle connectivity, the promise of emerging technology is accompanied with a degree of new risk. With the increasing proliferation of electronics and software, our vehicles are exposed to additional failure modes, vulnerabilities, and threats that could jeopardize the safety of the public. Connectivity and automation raise the cybersecurity stakes, and without proactive measures taken across the vehicle lifecycle, risks will rise accordingly. Methodical identification of potential issues and proactive management of complexity are essential to designing vehicle architectures that will respond safely even when there are electronic system failures, software errors, or cybersecurity vulnerabilities. The Vehicle Electronics and Emerging Technologies research program broadly covers two major research areas: Automated Driving Systems (ADS – SAE Levels 3-5 as defined in SAE J3016) and electronics functional and systems safety (automated and non-automated), including a strong emphasis on cybersecurity and electronics reliability research.

For ADSs, the program will address several important areas that are critical to building a strong safety assurance approach for ADS-equipped vehicles, such as continuing to develop and define testable scenarios over the next several years; continuing to develop physical and virtual test methods for ADS systems (i.e., given a set of scenarios, what test methods may be 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 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 human machine interface (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 older adults and the disabled community by researching what design elements are needed on vehicles used as part of future mobility services.

In the electronics areas, research will address functional and systems safety, cybersecurity, as well as electronics reliability. Electronics functional safety is an important part of overall systems safety that deals with safety risk management associated with random failures in sensors, components, systems, and software implementation, as well as operator errors and environmental changes. Vehicle Cybersecurity research deals with the safety risk management associated with intentional manipulation of the vehicular systems and software. While the need for functional safety and cybersecurity both originate from the same systems, risk assessment, risk mitigation, and effective means of life-cycle risk management differ in some areas across

these two safety domains.

Program Objectives: The objectives of the Vehicle Electronics and Emerging Technologies research program area are to continue to focus 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. The program will also continue other core research associated with these systems such as software safety, vehicle cybersecurity, and human factors needs. The program seeks to support improvements in the electronics reliability and cybersecurity posture of motor vehicles, and understand and promote contemporary methods in software development, testing practices, and requirements management as they pertain to robust management of underlying hazards and risks across the vehicle life-cycle. These activities include close collaboration with industry to promote a strong risk management culture and associated organizational and systems engineering processes.

Automated Driving Systems (ADS)

Research to Support Decisions on the Removal of Potential or Unnecessary Barriers for ADS Vehicles

Most FMVSSs were developed assuming a human driver would be operating the vehicle. With ADS, vehicle manufacturers are presented with opportunities to re-imagine and redesign new vehicle interiors. NHTSA will complete its initial research reviewing the full range of its FMVSS in FY 2020; but the agency anticipates emerging new concepts will necessitate additional research in support of innovative approaches. The objective of this research is to gather data and evidence that could support decisions about potential adaptation and/or translation of regulations to address unnecessary barriers while ensuring safe operation of vehicles with ADS. NHTSA will also support the review of research, design, and test data submitted as part of exemption petitions; survey other research findings relevant to the case; conduct research activities to confirm or augment available data; and identify a means to categorize and streamline exemption requests.

Research on System Safety Performance of ADS Vehicles

In conjunction with the industry and standards setting organizations, this research will explore approaches, methods, metrics, and tools for public safety assurance purposes to assess how well the ADS performs at a system level to avoid crashes. Research will explore the mix of simulation, test track, and on-road testing and their role in assuring safety for the public while allowing for different approaches and innovations to take place. This research will explore variable testing concepts around scenarios that could be loosely controlled, randomly introduced, or entirely naturalistic.

Human Factors Research for ADS Vehicles

Topics will continue significant research areas initiated in FY 2019. This includes researching driver engagement in SAE L3 and Dual-mode Level 4 ADS. Vehicles that are designed in a manner where it can be operated by both a driver and an ADS, involving control handoff between drivers and ADS in certain circumstances. A driver's readiness to resume control in

SAE L 3 ADS is very critical to safety. For example, emerging driver engagement strategies, such as applying sufficient force to the steering wheel, or simply looking at the roadway ahead, and other engagement strategies have been studied in other fields such as rail, aviation, and space operations will be explored. Driver engagement with the ADS is influenced by several issues, including the human-machine interface, the driver's experience and training with the system, and other situation- specific factors that affect behavioral responses. Near-term issues with driver engagement are predominantly behavioral; therefore, FY 2020 research efforts in this area previously funded under the Vehicle Safety account will be reallocated to the Highway Safety Research account. Another key area involves accessibility considerations in ADS vehicles. Driving automation is expected to provide mobility options not previously afforded to people with disabilities, regardless of cognitive, sensory, physical, or even the degree of condition. Vehicles with ADS that are accessible to people with disabilities will be expected to provide information through appropriate modes to interact with the occupants. Research will be initiated to explore the information needs of people with disabilities and how these needs could be implemented effectively within a human-machine interface (HMI). Finally, the topic of human behavior in response to automation will be addressed, for example, what behaviors might pedestrians or passengers engage in if they think there is no human monitor.

Crashworthiness of ADS Vehicles
Vehicle crash mechanics and occupant restraint systems are not directly affected by driving automation. However, changes to occupant behavior will affect safety priorities. Enhanced sensor systems can provide opportunities to enhance occupant crash safety. Crashes with manually operated vehicles will inevitably occur during the transition period, and protection of ADS occupants will be a priority. In FY 2020, initial research will be completed in evaluation and refinement of existing tools (dummies, human body computer models) for ADS alternative seating arrangements (e.g., rear-facing, reclined). Experimental data collected in FY 2018 and FY 2019 will support this effort. Research will also support the development of refined dummies/human body computer models that can better predict occupant injuries associated with alternative seating arrangements for ADS-equipped vehicles.

Vehicle Electronics Functional Safety

Functional Safety of Driving Automation Systems
This research will provide an examination of the extensibility of industry process standards in functional and system safety, and hazard analyses techniques for the electronic systems and software of driving automation systems. It will include leveraging standards such as ISO 26262 (Road Vehicles-Functional Safety) and ISO 21448 (Safety of Intended Functionality) to assess overall functional safety and hazards analysis of ADS systems and components.

Software Assurance Approaches
Research will explore contemporary methods in automated tools and approaches in software development, testing, and deployment, such as formal methods, and their potential applicability to automotive applications.

Vehicle-to-Everything (V2X) Communication Technology Deployment

NHTSA and the USDOT have committed to supporting the deployment of Vehicle-to-Everything (vehicles, infrastructure, and other road users or collectively Vehicle-to-Everything, or V2X), as an extension of the early work of vehicle-to-vehicle (V2V) communication technology. Specific interests in the coming year include the First Responder Safety Technology Pilot Program that will help equip emergency response vehicles and key infrastructure with V2X communication technology. V2X is a technology-agnostic, wireless communications-based, vehicle technology that has the potential to drastically reduce motor vehicle crashes, improve mobility, and could also expand the operational domains of emerging driving automation solutions by providing redundant sensing capabilities. V2X technology offers advantages for vehicle crash avoidance system developers and applications as, unlike radar, camera or even lidar, it does not rely on line-of-sight targeting to identify possible crash threats. This V2X pilot will utilize the 5.9 Gigahertz Safety Band of spectrum currently allocated for use solely by the transportation sector to enable vehicles to transmit and receive information about the immediate driving environment, thus increasing the functionality of vital crash avoidance technology. Incorporating infrastructure, pedestrians, devices, and the grid increases the communications capabilities and thus further increases the potential for safety of roadway users.

Vehicle Cybersecurity

Research to Advance NIST Cybersecurity Framework Application in Automotive Domain

Research to support the automotive industry's adoption and implementation of the NIST Cybersecurity Framework across their organizations. This will include targeted research in risk assessment, protection methods, intrusion detection, real-time response mechanisms, as well as planning for expeditious recovery from incidents.

Research to Enhance Cybersecurity Readiness

This research will explore and support industry and NHTSA's ability to continually improve and assess organizational readiness to respond to potentially critical and large-scale cyber incidents. This would include exercises engaging industry stakeholders, all relevant departmental organizations, and other government agencies to practice and refine internal processes. This activity will include additional investments in NHTSA's applied cybersecurity capabilities to maintain technical expertise, assess emerging issues independently and expeditiously, and facilitate informed decision-making.

Contemporary Tools, Methods for Vehicle Cybersecurity Resiliency

Continue research in tools, methods, and practices to design cybersecurity resiliency into vehicular systems that could effectively mitigate safety risks. This research would include the possibilities for automated tools that could identify and mitigate some vulnerabilities, such as those explored in Defense Advanced Research Projects Agency (DARPA) challenges.

Collaborative Research

Collaborate and leverage research with key stakeholders, the automotive industry, standards setting organizations, and government agencies to include: Automotive Information Sharing and Analysis Center (Auto-ISAC), OEMs, Department of Homeland Security (DHS), NIST, Department of Defense (DOD), SAE, and National Aeronautics and Space Administration

(NASA).

Manufacturers continue to introduce new features into modern vehicles at a record pace. What enables many of the new features is software and other advances 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 the business side. This program enhances the Agency'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 Electronics 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.

The Vehicle Electronics and Emerging Technologies Program is not a statutory mandate. NHTSA will continue to collaborate with internal agencies on funding and other research programs. The Agency is also the lead for the Departmental Cybersecurity Working Group (supports USDOT Innovation goal) to develop approaches for maintaining the cybersecurity of the transportation system. The Vehicle Electronics and Emerging Technologies Program meets the annual funding appropriations act's requirement to conduct safety research.

Program Alignment with Strategic 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."

In support of NHTSA's Strategic Goals and Objectives 2016-2020, the Vehicle Electronics and Emerging Technologies Program conducts testing, research, and data collection and analysis to support its safety mission in addressing functional and system safety performance, driver behavior; developing methods, 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. Research under this program area benefits U.S. communities at large. See Chapter 1 Evaluation and Performance Measurement for more detailed information.

USDOT Strategic Goals	Topical Research Areas	USDOT Research Priorities
Safety	• Automation • Systemic Safety Approach • Human Factors • Emerging and Enabling Technologies • Mobility Innovation • Technology • Transfer/Deployment • Data	• Regulatory Reform • Performance-Based Safety Rules • Underserved Communities

Research Collaboration Partners

NHTSA collaborates with Intelligent Transportation Systems Joint Program Office (ITS JPO), Federal Motor Carrier Safety Administration (FMCSA), Federal Highway Administration (FHWA), and Federal Transit Administration (FTA) on studies related to light vehicle, heavy truck, and motor coach electronics, functional safety, and cybersecurity. NHTSA collaborates with other government agencies, as well including the DHS, NIST, NASA, DOD, Department of Energy (DOE), and the Federal Communications Commission (FCC) in sharing research being conducted with emerging technology, their testing, assessment, and cyber resiliency. 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's VSR office also 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. The agency also publishes reports and data to seek feedback from all interested parties. Additionally, NHTSA 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.

Program: Advanced Safety Technologies – FY2020
$5,351

Program Description/Activities: Advanced Safety Technologies research focuses on safety countermeasures for passenger vehicles, and large trucks and buses that assist drivers in preventing crashes. Roadway safety continues to be a major public health and economic challenge in the United States. There were 37,133 people killed in crashes on U.S. roadways during 2017. Furthermore, traffic fatalities increased in almost all segments of the population—passenger vehicle occupants, occupants of large trucks, pedestrians, pedal-cyclists, motorcyclists, etc. There is a promising note in the crash statistics that most of these crashes are preventable, and incorporation of advanced safety technologies may have the potential to provide an additional safety margin that can help drivers avoid or significantly mitigate crashes.

While ADS[2] are being developed, almost all current crashes that occur on our roadways still involve human drivers who drive themselves. An increasing portion of these vehicles feature advanced safety technologies that assist the drivers to avoid crashes when they find themselves in difficult and risky circumstances. This program area focuses on the safe development, evaluation, and deployment of systems that encompass ADAS. These include technologies that warn the driver and/or respond to specific crash imminent situations (i.e., SAE automation L0), as well as driving automation systems that enable partial driving automation, but still require full driver engagement (SAE automation L1 & 2).

In SAE L1, the driving automation system performs sustained Operational Design Domain (ODD)-specific execution of either lateral or longitudinal vehicle motion control with the driver responsible for the remainder of the driving task. As sensor and software capabilities have matured, the market is evolving with increasing market penetration of SAE Level 2 driving automation availability on modern vehicles, which involve sustained and ODD-specific execution of both lateral and longitudinal vehicle motion control with the driver continuing to ensure the safety of their vehicle even when the system is engaged. The automotive industry has made significant progress in the development of advanced technologies intended to prevent and/or mitigate roadway crashes. Today's advanced safety technology systems (also known as crash avoidance systems) rely on sensors such as radar, Light Detection and Ranging (LIDAR), camera, ultrasonic, and others to detect potential collisions with other vehicles, pedestrians, or other objects and then warns 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.

The effectiveness of advanced safety technologies often relies on the way the (human) driver interfaces with the system—ranging from simply whether (or not) they engage the system (i.e., controls), to how warnings are conveyed (i.e., driver-vehicle interface). Similarly, more advanced driving automation systems (that are anything short of "fully automated") also rely on the driver's ability to properly understand the capabilities, constraints, and control settings of driving automation—including the circumstances and way the human driver takes-over or "partners" with the systems to complete the driving task. This program is not statutorily mandated.

Program Objectives: This program is focused on advanced safety systems and innovations that directly map to crashes involving light and heavy vehicles. Recent examples include new braking technologies (automatic emergency braking (AEB) to reduce rear end collisions), as well as important contributions for stability control systems estimated to prevent a significant number of both light and heavy vehicle crashes. This program will continue to focus on emerging innovative safety systems that demonstrate potential to address real world crashes and improve vehicle safety performance with respect to frequent and severe crashes. Emerging technologies in this area include innovative active safety systems such as: cross traffic alert systems that have potential in addressing some types of intersection crashes; blind spot intervention systems that automatically apply steering or braking to assist drivers in avoiding lane change/merge collisions; opposite direction (head on) collision avoidance systems; and Traffic Jam Assist (TJA) systems that provide steering and speed control assistance to a driver during low speed, stop-and-go driving circumstances. Additional technology innovations will also be part of this program and are envisioned to include new displays used as part of in-vehicle systems that interact with drivers via human-machine interfaces (HMIs), as well as technologies for side and rear vision enhancement for drivers (e.g., camera-based technologies).

For the ADAS program, passenger vehicles and light trucks will be the primary focus. In the Heavy Vehicle Safety Technologies program, the focus will be on tractor-trailer vehicles, single unit trucks, and buses. This research area will support the safe testing and future deployment of ADAS priorities, and will include:

Reducing Unnecessary Barriers for Emerging ADAS
As automotive OEMs and industry suppliers continue to innovate and develop new ADAS, there is the potential for various design features or functional aspects of these systems to encounter conformance difficulties with legacy FMVSS that govern the performance of such systems. The agency will conduct research as appropriate to complete a timely, efficient, yet thorough evaluation of the new technology, and of potential unintended challenges that may be posed by the existing standards.

System Reliability, Potential Unintended Consequences, and Safety Benefits
This area involves system and component-level research on sensor reliability factors, system repairs, and performance degradation. Results will allow increased understanding of longer term operational factors that may reduce safety effectiveness. This area will also focus on the benefits and customer use of new emerging advanced technologies. Fundamental information about if and how customers use ADAS systems (e.g., under what driving circumstances systems are engaged or disengaged, differences in use patterns among driver demographics, impacts of various driver interface designs, etc.) are invaluable to understand consumer acceptance factors and challenges, and refine product designs to enable broad-based and proper usage. To accelerate important lessons-learned from early deployments of ADAS technologies, and to help better understand safety benefits, NHTSA performs operational evaluations of novel systems in collaboration with industry partners and performs targeted safety benefit assessment studies to help guide the agency's focus on the most safety-beneficial technologies.

ADAS Human-Machine Interfaces (HMI)

Advanced vehicle technologies that support the driver have a range of interaction points when information is communicated to the driver and responses are expected. For example, drivers may be expected to enter a destination when prompted or to react when an auditory warning sounds as the vehicle's headway distance closes at a rate that will risk a collision unless the driver intervenes. As HMIs continue to evolve, leveraging new advanced control and display technologies, new and additional considerations will emerge. Head-up displays, gesture-based inputs, and augmented reality displays are some examples of emerging HMI technologies that are making their way into vehicles and are part of NHTSA's research program.

Driver Adaptation to ADAS

When examining the cooperation between drivers/users and vehicles/systems, it is critical to measure behavioral changes that could occur beyond reactions to HMI, such as the choices drivers make for trip planning, and the strategies they employ when driving. How drivers/users learn and adapt to vehicle technologies can lead to both positive and negative outcomes. For example, if a driver/user begins to take more risks because he or she believes (correctly or not) an advanced safety system will intervene in time, then that is a negative adaptation. Alternatively, if drivers begin to adopt similar headway distances as an adaptive cruise control system, then there may be a positive adaptation, leading to fewer critical events. Behavioral adaptations represent a significant point of uncertainty.

The light vehicle ADAS research program is engaged in a body of research for vehicle technologies that supports safer drivers by presenting them with safety warnings when needed, providing active assistance through automatic interventions in crash imminent situations, and discouraging unsafe driving behaviors such as distracted and alcohol-impaired driving through technological solutions. Research also focuses on technologies that enhance the safety of vulnerable and at-risk populations such as teen drivers, older drivers, pedestrians, bicyclists, and motorcyclists. NHTSA's research in ADAS will continue to focus on identifying emerging safety technologies; partnering with industry to develop more efficient and comprehensive assessment methods for safety performance and enhancing our understanding of HMI issues; long-term safety impacts of these advanced technologies; and architectural improvements. The result of this research investment will help NHTSA prioritize its research in technologies that offer the most significant societal benefits and industry to build safety technologies that save lives, prevent injuries for all road users, and mitigate potential unintended consequences.

The outcome of this work will be research findings relative to important aspects of ADAS, such as effective HMI design, estimated safety benefits, and performance-based test procedures. These and other outputs from this program will help automotive manufacturers, suppliers, and other industry entities to improve their products through more accurate and efficient product evaluations such that societal safety benefits can be enhanced. Furthermore, the field testing of new ADAS to be completed by NHTSA and industry partners will provide insights for further product refinements, as well as for developing programs to promote voluntary adoption of advanced safety technology systems and enhance competitiveness among vehicle manufacturers and other industry entities for

offering high value and high-performance systems.

The Heavy Vehicle program is focused on safety systems and innovations that directly map to crashes involving heavy vehicles on US roadways. By continuing to focus on emerging innovative advanced safety systems on heavy vehicle platforms that show potential to address real world crashes, the goal is to improve the safety performance of heavy vehicles. In some cases, the nature of heavy vehicle operations makes certain ADAS and ADS capabilities more appealing, such as technologies that target managing or addressing driver fatigue. Research will address the special considerations associated with, and benefits stemming from, the application of ADAS technologies on heavy vehicles.

NHTSA 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. NHTSA also publish reports and data to seek feedback from all interested parties. Additionally, NHTSA 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 outputs 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.

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 "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 assist technologies directly supports safety and innovation and has an impact on all communities. See Chapter 1 Evaluation and Performance Measurement for more detailed information.

In support of NHTSA's Strategic Goals and Objectives 2016-2020, the Advanced Safety Technologies 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.

USDOT Strategic Goals	Topical Research Areas	USDOT Research Priorities
Safety	• Systemic Safety Approach • Emerging and Enabling Technologies • Technology Transfer/Deployment • Data	• Regulatory Reform • Performance-Based Safety Rules

Research Collaboration Partners: NHTSA collaborates and reviews FHWA, FMCSA, FTA, and PHMSA studies on light vehicle, heavy truck, and motor coach 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.

Program: Crashworthiness
FY2020
$13,110

Program Description/Activities: The Crashworthiness research program (biomechanics and safety systems) focuses on vehicle safety countermeasures to reduce the number of serious injuries and fatalities that occur from motor vehicle crashes in the U.S. 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: 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. See Chapter 1 Evaluation and Performance Measurement for more detailed information.

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.

USDOT Strategic Goals	Topical Research Areas	USDOT Research Priorities
Safety	• Systemic Safety Approach • Emerging and Enabling Technologies • Technology Transfer/Deployment • Data	• Regulatory Reform • Performance-Based Safety Rules

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.

Biomechanics research 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. Biomechanics research 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 computer simulations. The new knowledge that is gained through injury research is applied towards the refinement of crash test dummies and associated injury measures as well as towards the enhancement of computer models (e.g., human-body models). These tools are then utilized to support vehicle safety countermeasure development.

In 2020, Biomechanics research will continue to focus on completing the development, evaluation and documentation associated with advanced testing and simulation tools (ATDs, human body models). The application of these enhanced tools will increase both the agency's and industry's ability to assess occupant protection safety in frontal, side, oblique, and rear impact crash modes. Included in these efforts is research supporting the completion of testing, evaluation, and documentation associated with a new small female frontal crash test dummy, THOR 5^{th}.

Additionally, the program focuses 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).

Safety Systems research supports agency actions aimed at reducing the number of fatal and serious injuries to occupants in motor vehicles that occur in the U.S. 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, materials, and equipment to enhance safety for all occupants in the event of a crash. In 2020, Safety Systems research will use the tools and criteria developed through Biomechanics research to continue developing strategies for enhancing occupant safety. Child safety continues to be a major focus area, with research toward improving the frontal crash performance of child restraints, including the use of a new 10- year-old dummy, and toward improving the usability of child restraint attachments in vehicles.

Vehicle crash compatibility will also be an area of focus, particularly with regards to light-weight, fuel efficient vehicle designs. Occupant safety in side crashes to both near and far-sides of the vehicle will be assessed using new, advanced side impact crash test dummies. Frontal crash protection will focus on improving safety for rear seat occupants, including research to reduce head injuries from contacts with seat backs and interior surfaces. Rear seat safety will also evaluate seat belt elongation requirements. Rollover crashes will be addressed with research to reduce occupant ejection through roof openings. A new rear impact dummy will be used to

develop test procedures to assess seat back strength and headrest performance in rear impacts.

The Crashworthiness research program 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 motor coach 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. NHTSA 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.

Program: Alternative Fuels Vehicle Safety – FY2020
$674

Program Description/Activities
The Alternative Fuels Vehicle Safety research program will examine the safety issues and promote research to enhance industry best practices for new engine technologies. Electric battery vehicles are becoming increasingly common and research is needed to develop best safety practices for these rapidly evolving systems. Research is needed to support emergency medical services (EMS), towing, and recycling of lithium ion battery vehicles. Additionally, hydrogen and compressed natural gas vehicles are seeing increasing market penetration. Research is needed to develop and standardize safety assessment methods. This program is not statutorily mandated. NHTSA 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 fuels 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."

In support of NHTSA's Strategic Goals and Objectives 2016-2020, NHTSA's Alternative Fuels Vehicle Safety program will address the safety of alternative fuel technologies that will be used in conventional and future ADSs. The Alternative Fuels Vehicle Safety research program has impacts for all communities. See Chapter 1 Evaluation and Performance Measurement for more detailed information.

USDOT Strategic Goals	Topical Research Areas	USDOT Research Priorities
Safety	• Systemic Safety Approach • Environmental Stewardship • Emerging and Enabling Technologies • Technology Transfer/Deployment • Data	• Regulatory Reform • Performance-Based Safety Rules

Program Objectives: NHTSA is currently developing a safety assessment for wireless charging systems being evaluated by the DOE. This assessment will direct research to enhance wireless charging safety. NHTSA is also working with the DOE laboratories to evaluate the safety of extremely fast charging techniques intended to recharge a vehicle in around 10 minutes. These systems use higher voltages than existing equipment and currently utilize liquid cooled charging cables. The existing battery charging test procedures will be extended to encompass the increased safety concerns for these vehicles.

In FY 2020, NHTSA requests $674for the Alternative Fuels Vehicle Safety research program. Specifically, the requested funding will allow the agency to develop safety test procedures for extreme fast charging systems.

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 fuels 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. The Agency actively participates in the Departmental Environmental Stewardship Working Group (supports USDOT Infrastructure goal) to preserve the environment, ensure the safety and cost- effectiveness of alternative transportation energy sources, and ensure the safe transportation of hazardous materials. NHTSA collaborates with DOE 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 to solicit feedback on future safety concerns. NHTSA participated in the DOT liquefied natural gas safety research meeting.

Program: Vehicle Research and Test Center (VRTC), Ohio
FY2020
$500

Program Description/Activities: NHTSA's in- house applied 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 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 defects investigations and possible cybersecurity incidents. 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, advanced safety technologies, vehicle electronics and emerging technologies). This program is not statutorily mandated.

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 "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." Additionally, VSR's VRTC contributes to DOTs innovation goal by developing new cutting-edge test tools and methods used to test advanced technologies and improve occupant protection. 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 safety technology 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.

This also 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." In support of NHTSA's Strategic Goals and Objectives 2016-2020, VSR's 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 Advanced Safety Technologies 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. See Chapter 1 Evaluation and Performance Measurement for more detailed information.

USDOT Strategic Goals	Topical Research Areas	USDOT Research Priorities
Safety	• Automation • Systemic Safety Approach • Human Factors • Environmental Stewardship • Emerging and Enabling Technologies • Mobility Innovation • Technology Transfer/Deployment • Data	• Regulatory Reform • Performance-Based Safety Rules • Underserved Communities • Cybersecurity

Program Objectives: The FY 2020 funding will be used to procure equipment needed to conduct research and analysis of ADS equipped 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, 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-JPO).

In FY 2020, the VRTC plans to support a broad range of critical safety areas including:

- Advanced Safety Technologies research (light and heavy vehicles), including support for adapting existing agency safety tests and research of new emerging advanced driver assistance technologies;
- Crashworthiness research, including support for adapting existing agency tests and test procedures as well as research on new occupant protection topics to enable deployment of innovative new technologies;
- Biomechanics research including adapting and upgrading existing tools (crash test dummies) for compatibility with new technologies such as ADS;
- Lab and in-field support for safety defects investigations; and
- Vehicle Electronics and Emerging Technologies research into complex areas such as ADS and cybersecurity to support development of safety approaches, methods, and tests.

•

VRTC conducts testing, research, and development necessary to support Federal motor vehicle safety standards, 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 advanced safety technologies, 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, 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 ADS 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 (DHS, DOD, 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, advanced safety technologies, vehicle electronics and emerging technologies. 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 and Consumer Information.
- Other DOT agencies: FHWA, FMCSA, FTA, ITS JPO.
- 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.

Office of Behavioral Safety Research (BSR)

Program: Highway Safety Research – FY2020
$14,073

Program Description: The primary objective of the Highway Safety Research program is to improve the return on investment from the Congressionally-mandated Highway Safety Grant program. Highway Safety Research directly supports the Departmental safety priority by providing the scientific basis for the development of effective behavioral countermeasures to reduce the occurrence and severity of traffic crashes. Highway Safety Research also evaluates the effectiveness of programs to reduce fatalities and injuries on our highways, which is critical to assist States in allocating resources effectively and achieving national performance targets. In addition, Highway Safety Research monitors and measures both safe and unsafe driving behaviors to track progress and identify emerging safety problems. The Office of Behavioral Safety Research disseminates research, analysis, and evaluation program results to the States for use in identifying problems and selecting effective countermeasures for implementation through the highway safety formula grant program (Section 402). Recent areas of research include alcohol and drug impaired driving, speeding and speed management, occupant protection (seat belt use and child safety seats), pedestrian and bicyclist safety, pupil transportation safety, distraction, driver drowsiness, motorcyclist safety, older driver safety, young and novice driver safety, and emergency medical services.

In FY 2020 Highway Safety Research plans to focus on three priority areas. The first area is drug- impaired driving. Many substances can impair driving, including alcohol, some over-the-counter and prescription drugs, and illegal drugs. The increased availability of marijuana products, and increased use of opioids, as well as the use of illicit drugs like methamphetamines and the use of pharmaceutical products, all contribute to this growing safety risk. NHTSA will continue research into field tests of drug impairment and field test devices that could be used by law enforcement to detect drivers impaired by drugs, with a focus on marijuana, as well as research supporting successful prosecution of drug-impaired drivers, improvements in data collection systems, and more effective messaging and communication strategies.

The second area is ADS Human Factors Research. In vehicles equipped with ADS, the expectations of human behavior and system behavior become intertwined and interdependent in their effects on safety. For example, safe control handoff between human drivers and ADS depends equally on the human driver's understanding of the state of ADS, how it functions, and the human's readiness to resume control, and the system's ability to communicate its state, including when it needs the human driver to resume control. Keeping the human driver engaged, therefore, is critical for safety. Emerging driver engagement strategies, such as applying sufficient force to the steering wheel, or simply looking at the roadway ahead, and other engagement strategies that have been studied in other fields such as rail, aviation, and space operations will be explored. Driver engagement with the ADS is influenced by several issues, including the human-machine interface, the driver's experience and training with the system, and other situation-specific factors that affect behavioral responses. Historically, these types of research questions were featured in Vehicle Safety programs, but the changes in driving role for vehicles equipped with ADS mean that near term issues with driver engagement are

predominantly behavioral and must be closely studied.

The third area of research is ADAS Driver Adaptation Research. When examining the interaction between human drivers and vehicles equipped with ADAS technologies, it is critical to measure behavioral changes that could occur beyond reactions to ADAS features and functioning. How drivers/users learn and adapt to vehicle technologies can lead to both positive and negative outcomes. For example, if a driver/user begins to take more risks because he or she believes (correctly or not) an advanced safety system will intervene in time, then that is a negative adaptation. Alternatively, if drivers begin to adopt similar headway distances as an adaptive cruise control system, then there may be a positive adaptation, leading to fewer critical adverse events. The adaptation to vehicle functioning and human-machine interface designs has implications for both driver behavior programs and vehicle safety. The focus for FY 2020 will be on changes in human behavior relating to these systems over time.

Highway Safety Research also funds the DADSS program. DADSS is a collaborative research partnership between the Automotive Coalition for Traffic Safety, representing 17 automobile manufacturers in the U.S., 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). 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 2020 Highway Safety Research also will continue efforts to identify more effective and efficient countermeasures for existing traffic risks such as alcohol-impaired driving, speeding, nonuse of seat belts, nonuse and misuse of child restraints, and to develop new solutions for emerging and resurgent problems such as pedestrian and bicyclist safety and distracted driving. In addition, the program will begin investigating issues related to the behavioral aspects of pedestrian and bicyclist safety specific to their engagement with passenger-carrying and non-passenger-carrying automated vehicles.

The Highway Safety Research program is authorized by the Highway Safety Act, Title 23, United States Code, Chapter 4 and related Highway Safety Provisions administered by the NHTSA. Specific guidance is often provided through the appropriation process in funding bills and associated reports.

Program Alignment with Strategic Goals:

USDOT Strategic Goal	Topical Research Areas	USDOT Research Priorities
Safety	Systemic Safety Approach Human Factors	Mobility/Underserved Communities
Innovation	Emerging/Enabling Technology	

Highway Safety Research directly supports the Department's safety goal by showing how States and communities can change driver, pedestrian and bicyclist behavior to reduce crashes, deaths

and injuries. These efforts typically fall within the topic area of human factors. Some of the planned research also overlaps with automation. The DADDS program supports innovation involving a new technology.

Program Objectives: The primary objective of the Highway Safety Research program is to improve the return on investment from the Congressionally-mandated Highway Safety Grant program. The 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.

Market Failure: There is relatively little research about traffic safety programs 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. 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 nongovernmental research institutes and allowed them to develop necessary expertise to make a difference.

Research Collaboration Partners: The Highway Safety Research program receives input from our program offices, regional offices, State highway safety offices, nongovernmental stakeholder organizations, Transportation Research Board standing committees, and a variety of other sources. Their input factors into our research planning process.

NHTSA collaborates with OST, FHWA, and FMCSA on specific topics of driver behavior. For example, NHTSA 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. Along with OST and FHWA, we recently funded focus city grants to address pedestrian and bicyclist safety. NHTSA works with the OST Office of Drug and Alcohol Policy and Compliance (ODAPC) to ensure the accuracy of alcohol testing performed for the over 60,000 employees who work in safety sensitive positions and to provide expert information on drug use by vehicle operators.
In addition, Highway Safety Research collaborates with other federal agencies such as 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), and CDC (Centers for Disease Control and Prevention) to leverage our resources and involve the public health community in our efforts to change

behavior.

We also work with a variety of nongovernmental Organizations including the 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 Destructive Decisions), NETS (Network of Employers for Traffic Safety), and ACTS (Automotive Coalition for Traffic Safety).

Chapter 4 – FY 2021 Program Descriptions

Office of Vehicle Safety Research (VSR)

Program: Vehicle Electronics and Emerging Technologies FY2021

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: 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."

In support of NHTSA's Strategic Goals and Objectives 2016-2020, the Vehicle Electronics and Emerging Technologies Program conducts testing, research, and data collection and analysis to support its safety mission in addressing system safety performance, driver behavior; developing methods, 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. This program also conducts work to remove potential regulatory barriers to ADS and other advanced technology innovations, development of ADS safety assurance frameworks and methods, enhancing occupant protection for current and future vehicle designs, addressing critical human factors issues for both ADS and other advanced technologies. ADS program research has impacts for all communities.

USDOT Strategic Goals	Topical Research Areas	USDOT Research Priorities
Safety	• Automation • Systemic Safety Approach • Human Factors • Emerging and Enabling Technologies • Mobility Innovation • Technology Transfer/Deployment • Data	• Regulatory Reform • Performance-Based Safety Rules • Underserved Communities

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.

Additionally, due to proactive government involvement, public-private collaborative research investments, and innovative leadership inherent to the American culture, the U.S. established an early worldwide leadership in ADS development. Supporting this competitive landscape, NHTSA is focusing research on key topics to advance the safe testing and deployment of ADS vehicles that do not include a driver in the vehicle or offer manual driving controls. Preliminary research indicates if deployed responsibly, there are significant safety enhancement potentials associated with ADS. ADS also offer mobility accessibility to the previously underserved community of individuals unable to acquire a driver's license, to include the elderly and people with disabilities, both cognitive and physical. It is envisioned that the ingenuity and innovation accompanying ADS technologies will be harnessed to provide safe transportation options for all the traveling public. The FY 2021 request will enable research efforts supportive of agency decisions with respect to updates to FMVSS and associated test procedures to accommodate non-standard vehicle design concepts. Research will also be sponsored and conducted that proactively mitigates public perception concerns through improved transparency and a data-driven approach to safety.

What problem will be addressed? While these systems are promising to enhance the 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. NHTSA vehicle electronics 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.

For ADS research, the following topics will be addressed:

Research to Support Decisions on the Removal of Potential Barriers for ADS Vehicles
Most FMVSSs were developed assuming a human driver would be operating the vehicle. With ADS, vehicle manufacturers are presented with opportunities to re-imagine and redesign new vehicle interiors. NHTSA will complete its initial research reviewing the full range of its FMVSS in FY 2020; but the agency anticipates emerging new concepts will necessitate additional research in support of innovative approaches. The objective of this research is to gather data and evidence that could support decisions about potential adaptation and/or translation of regulations to address unnecessary barriers while ensuring safe operation of vehicles with ADS. NHTSA will also support the review of research, design, and test data submitted as part of exemption petitions; survey other research findings relevant to the case; conduct research activities to confirm or augment available data; and identify a means to categorize and streamline exemption requests.

Research on System Safety Performance of ADS Vehicles
In conjunction with the industry and standards setting organizations, this research will explore approaches, methods, metrics, and tools for public safety assurance purposes to assess how well the ADS performs at a system level to avoid crashes. Research will explore the mix of simulation, track and on-road testing and their role in assuring safety for the public while allowing for different approaches and innovations to take place. This research will explore variable testing concepts around scenarios that could be loosely controlled, randomly introduced, or entirely naturalistic.

Human Factors Research for ADS Vehicles
Driver Engagement in SAE Level 3 and Dual-mode Level 4 ADS Vehicles that are designed in a manner where it can be operated by both a driver and an ADS involve control handoff between drivers and ADS in certain circumstances. A driver's readiness to resume control in SAE Level 3 ADS is very critical to safety. For example, emerging driver engagement strategies, such as applying sufficient force to the steering wheel, or simply looking at the roadway ahead, and other engagement strategies have been studied in other fields such as rail, aviation, and space operations will be explored. Driver engagement with the ADS is influenced by several issues, including the human-machine interface, the driver's experience and training with the system, and other situation-specific factors that affect behavioral responses. Near-term issues with driver engagement are predominantly behavioral; therefore, behavioral research efforts will be funded under the Highway Safety Research and Development account.

Crashworthiness of ADS Vehicles
Vehicles with ADSs may incorporate novel occupant compartment designs and seating conditions. Side- and rear-facing seat positions are common for transit buses and may be considered for smaller, higher-speed ADSs. Changes in occupant seating and restraint systems will affect the injury mechanisms and risk factors. Human Body Models (HBMs) and ATDs are being enhanced to support the safety evaluation for the range of seating conditions anticipated for new ADS designs, including research on human response and injury metrics for various alternative seating and crash conditions.

These enhanced engineering tools will be used to create objective and reproducible test procedures and to evaluate new vehicle designs and countermeasures, with the goal of demonstrating feasibility of occupant protection for new ADS seating configurations. Also, the agency will continue to develop best practices for safe interaction of non-occupied ADSs with existing vehicles, roadside hardware, pedestrians, cyclists, and motorcyclists.

Accessibility Considerations in ADS Vehicles Driving
Automation is expected to provide mobility options not previously afforded to people with disabilities, regardless of cognitive, physical, or even the degree of condition. Vehicles with ADS that are accessible to persons with disabilities will be expected to provide information through appropriate modes to interact with the occupants. Research will be initiated to explore the information needs of persons with disabilities and how these needs could be implemented effectively within a HMI.

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.

NHTSA also needs to develop data to better inform future decisions pertaining to the safety of vehicles with ADS. Some of this research may directly support rulemaking changes to the FMVSS to remove regulatory barriers for new innovative vehicle designs. It will also provide knowledge and analyses necessary for the agency to respond to petitions for temporary exemption for vehicles equipped with ADS. Investing in this research will also result in the development of readily available tools and capabilities for use in the assessment of: crash mitigation, protection to occupants, vehicle communication with occupants, and safe mobility solutions for persons with disabilities. Such tools may otherwise remain proprietary to individual companies.

Who else is researching this issue?
Small and large motor vehicle manufacturers (including those that manufacture low-speed shuttles, trucks, vehicles without occupant compartments), automotive technology suppliers, software companies, domestic and international standards setting organizations, and members of academia also perform research and testing to support vehicle electronics and towards the safe deployment of vehicles with ADS. NHTSA leverages these resources and performs research to

fill 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.

Likewise, for the past several years, NHTSA has invested in research projects that examine various aspects of automotive safety for vehicles with ADS. This includes evaluating test tools and system capabilities that will further their safe deployment on U.S. roads.

To date, NHTSA has researched technical translation options to address potential regulatory barriers in over 30 FMVSS. NHTSA has also started developing and evaluating test procedures for prototype vehicles with ADS and gaining an understanding of crash injury protection in unconventional seating arrangements. The agency has also completed research studies on testable case scenarios, functional safety, and exploratory research on evaluating safety metrics for vehicles with ADS, including modeling and simulation.

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 12-24 months from award. This may include tangible proposals and changes to the FMVSS, depending upon the regulatory priorities of the Department

Program Description/Activities
There are many lives to be saved with further advancements in new ADSs. However, in the transportation sector, where nine out of ten serious roadway crashes occur due to human behavior, driving automation technologies possess a significant potential to not only save thousands of lives, but reduce congestion, enhance mobility, and improve productivity. Hence, ADS, categorically referring to the driving automation systems in the SAE Automation Levels 3, 4 and 5, is a major area of research emphasis for NHTSA in addition to research on ADAS. The principal objective of this program area is to focus on the most promising safety-enhancement segment of driving automation and to align the agency's activities to support and maintain the United States' global leadership in the safe development, testing, and future deployment of ADS through technological innovation and open market access. Because ADS are still in the development and testing stages - continually and quickly evolving - the agency's research to support public safety assurance needs to adapt quickly as new innovations are conceived. NHTSA partners closely with technology developers to understand the varying nature of approaches and temporal changes through data gathered through private-sector testing. Through such collaboration, NHTSA focuses on ADS research activities that provide value by bridging research gaps with leveraged resources and provide leadership through efforts to spur the community to share appropriate information and agree on fundamental safety goals and leverage best practices.

Program: Advanced Safety Technologies – FY2021

Program Description/Activities: U.S. traffic crash fatalities have increased in recent years. In 2017, motor vehicle crashes on U.S. roadways claimed 37,133 lives. This is a 1.8 percent decrease from 2016, but a 4.6% increase from 2015. These statistics support the need for an increased emphasis on advanced safety 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, advanced safety technology 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: 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."

In support of NHTSA's Strategic Goals and Objectives 2016-2020, the Advanced Safety Technologies 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.

USDOT Strategic Goals	Topical Research Areas	USDOT Research Priorities
Safety	• Systemic Safety Approach • Emerging and Enabling Technologies • Technology Transfer/Deployment • Data	• Regulatory Reform • Performance-Based Safety Rules

Program Summary

This program is focused on safety systems and innovations that directly map to crashes involving light and heavy vehicles. Recent examples include new braking technologies (AEB to reduce rear end collisions), as well as important contributions for stability control systems estimated to prevent a significant number of both light and heavy vehicle crashes. This program will continue to focus on emerging innovative safety systems that demonstrate potential to address real world crashes and improve vehicle safety performance with respect to frequent and severe crashes.

Emerging technologies in this area include innovative active safety systems such as: cross traffic alert systems that have potential in addressing some types of intersection crashes; blind spot intervention systems that automatically apply steering or braking to assist drivers in avoiding lane change/merge collisions; opposite direction (head on) collision avoidance systems; and TJA systems that provide steering and speed control assistance to a driver during low speed, stop-and-go driving circumstances. Additional technology innovations will also be part of this program and are envisioned to include new displays used as part of in-vehicle systems that interact with drivers via HMIs, as well as technologies for side and rear vision enhancement for drivers (e.g., camera-based technologies).

What problem will be addressed? In FY 2021, the Advanced Safety Technologies program will continue to focus on test and evaluation projects involving ADAS. Like the 2020 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 advanced safety technologies 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 FY 2021 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? Advanced Safety Technologies 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 advanced safety technologies 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? NHTSA has invested in Advanced Safety Technologies 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 Advanced Safety Technologies program anticipates completing projects that result in research data, test procedures, and reports (tangible outcomes) on key topics for projects funded in FY 2021. This is consistent was previous years' research in the Advanced Safety Technologies program area.

Program: Crashworthiness—FY2021

Program Description/Activities: The Crashworthiness program 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: 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."

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 in crash scenarios.

USDOT Strategic Goals	Topical Research Areas	USDOT Research Priorities
Safety	• Systemic Safety Approach • Emerging and Enabling Technologies • Technology Transfer/Deployment • Data	• Regulatory Reform • Performance-Based Safety Rules

Program Summary

Crashworthiness research focuses on vehicle safety countermeasures to reduce the number of serious injuries and fatalities that occur from motor vehicle crashes in the U.S. 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, computer models, and appropriate injury metrics.

- **What problem will be addressed?**

The purpose of the Crashworthiness 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. In FY 2021, the program will continue to work with trauma centers

to understand the detailed nature of occupant injuries that still occur in motor vehicle crashes. The knowledge that will continue to be gained through field data studies and associated laboratory- and simulation-based research will continue to be applied towards the refinement of crash test dummies and associated injury measures as well as towards the enhancement of computer models (e.g., human-body models). These research efforts will continue to produce advancements in both test and simulation tools in FY 2021.

In addition to the basic research that supports the development of crash testing tools such as advanced crash test dummies, the Crashworthiness program also supports research that involves the application of these tools. For example, the new generation of ATDs (THOR, WorldSID, BioRID, and LODC) is expected to improve the understanding of occupant protection, and they will be used to influence restraint design and optimization in frontal, frontal oblique, side, and lower-speed rear impact crashes. Crashworthiness research will use these new ATDs to replicate real-world crash conditions and evaluate safety countermeasures. The test results, combined with human body and ATD crash simulations, will encourage the development of more effective occupant protection systems for a more diverse population, including older and obese occupants, large children, and rear seat occupants in general. Crashworthiness research will continue to study how new, lightweight materials and joining techniques can be used to improve fuel economy, vehicle crash compatibility, and occupant crash safety. Crashworthiness research will also continue to evaluate opportunities to improve occupant safety through improved integration between vehicle advanced safety technologies and restraint control systems.

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

These research topics support the development and demonstration of analytical tools and test methods 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, universities, 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?**

The Crashworthiness program anticipates completing projects that result in research reports on key topics within 18-24 months from award**.**

Program: Alternative Fuels Vehicle Safety—FY2021

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. There are new concerns regarding the safety of these vehicle systems. This research will document any safety issues and promote industry best practices. Test procedures and assessment methods will be developed to standardize safety assessment methods.

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 "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."

In support of NHTSA's Strategic Goals and Objectives 2016-2020, NHTSA's Alternative Fuels Vehicle Safety research program will address the safety of alternative fuel technologies that will be used in conventional and future ADS equipped vehicles.

USDOT Strategic Goals	Topical Research Areas	USDOT Research Priorities
Safety	• Systemic Safety Approach • Environmental Stewardship • Emerging and Enabling Technologies • Technology Transfer/Deployment • Data	• Regulatory Reform • Performance-Based Safety Rules

Program Summary
NHTSA's FY 2021 alternate fuels vehicle safety research program will focus on wireless charging systems for commercial and personal vehicle applications. NHTSA will also coordinate with DOE research to understand the safety of solid state battery systems and begin consideration of the need for performance testing. These technologies should all involve research between the DOE national laboratories, the automotive OEMs and their suppliers. The planned research would apply past research on charging safety to wireless methods and consider both commercial and residential applications.

- **What problem will be addressed?**

NHTSA will conduct research to identify safety concerns, develop test procedures, and best practices to minimize safety concerns with vehicles designs utilizing alternative fuels.

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

New vehicle fuel technologies have different safety considerations and it is desirable to establish baseline or standard practices for identifying and remediating safety issues.

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

Safety of alternative fuels is an industry wide concern that involves safety researchers, academia, vehicle designers, equipment suppliers, and a range of government organizations including the DOE, NIST, FMCSA, FHWA, and others.

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

NHTSA has developed tests procedures for battery charging, hydrogen pressure vessels and fuel cell systems. These test procedures have been shared with industry, debated and incorporated into SAE and ISO practices.

- **What is the projected time of completion for a tangible outcome?**

The Alternative Fuels Vehicle Safety research program anticipates completing projects that result in research reports on key topics within 24-36 months from award.

Program: Vehicle Research and Test Center – Ohio – FY 2021

Program Description/Activities: 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 defects investigations and possible cybersecurity incidents. 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:
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." Additionally, VSR's VRTC contributes to DOTs innovation goal by developing new cutting-edge test tools and methods used to test advanced technologies and improve occupant protection. 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 safety technologies and 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.

This also 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." In support of NHTSA's Strategic Goals and Objectives 2016-2020, VSR's 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 Advanced Safety Technologies 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 under Vehicle Electronics and Emerging Technologies such as Automated Driving Systems and cybersecurity.

USDOT Strategic Goals	Topical Research Areas	USDOT Research Priorities
Safety	• Automation • Systemic Safety Approach • Human Factors • Environmental Stewardship • Emerging and Enabling Technologies • Mobility Innovation • Technology Transfer/Deployment • Data	• Regulatory Reform • Performance-Based Safety Rules • Underserved Communities • Cybersecurity

Program Summary

In FY 2021, VRTC plans to support a broad range of critical safety areas including: Advanced Safety Technologies 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 under Vehicle Electronics and Emerging Technologies such as Automated Driving Systems and cybersecurity.

- **What problem will be addressed?**

VRTC conducts testing, research and development necessary to support federal motor vehicle safety standards, 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 2017, motor vehicle crashes on U.S. Highways claimed 37,133 lives. This is a 1.8% decrease from 2016 but a 4.6% increase from 2015. 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: Advanced Safety Technologies 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 under Vehicle Electronics and Emerging Technologies such as Automated Driving Systems 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 ADS 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 advanced safety technologies, 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 vehicle electronics and emerging technologies, advanced safety technologies, crashworthiness, and biomechanics research.

Office of Behavioral Safety Research (BSR)
Program: Highway Safety Research – FY2021

Program Description:
The primary objective of the Highway Safety Research program is to improve the return on investment from the Congressionally-mandated Highway Safety Grant program. Highway Safety Research directly supports the Departmental safety priority by providing the scientific basis for the development of effective behavioral countermeasures to reduce the occurrence and severity of traffic crashes. Highway Safety Research also evaluates the effectiveness of programs to reduce fatalities and injuries on our highways, which is critical to assist States in allocating resources effectively and achieving national performance targets. In addition, Highway Safety Research monitors and measures both safe and unsafe driving behaviors to track progress and identify emerging safety problems. BSR disseminates research, analysis, and evaluation program results to the States for use in identifying problems and selecting effective countermeasures for implementation through the highway safety formula grant program (Section 402). Recent areas of research include alcohol and drug impaired driving, speeding and speed management, occupant protection (seat belt use and child safety seats), pedestrian and bicyclist safety, pupil transportation safety, distraction, driver drowsiness, motorcyclist safety, older driver safety, young and novice driver safety, and emergency medical services.

Program Alignment with Strategic Goals:
Highway Safety Research directly supports the Department's safety goal by showing how States and communities can change driver, pedestrian and bicyclist behavior to reduce crashes, deaths and injuries. These efforts typically fall within the topic area of human factors. Some of the planned research also overlaps with automation.

USDOT Strategic Goal	Topical Research Areas	USDOT Research Priorities
Safety	Systemic Safety Approach Human Factors	Mobility/Underserved Communities

- **What problems will be addressed?**

In FY 2021 Highway Safety Research will continue to focus on the three high priority issues identified in FY 2020: drug-impaired driving, ADS human factors research, and ADAS driver adaptation research.

In FY 2021 Highway Safety Research also will continue efforts to identify more effective and efficient countermeasures for existing traffic risks such as alcohol-impaired driving, speeding, nonuse of seat belts, nonuse and misuse of child restraints, and to develop new solutions for emerging and resurgent problems such as pedestrian and bicyclist safety and distracted driving.

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

The increased availability of marijuana products, and increased use of opioids, as well as the use of illicit drugs like methamphetamines and the use of pharmaceutical products, all contribute to the growing safety risk associated with drug-impaired driving. NHTSA will continue research into field tests and will field test devices that could be used by law enforcement to detect drivers

impaired by drugs, with a focus on marijuana, as well as research supporting successful prosecution of drug-impaired drivers, improvements in data collection systems, and more effective messaging and communication strategies. 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 obtaining a body fluid test for cannabis.

In vehicles equipped with ADS, the expectations of human behavior and system behavior become intertwined and interdependent in their effects on safety. Keeping the human driver engaged even with ADS equipped vehicles, therefore, is critical for safety, and Highway Safety Research will continue to study emerging driver engagement strategies.

Highway Safety Research also will continue to research behavioral changes that could occur beyond reactions to ADAS features and functionality. How drivers/users learn and adapt to vehicle technologies can lead to both positive and negative outcomes. The adaptation to vehicle functioning and human-machine interface designs has implications for both driver behavior programs and vehicle safety, and the focus for FY 2021 will continue to be on changes in human behavior over time. The program's activities related to the behavioral aspects of pedestrians and bicyclists safety specific to their engagement with passenger- carrying and non-passenger-carrying automated vehicles will continue.

The results of the program research 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 the annual *Click It or Ticket* high visibility enforcement program, sobriety checkpoints, the Standardized Field Sobriety Test, Zero Tolerance laws for underage drinking and driving, and Graduated Driver Licensing laws for young novice drivers.

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

ADS human factors research and ADAS driver adaptation research overlaps with work in NHTSA's vehicle safety programs. Related work on these topics is also conducted by other modes, particularly in other fields such as rail, aviation, space operations, and pipeline monitoring. Finally, vehicle manufacturers and universities are conducting research in this important area.

Some drug-impaired driving, research is conducted by other agencies such as the Centers for Disease Control and Prevention, by some NGOs such as the Governors Highway Safety Association, and by universities. For example, the State of California funded work on developing a field test for marijuana that is taking a different, but complimentary approach, to our effort.

Research supporting the development and evaluation of more effective and efficient countermeasures for existing traffic risks as well as emerging and resurgent problems is not typically conducted outside of NHTSA. However, some NGOs and universities conduct small projects.

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

ADS human factors research and ADAS driver adaptation research with a behavioral focus is proposed to begin in FY 2020. The research to date has been conducted by NHTSA's vehicle safety programs and is described under those programs.

Highway Safety Research has studied drug-impaired driving for many years. For example, the 2013-2014 national roadside survey provided details regarding increases in drug use among drivers on the road. In 2017 NHTSA released a report to Congress "Marijuana- Impaired Driving," which detailed what we know and do not know about marijuana and driving. In 2017 Highway Safety Research also released a report on the Impact of the Legalization and Decriminalization of Marijuana on the DWI System. We have been working on developing a field test for marijuana impairment for a couple of years. Prior work included a systematic review of previous research in to identify ways in which marijuana 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 and without expensive equipment. This approach 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 various levels of experience using marijuana.

The culmination of research supporting the development and evaluation of more effective and efficient countermeasures for existing traffic risks as well as emerging and resurgent problems is contained in "Countermeasures That Work: A Highway Safety Countermeasures Guide for State Highway Safety Offices."

- **What is the projected time of completion for a tangible outcome?**

Many of the ADS human factors projects and ADAS driver adaptation research will require four or five years to complete, which includes a year to receive Paperwork Reduction Act (PRA) clearance to begin data collection. Projects that do not require PRA clearance usually require three years to complete.

BSR 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. However, there is no data yet indicating whether any of the measures will accurately and reliably detect marijuana impairment when appropriate without incorrectly suggesting some non-users are marijuana-impaired.

Appendix A

Program Performance Measures

Program Performance Measures				
Term	*Measure Type*	*Measure Name*	*Description*	*Calculation Methodology*
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 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