United States Department of Transportation
Annual Modal Research Plan FY 2021
Program Outlook FY 2022

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Chapter 1 – Executive Summary

In calendar year 2020, the National Highway Traffic Safety Administration (NHTSA) celebrates its 50th anniversary. NHTSA was established by the Highway Safety Act of 1970, as the successor to the National Highway Safety Bureau, to carry out safety programs under the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966. NHTSA works every day to help Americans drive, ride, and walk safely. The Agency does this by promoting vehicle safety innovations, identifying vehicle safety defects, setting safety standards for cars, trucks, buses, and motorcycles, and educating Americans to help them make safer choices. The Agency is proud of its accomplishments over the past five decades. Research is a big component that powers the Agency's safety programs and allows identification of countermeasures that have led to hundreds of thousands of lives saved on our Nation's roadways throughout its existence.[1]

NHTSA is grounded in data, scientific research, and sound 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 that might be caused in the development of policy, programs, or regulations, and in issuing information to the public. Safety is NHTSA's number one priority, and with rigorous engineering and a data- and science-driven approach, NHTSA strives to build public trust and confidence in every action taken because lives depend on it.

NHTSA houses two main research bodies: The Office of Vehicle Safety Research (VSR) and, within the Office of Research and Program Development, the Office of Behavioral Safety Research (BSR). NHTSA's research programs directly support the Agency's mission, continuously assessing potentials for alternative approaches (e.g., guidance, best practices, research performance tests and criteria) that could expedite 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 potential safety need is identified for a new Federal motor vehicle safety

[1] See, for example, https://www-esv.nhtsa.dot.gov/Proceedings/24/files/24ESV-000291.PDF

Note: The FY 2021-2022 AMRPs will be certified using the President's budget numbers and revised with enacted budget numbers after the budget passes.

standard (FMVSS), NHTSA conducts research to understand the safety need in detail, to develop and evaluate safety countermeasures, and to establish and validate objective, repeatable, and reproducible performance tests that address the safety need. To address safety priorities as indicated by the Agency's preeminent traffic safety data, and other emerging issues, the Agency pursues research to identify and evaluate new safety countermeasures to address them, and new crash tests that can enable improved occupant protection in new vehicle designs. NHTSA has reviewed current and future projects across the agency and confirms there is no intra-agency duplication. NHTSA has reviewed all ongoing research to determine the effects of the pandemic on the ability to perform research. For projects involving researcher interactions with human subjects, there are delays as research-organizations' Institutional Review Boards amend protocols to protect participants and staff from additional risks. To accommodate these delays, NHTSA is exploring all appropriate measures, including no-cost time extensions and refinements to data collection protocols.

Outside of our research program, NHTSA is closely examining changes in travel patterns, travel rates, and resulting crashes, injuries, and fatalities to determine its programmatic response.

VSR and BSR Activities

VSR and BSR share the mission to provide national leadership in strategizing, planning, implementing, and communicating research programs to continually further NHTSA's goals in the reduction of crashes, fatalities, and injuries.

The scope of research activities under VSR includes all levels of emerging technology, as well as other conventional systems impacting vehicle safety including driver controls, tires, lighting, and occupant and non-occupant (e.g., pedestrian) crash protection systems. NHTSA's research targets all motor vehicle classes, including heavy and light trucks, light passenger vehicles, buses, multi-purpose passenger vehicles, low-speed vehicles, and motorcycles, and spans the full crash timeline, including crash avoidance, crash energy mitigation, and injury reduction. The office conducts crash data analyses, monitors market trends, and engages in extensive stakeholder outreach and feedback to identify priority safety areas and potential emerging safety risks and opportunities related to motor vehicles and motor vehicle equipment.

VSR's Vehicle Research and Test Center (VRTC), located in East Liberty, Ohio, conducts applied research in support of NHTSA and the United States Department of Transportation (USDOT) programs and goals to reduce crashes, fatalities, and injuries on the nation's roadways. This is accomplished by supporting Agency's regulatory agenda and safety defect investigations, developing performance test metrics and methods for existing and new vehicle technologies, providing quick engineering assessments of urgent concerns such as newly reported cyber vulnerabilities, and conducting other applied research.

In fiscal year (FY) 2021, major VSR research areas include Vehicle Electronics and Cybersecurity, Automated Driving Systems (ADS) (focusing on SAE International driving automation Levels 3-5 technologies) which are systems still under testing and development, and at maturity, would perform the full driving task without an attentive human driver; Advanced Safety Technologies (focusing on SAE International driving automation Levels 0-2 Advanced Driver Assistance Systems (ADAS) and Heavy Vehicle Technologies) which represent systems mostly available to consumer today and support the drivers, but require their full and continuous

attention to remain on the driving task; Crashworthiness research to improve crash survivability; and Alternative Fuels Vehicle Safety.

Research funding in these areas will address vehicle electronics safety through the development of enhanced computer modeling tools for emerging technologies in the driving automation area, as well as other safety systems and technology innovations (including software). Additional research will include methods of hardening vehicles against cybersecurity attacks, development of ADS safety assurance frameworks and methods, enhancing occupant protection for current and future vehicle designs, exploring critical human factors issues associated with both ADS and other advanced technologies, and addressing the safety of alternative fuel technologies in modern vehicles as well as future vehicles equipped with ADS. Funding will also allow NHTSA to enhance and expand its testing capabilities of advanced technologies at VRTC.

For FY 2022, VSR's major research areas will remain relatively unchanged. New projects will continue to address open safety research questions, emerging trends, and Agency priorities.

Behavioral research provides an evidence-based foundation for State and community traffic safety programs. The primary objective of BSR is to improve the return on investment from the formula-based Highway Safety Grant program. The research program is designed to find effective ways to influence 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.), as well as reduce unsafe behavior (alcohol- and drug-impaired driving, texting, speeding, etc.) that are critical to prevent motor vehicle crashes, deaths, and injuries.

BSR focuses on unsafe driving behaviors that contribute significantly to death and injury from crashes on the Nation's roadways, thus supporting Department and Agency safety goals. 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 Highway Safety Grant program (23 U.S.C. 402) and the National Priority Safety programs (23 U.S.C. 405).

In FY 2021, BSR plans to focus on four priority areas: preventing alcohol- and drug-impaired driving, improving pedestrian safety, preventing distracted driving, and improving novice driver safety. Planned projects to improve pedestrian and novice driver safety will address human factors issues related to ADAS and ADS technologies. BSR will also continue to collaborate with VSR's Automated Driving Systems and Advanced Safety Technologies research programs to address human factor issues including behavioral adaptation and child-specific safety considerations related to vehicle technologies. Examples of these issues include the use of child restraint systems in shared mobility situations and human factors concerns involving unattended children in ADS vehicles.

Likewise, BSR will further its efforts to identify more effective and efficient countermeasures for existing traffic risks such speeding, nonuse of seat belts, nonuse and misuse of child restraints, and to develop new solutions for emerging and resurgent problems.

In FY 2022, BSR will decide on several emphasis areas based upon problem identification and research needs, although continued efforts are expected in preventing drug-impaired driving and addressing the effects of new technologies on behavioral safety. In these emphasis areas, BSR plans to conduct foundational research to understand the nature or scope of the problem, developmental research that helps refine the delivery of solutions, and a hybrid that combines research into big ideas and potential ways to develop those ideas into safety programs.

Collaboration Efforts

NHTSA's VSR programs primarily produce data, reports, and tools for use by the agency, 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. With automation at 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 challenge for them. Types of information provided to these stakeholders include knowledge associated with emerging technologies' operation, effectiveness, and safety.

NHTSA works closely with stakeholders in academia, which use our information to conduct complimentary research or develop new materials, test methods, or test devices. Consumer organizations incorporate the Agency's research into their own programs in order to deliver safety messages, improve information to the public, and incorporate NHTSA research outcomes into strong strategic programs. State and local governments may use information to make decisions, such as whether or how to allow for testing of vehicles with ADS on their roadways. VSR products are also used within NHTSA to support continued efforts in rulemaking activities, to support data-driven policy decisions, and in effective safety program development. They are similarly used within other agencies for supporting research and implementing policies, practices, and standards development.

VSR activities often result in the development of test devices and injury criteria used industry-wide for crash testing, as well as standardized performance tests and technology evaluations that either 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 that 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 Grant program (23 U.S.C. 402) and The National Priority Safety programs (23 U.S.C. 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 Standardized Field Sobriety Tests (SFST) by law enforcement officers investigating impaired driving cases, enactment of primary seat belt and distracted-driving laws, the national .08 Blood Alcohol Concentration (BAC) limit, advancement of Graduated Driver Licensing (GDL) laws, greater understanding of older-driver issues, and development and testing of effective pedestrian and bicyclist safety programs.

BSR's research often results in the development of training programs for use by a variety of state and local governments and nongovernmental safety organizations. One example is 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. Another example is the child safety seat inspection station program developed by BSR, which is currently managed by Safe Kids International.

NHTSA also partners with other USDOT modal agencies, such as the Federal Highway Administration (FHWA), the Federal Motor Carrier Safety Administration (FMCSA), and the Federal Transit Administration (FTA), on research activities that have multimodal applications. NHTSA makes use of the Office of the Secretary's (OST) Topical Research Working Groups as relevant and highlighted throughout this document to assist with coordination across the Department. Additionally, to ensure no research duplication with known prior or current projects both internal and external to the Agency, NHTSA cooperates with OST's Research Review Working Group, which reviews Agencies' Annual Modal Research Plans (AMRPs) and project spend plans. Other collaboration efforts are detailed under individual program areas.

Technology Transfer (T2)/Deployment Activities

Technology Transfer (T2) refers to handing off and sharing research information and results to stakeholders. The outcomes of VSR work are publicly accessible information that allows external stakeholders to perform test procedures and manufacture test devices and evaluation tools. BSR works to develop sound data by which to develop and verify countermeasures to affect or change driver behaviors and provide local communities with information and tools to initiate and administer safety programs.

NHTSA research outcomes are in the form of written documentation of research results and packages of materials designed for public consumption rather than tangible devices or materials intended for market. T2 and deployment activities for NHTSA Research are focused on opportunities and methods for providing these materials in public forums: document databases (National Transportation Library (NTL) and USDOT Research Hub), internet (NHTSA website, Github), NHTSA public meetings, national conferences (e.g. Lifesavers, SAE International Government/Industry), international conferences (International Technical Conference on the Enhanced Safety of Vehicles (ESV)), journal publications, public speaking engagements, and presentations.

For BSR, all recent projects are listed in the USDOT Research Hub as imported from the Transportation Research Board's (TRB) Research in Progress (RiP) database. Records are updated at the end of each fiscal year to reflect new awards and contract modifications. As research projects produce deliverables, reports and dissemination materials approved by the Agency are provided to the NTL Digital Library to be added to the Behavioral Safety Research collection, and links to the documents are added to the Research Hub record.

VSR also provides published reports directly to the NTL Digital Library through coordination with the Office of Communication and Consumer Information. In a further effort to make the public aware of available research, NHTSA Research has implemented a periodic notification practice to notify stakeholders of new public materials and research data that have recently

become publicly accessible.

NHTSA is also 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 USDOT modes for successful and effective methods of T2 strategies (supports USDOT Accountability goal). NHTSA Research continues to work with the Public Access Implementation Working Group to provide greater continuity and coordination of information across sites and databases as these efforts directly feed into T2.

Evaluation/Performance Measurement

Performance measures are set for each specific project and 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 that are updated annually, and targets are usually set for the next 3-5 years and revisited and revised as necessary based on performance data and trends, with documentation to explain any 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., Road to Zero). The Agency also actively participates in the Departmental Evaluation/Performance Measurement Working group (supporting USDOT's Accountability goal) to monitor and evaluate the contribution of research, development and technology activities toward the achievement of USDOT strategic goals and objectives. Likewise, its Data Working Group (also supporting USDOT's Accountability goal) ensures access to high-quality data to support data-driven technologies, operations, and decision making.

When new vehicle safety countermeasures are developed by the Agency, through voluntary agreements, the New Car Assessment Program (NCAP), 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 USDOT's and NHTSA's short- and long-term performance metrics.

Similarly, for traffic safety countermeasures, NHTSA continuously monitors the extent to which States and communities adopt its programs, demonstrate the showing the extent to which desired outcomes, are achieved 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, including seeking input from NHTSA regional offices, State highway safety offices, nongovernmental stakeholder organizations, and TRB standing committees. This information is used by the Agency to develop new programs or to modify current programs and practices to

increase efficiency and effectiveness, as well as to address emerging trends.

Additionally, in assessing behavioral changes, including seat belt use, correct child safety seat use, speeding, hand-held cell phone use, and other changes, the Agency often conducts observations to measure behaviors before and after program implementation. In other cases, the Agency measures the change in the number of crashes that occur after a program is implemented. On a routine basis, OST also meets with each modal administration to review its progress toward meeting performance targets and indicators under its internal Performance Management Review process. The Agency uses this channel to discuss trends that may impact meeting strategic goals and planned approaches to get back on track or to 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 retroactive regulatory analyses to evaluate the actual effectiveness of programs (generally about 10 years after introduction to allow for fleet penetration and for the collection of sufficient field data to support analysis).

The work conducted under NHTSA's research programs support USDOT'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 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.

Likewise, 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 toward achievement of NHTSA's mission. NHTSA reviews and updates its goals annually as part of the OST PMR process.

NHTSA has reviewed all ongoing research to determine the effects of the pandemic on the ability to perform research. For projects with researcher interactions with human subjects, there are delays as research-organizations' Institutional Review Boards amend protocols to protect participants and staff from additional risks. To accommodate these delays, NHTSA is exploring all appropriate measures, including no-cost time extensions and refinements to data collection protocols. NHTSA is also closely monitoring proposed practices for protection of human subjects that is under development at the Departmental level, and will provide contractors with the final document when it is complete. NHTSA's RD&T activities are non-duplicative with known prior or current projects within your agency

FY 2021 RD&T Program Funding Details

RD&T Program Name	FY 2021 Enacted ($000)	Basic ($000)	Applied ($000)	Development ($000)	Technology ($000)
Vehicle Electronics and Cybersecurity	$3,714		$3,714		
Automated Driving Systems	$5,570		$5,570		
Advanced Safety Technologies	$8,800		$8,800		
Crashworthiness	$12,017		$12,017		
Alternative Fuels Vehicle Safety	$600		$600		
Vehicle Research & Test Center	$500		$500		
Program Execution Expenses	$3,501		$3,501		
Highway Safety Research	$14,358		$9,058		$5,300
Totals	**$49,052**		**$43,760**		**$5,300**

Note: Highway Safety Research program-level budget figures were not provided in NHTSA's FY 2021 President's budget submission. FY 2020 levels are provided here as an estimate.

Alignment: All NHTSA research program efforts are directed at the Department's priority in "building upon USDOT'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 annual overall outcome on performance measures, as previously noted under Evaluation/Performance Measurement, with the goal 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 USDOT's Accountability strategic goal to "serve the Nation with reduced regulatory burden and greater efficiency, effectiveness, and accountability," with its work to remove unintended and unnecessary regulatory barriers to allow for innovation and emerging technologies.

These goals 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).

FY 2021 RD&T Program Budget Request by USDOT Strategic Goal

RD&T Program Name	FY 2021 Enacted ($000)	SAFETY ($000)	INFRASTRUCTURE ($000)	INNOVATION ($000)	ACCOUNTABILITY ($000)
Vehicle Electronics and Cybersecurity	$3,714	$3,714			
Automated Driving Systems	$5,570	$5,570			
Advanced Safety Technologies	$8,800	$8,800			
Crashworthiness	$12,017	$12,017			
Alternative Fuels Vehicle Safety	$600	$600			
Vehicle Research & Test Center	$500	$500			
Program Execution Expenses	$3,501	$3,501			
Highway Safety Research	$14,358	$9,058		$5,300	
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Chapter 2 – FY 2021 RD&T Programs
Office of Vehicle Safety Research (VSR)

Program Name: Vehicle Electronics and Cybersecurity[2]
$3,714

Program Description: The evolution of automotive technology has included the expanded use of electronic systems, software, and wireless connectivity. This process dates back to the late 1970s and the pace of technological evolution has increased significantly over the past decade, leading to modern vehicles becoming one of the most complex computerized consumer products. Enhanced wireless connectivity and continued innovations in electronic control systems introduce substantial benefits to highway transportation safety, mobility, and efficiency. However, with the proliferation of computer-based control systems, software, connectivity, and onboard digital data communication networks, modern vehicles need to consider additional failure modes, vulnerabilities, and threats that could jeopardize benefits if the new safety risks are not appropriately addressed. Connectivity and safety technologies that can intervene to assist drivers with control of their vehicles (e.g., automatic emergency braking) could also increase cybersecurity risks, and without proactive measures taken across the vehicle lifecycle, risks could rise accordingly.

Methodical identification of potential issues and proactive management of increased risks related to advanced electronic and software controlled systems are essential to designing vehicle architectures that will respond safely even when there are electronic system failures, software errors, or malicious software attacks. The Vehicle Electronics and Cybersecurity research program broadly covers two major research areas: electronics functional safety and vehicle cybersecurity. Electronics functional safety is an important part of overall systems safety that deals with safety risk management associated with potential failures in sensors, components, systems, and software implementation, as well as operator errors and environmental changes. Vehicle cybersecurity research deals with safety risk management associated with intentional manipulation of vehicle software, hardware, sensors, and associated communication networks by malicious actors. While the need for functional safety and cybersecurity both focus on safety, operational vulnerabilities associated with electronic and software based systems, risk assessment, risk mitigation, and effective means of life-cycle risk management differ across these two safety domains.

Program Objectives: The goal of the Vehicle Electronics and Cybersecurity research program area is to support enhanced reliability and resiliency of vehicle electronics, software, and related vehicle control systems not only to mitigate safety risks associated with failure and/or cyber compromise of such systems, but also to ensure that such concerns do not pose public acceptance barriers for proven safety technologies and driving automation systems. The program seeks to

[2] *Note: Program titles map to NHTSA's FY20 AMRP, except for a new program category for ADS Research, which the Agency includes as a separate area to more appropriately account for such research expenditure. It is carved out of the historical "Vehicle Electronics and Emerging Technologies" program area in NHTSA's FY2020 budget request. When ADS Research is removed into a stand-alone program area, "Vehicle Electronics and Cybersecurity" becomes a more appropriate program title for the remaining research within this category, as currently reflected in NHTSA's FY2021 Budget. The Agency anticipates that this action will have no impacts, either positive or negative for the audience.*

support improvements in the cybersecurity resiliency in motor vehicles and to 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.

Anticipated Program Activities:

Vehicle Electronics Functional Safety: Research will continue on functional safety projects in FY 2021 that were initiated in FY 2020. Research focuses on methods for assessing the functional safety and reliability of heavy vehicle safety-critical subsystems including, steering and braking. Research will also leverage industry process standards (such as International Organization of Standardization (ISO) 26262) as well as traditional hazard assessment techniques such as failure mode & effects analyses (FMEA) and fault tree analysis (FTA) for the electronic systems and software associated with SAE International driving automation Level 4 ADS functions. NHTSA will also conduct analyses related to the Safety of the Intended Functionality (SOTIF) using industry standards (such as ISO 21448) for assessing reliability, safety and potential unintended consequences associated with advanced electronic control systems, software, and electro-mechanical systems due to misuse and/or misapplication of the systems beyond their intended functionality and operating domain.

Vehicle Cybersecurity: NHTSA will continue research to advance the automotive industry's adoption and implementation of the National Institute of Standards and Technology (NIST) Cybersecurity Framework across their organizations and products. This will include targeted research on how the auto industry addresses the full life-cycle of cyber risks including identifying, protecting against, detecting, responding to, and recovering from cyber threats. The cybersecurity research program is cross-cutting, in that research results will generally be applicable to conventional vehicles as well as those equipped with advanced systems and technologies such as ADS. Activities will include:

- Continuing research on cybersecurity assessment and testing methods – This research will focus on exploring the development of objective cyber risk evaluation methods that may be applied to a motor vehicle and its associated information-sharing ecosystems (e.g., telematic services, repair and warranty activities, connectivity (cellular) providers, etc.). The research is targeted at leveraging cyber assessment activities from other industries and adapting them as appropriate for the automotive sector.
- Research to enhance cybersecurity response readiness –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 related to cyber incidents.
- Research related to cyber data analytics: This would include researching relevant cybersecurity data that can answer questions such as how and when an attack was launched and where it may have originated. Successful identification of attack origins and methods would help develop countermeasures and potentially deploy containment strategies until remedies may be put in place.

Expected Program Outcomes: While no crashes or fatalities have been directly attributed to a vehicle cybersecurity incident to date, the potential for large scale cyberattacks on vehicles is well-recognized, and as such, this risk warrants pre-emptive and proactive attention. Further, cyber vulnerabilities may also influence public confidence in our Nation's transportation system and could create a roadblock for the adoption of proven safety technologies as well as future ADS-equipped vehicles. If not appropriately addressed through design and lifecycle risk management processes, a successful cyberattack on automotive computer systems and their associated networks may not only lead to the loss of information and data but may also adversely impact vehicle control systems such as steering, braking, and throttle, potentially influencing occurrence of crashes fatalities and injuries. Therefore, electronic systems' safety and cybersecurity will play an important role in public acceptance of emerging technologies, such as ADAS and ADS, that have the potential to significantly reduce motor vehicle crashes.

Collaboration Partners: NHTSA will collaborate and leverage research with key stakeholders, the automotive industry, standards setting organizations, and Government agencies, including: Automotive Information Sharing and Analysis Center (Auto-ISAC), Original Equipment Manufacturers (OEMs), automotive suppliers, ADS technology companies, Department of Homeland Security (DHS), ISO, NIST, Department of Defense (DOD), and SAE International.

Program Name: Automated Driving Systems (ADS)

$5,570

Program Description: ADS (i.e., SAE International driving automation Levels 3, 4, and 5) is a major area of research emphasis for NHTSA even though they are still primarily in development, and testing stages. These systems, when engaged, can perform the full driving task without an expectation of an engaged driver. In the highway transportation sector, approximately nine out of ten roadway crashes are related to human behaviors; therefore, ADS-equipped vehicles hold the potential for substantially more safety benefits (above and beyond those possible through vehicle technologies that assist the drivers) while also delivering enhanced mobility and improved transportation system efficiency.

Program Objectives: This research area supports the safety assurance and future deployment of ADS technologies. Program objectives include development of ADS safety assurance frameworks; performance evaluation methods and metrics; human factors research to better understand human interactions with ADS-equipped vehicles—including communications and interfaces with other road users (human driven vehicles, pedestrians, cyclists), as well as ADS-equipped vehicle passengers, drivers, and/or operators; and ADS crashworthiness considerations and testing methods. NHTSA will also continue ongoing research to support decisions on the removal of unnecessary and unintended regulatory barriers for ADS-equipped vehicles.

Anticipated Program Activities:

*FMVSS translations to accommodate innovative (ADS) vehicle designs***:** NHTSA will continue research in FMVSS technical translation program areas that began in FY 2020 and continues in FY 2021. These include research considering unconventional seating configurations for crashworthiness/occupant protection standards; development of alternative test procedures for crash avoidance standards that would normally require a test driver (or a robotic apparatus affixed to conventional controls) to complete the maneuver; and the development of options for executing different vehicle functionalities (e.g., steering, braking, ignition function, parking brake, etc.) 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 compliance barriers while ensuring safe operation of vehicles equipped with ADS.

*Research on ADS safety performance***:** In conjunction with the industry and standards setting organizations, this research will explore methods, metrics, and tools for assessing the safety of ADS-equipped vehicles. Research will focus on developing and exercising a framework that will utilize multiple assessment methods which include modeling and simulation, closed course testing, and on-road naturalistic testing. The research will also include working with other industry standards organizations in developing a common "language" for describing ADS test scenarios. Additional research will focus on evaluating the application of leading-edge analytical methods that would utilize operational data (or results) from various testing venues to develop safety performance metrics. For 2021, NHTSA will continue our FY 2020 research related to ADS-equipped vehicle subsystems, including development of evaluation methods for examining the performance of ADS sensors and perception systems as well as sub-systems such as path-following. We will also advance our capabilities for executing multi-agent test scenarios in

controlled (test track) environments and will expand our research related to on-road ADS testing methods and data collection.

*Crashworthiness of ADS-equipped vehicles***:** Vehicles equipped with ADS 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 ADS-equipped vehicles. Changes in occupant seating and restraint systems will affect the ADS-equipped vehicle occupant's response in a crash and the associated injury scenarios and risk factors. By FY 2021, initial research will be completed to enhance existing Human Body Models (HBM) and anthropomorphic test devices (ATD) 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. In FY 2021, research will continue to further refine these tools. Also, 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-equipped vehicle seating configurations. The Agency will also continue to research potential best practices for safe interaction of non-occupied ADS-equipped vehicles with existing vehicles, roadside hardware, pedestrians, cyclists, and motorcyclists.

Research on human factors considerations for ADS-equipped vehicles: ADSs will likely change how humans interact with vehicles as compared to conventional vehicles. When an ADS issues a request to a human driver to resume control of the vehicle, the driver would need to understand when and how to intervene. Drivers' mental models influence interactions with ADSs. The Agency will continue to investigate these subject areas along with other emerging ADS human factors topical areas (e.g., external human-machine interface (HMI), communication of intent, etc.).

*Accessibility considerations in ADS-equipped vehicles***:** ADS-equipped vehicles may provide mobility options not previously afforded to people with disabilities –cognitive, physical, and/or sensory – or even the degree of the disability. Vehicles equipped with ADS that are accessible to people with disabilities will be expected to provide equivalent safety to standard seating conditions. In FY 2021, NHTSA will complete the preliminary design and testing of prototypes for automated wheelchair tiedown and restraint systems.

*Children in ADS-equipped vehicles***:** Research will be conducted to explore child-specific safety considerations in ADS-equipped vehicles. This research will examine safety considerations for child restraint system (CRS) installation and usage in unconventional seating conditions anticipated for future ADS-equipped vehicles. This research will also examine the capability of occupant sensors to distinguish between adults and children. Research related to safety and operational considerations for remote teleoperations of ADS-equipped vehicles with unattended children as passengers will also be initiated.

Expected Program Outcomes: The United States established and plans to maintain its leadership position in ADS development through continued joint efforts of the government, private sector, universities, and other stakeholders. Supporting the international competitive landscape, NHTSA is focusing research on key topics to advance the safe testing and

deployment of ADS-equipped vehicles that do not require a human driver. Preliminary research indicates that if deployed responsibly, there could be significant safety benefits associated with ADSs. Further, ADS-equipped vehicles offer access to mobility for previously underserved communities of individuals unable to acquire a driver's license, including the elderly and people with disabilities –cognitive, physical, and/or sensory. It is envisioned that ADS technologies could be harnessed to provide safe transportation options for the traveling public at large. Research efforts are supportive of Agency considerations about potential updates to FMVSS and associated test procedures to accommodate non-standard vehicle design concepts. Research will also be sponsored and conducted that supports improved transparency, development of objective safety performance evaluation methods, and a data-driven approach to safety assessments of this new promising technology.

Collaboration Partners: NHTSA will collaborate and leverage research with key stakeholders, the automotive industry, standards setting organizations, and Government agencies, including OEMs, automotive suppliers, ADS technology companies, NIST, ISO, SAE International, and other USDOT modes.

Program Name: Advanced Safety Technologies

$8,800

Program Description: Advanced Safety Technologies research focuses on motor vehicle technologies and systems that assist drivers in avoiding crashes of passenger vehicles, large trucks, and buses. This safety research program additionally addresses technologies targeted to improve the safety of motorcyclists, bicyclists, and pedestrians, and researches the potential role and impacts of connectivity in vehicle safety. Roadway safety continues to be a major public health and economic challenge in the United States. Despite decades of progress, an unacceptable number of fatalities and serious injuries continues to occur on U.S. roadways. Furthermore, traffic fatalities cause significant societal harm and economic cost. Statistics show that most of these crashes are preventable, and ADAS have the potential to provide an additional safety margin by helping drivers avoid crashes or significantly mitigating crash severity. An increasing portion of new vehicles feature ADAS technologies designed to operate in unison with drivers through warnings or, in some cases, temporarily engaging active vehicle control for avoiding/mitigating crashes. This program area focuses on the safe development, evaluation, and deployment of ADAS technologies that respond to specific crash imminent situations (i.e., SAE International driving automation Level 0), as well as driving automation systems that enable partial driving automation but still require full driver engagement (SAE International driving automation Levels 1 and 2). Examples of systems in SAE International driving automation Levels 0, 1, and 2 include Automatic Emergency Braking (AEB), Blind Spot Intervention (BSI), Lane Keep Assistance (LKA), Pedestrian Automatic Emergency Braking (PAEB), rear-cross traffic alert, and adaptive cruise control, as well as the combinations of such systems that could enable features such as traffic jam assist (TJA), cross-traffic alert, parking-assist and "highway chauffeur" systems.

The automotive industry has made significant progress in the development of advanced safety technologies intended to prevent and/or mitigate roadway crashes. Today's crash avoidance systems rely on an array of sensors such as Radio Detection and Ranging (radar), Light Detection and Ranging (lidar), video, ultrasonic, and others to detect objects within the vehicle's operational environment. Sophisticated computing and software functions apply the sensing inputs to classify the objects within the vehicle's field of view and assess the likelihood of potential collisions with other vehicles, pedestrians, or other objects and warn the driver to take appropriate action. More advanced safety systems may also automatically apply the vehicle's brakes or provide steering inputs to help 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 performance of the (human) driver as they interact with the system—ranging from simply whether (or not) they engage a system (i.e., lateral and longitudinal controls or automation applications), or how warnings are issued (i.e., driver-vehicle interface). Similarly, more advanced safety driving automation systems that remain short of "fully automated" include applications and performance that rely on the driver's ability to: properly understand the capabilities, constraints, performance limitations, operational boundaries; and control settings of driving automation, including the circumstances, timeliness, and manner in which the human driver takes over or "partners" with the systems to complete the driving task.

Program Objectives: The principle objective of this program is to lead national safety research to advance and accelerate the responsible deployment of ADAS, including those based on vehicle-based communications technologies, across the U.S. automotive fleet. This program is focused on safety systems and innovations that directly map to crashes involving light and heavy vehicles, motorcycles, and other vulnerable roadway users. Research is conducted with the objectives of attaining a comprehensive understanding of all ADAS enabling technologies and trends; quantifying ADAS performance, capabilities, limitations, effectiveness and risk for all classes of vehicles and all roadway users; and preparing for the safe transition to a ubiquitously connected vehicle ecosystem.

The program will continue to focus on harnessing emerging technologies and innovative safety systems that show potential to address real world crashes and improve vehicle safety performance, including those that detect and react to vulnerable road users, such as pedestrians, bicyclists, and motorcyclists. Emerging innovative technologies in this area include active safety systems such as cross traffic alert systems that have potential to address some types of intersection crashes, blind spot intervention systems that automatically apply steering or braking to assist drivers with 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.

Anticipated Program Activities: As sensor and software capabilities mature, the market is evolving with increasing proliferation of systems featuring partial driving automation systems that could be classified at SAE International driving automation Level 2, which provide both lateral and longitudinal vehicle motion control. Research will be performed to establish and validate test procedures to assess safety performance.

Research will additionally be performed to support crash avoidance inclusion (in the form of ADAS applications) in updates to the NCAP. Validated simulations mixed with controlled track testing will be employed to perform effectiveness analyses of select ADAS applications.

For the range of ADAS technologies (SAE International driving automation Levels 0-2), the driver is expected to be fully and continually engaged in the driving task while the system is engaged. Further research insights are needed in the implementation strategies for drivers' interaction with these systems, and the utility and performance of different attention management approaches as they pertain to roadway safety. Additional technology innovations often lead to novel HMI designs (which provide system status to drivers). NHTSA will continue to evaluate novel HMI designs. Similarly, new technology provides possibilities to enhance side and rear visibility enhancement for drivers (e.g., camera-based technologies). Human factors challenges and benefits with these new technologies will be continually evaluated.

The Heavy Vehicle and Medium Duty Safety Technologies program is focused on safety systems and innovations that directly map to crashes involving heavy and medium duty vehicles on U.S. roadways. Research in this program area will focus on identifying and addressing the real-world target crashes involving trucks that result in the highest societal costs, while highlighting the special considerations associated with, and quantifying the benefits stemming from, the application of ADAS technologies in heavy- and medium-duty vehicles.

Research will support the following program areas:

ADAS Innovation and Deployment: This work will include evaluating FMVSS compliance issues stemming from the implementation of novel design features or functional aspects of these systems that may hinder implementation. For example, new developments in lighting systems, camera-based mirrors and heavy-vehicle braking systems may necessitate adaptation of existing FMVSS to facilitate a pathway for compliance without compromising the safety performance set in the regulations. Research in this area will help facilitate such innovations while maintaining or advancing safety. Innovative technologies considered for research include active safety systems such as cross traffic alert systems that have potential to address some types of intersection crashes, blind spot intervention systems that automatically apply steering or braking to assist drivers with 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, and integration of level 2 driving automation systems into heavy vehicles.

Safety Performance Assessment of Advanced Driver Assistance System Technologies: This work will include the safety performance assessment of ADAS technologies (SAE International driving automation Levels 0, 1, and 2) deployed in new production motor vehicles including light and heavy vehicles, buses, and motorcycles. The assessment will include safety performance evaluations through computer simulations, closed-course testing, and naturalistic roadway evaluations. Research includes development of objective test procedures that may be leveraged by industry stakeholders to better compare and contrast performance of alternative system designs, thereby accelerating innovation and deployment. Some of these procedures could also be considered in updates to the NCAP program. Additionally, NHTSA's simulation capability for light vehicles is being validated through this testing and updated to include select ADAS applications.

*ADAS HMI***:** Advanced vehicle safety technologies that support the driver have a range of interaction points when information is communicated to the driver and responses are expected. The expected response to HMI warnings and alerts is evolving as the in-vehicle technology changes. These alerts include brake pulses, haptic seat/steering wheel vibrations, and auditory chimes. NHTSA's research program encompasses a broad HMI design concept. NHTSA will examine the effectiveness of lateral control warnings for improving driver response to unanticipated hazards.

*Safety Technologies Leveraging Connectivity***:** This research will include working with automotive industry, telecommunication providers and transportation infrastructure stakeholders to identify and understand future safety applications that leverage connectivity and support advancements in driving automation applications. The research will identify facts and data associated with spectrum needs, communication protocols, communication security, and the development of associated standards that support safety benefits through optimizing performance, developing use cases, and assuring interoperability among technologies.

Expected Program Outcomes: The mission of the light vehicle ADAS research program is to advance the safe deployment of life saving technologies enabling SAE International driving automation Levels 0-2. The research program is engaged in a body of research for vehicle technologies that supports safer drivers by presenting them with safety warnings and 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; and optimizing the long-term safety impacts while mitigating risks in deployment of these advanced technologies.

The outcome of this work will be research findings related to critical aspects of ADAS, such as effective HMI design and system operation characteristics to compliment driver performance, maximize safety benefits, and establish validated performance-based test procedures. These and other outputs from this program will enable automotive manufacturers, suppliers, and other industry entities to apply modern technology to improve their products through more accurate and efficient product evaluations, thereby enhancing societal safety benefits. Furthermore, the field testing of emerging ADAS technologies by NHTSA and industry partners will provide insights for further product refinements, as well as for developing programs to promote voluntary adoption of crash avoidance systems and enhance competitiveness among vehicle manufacturers and other industry entities offering high-value and high-performance safety systems.

The Heavy Vehicle Safety Technologies program is focused on safety systems and innovations that directly map to crashes involving heavy vehicles on U.S. roadways. By continuing to focus on emerging innovative safety systems on heavy vehicle platforms that show potential to address real-world crashes, the safety performance of heavy vehicles – with respect to frequent and severe crashes – may be significantly improved.

Collaboration Partners: NHTSA will collaborate and leverage research with key stakeholders, the automotive industry, standards setting organizations, and Government agencies, including Vehicle manufacturers, automotive suppliers, SAE International, and other USDOT modes.

Program Name: Crashworthiness

$12,017

Program Description: Crashworthiness research focuses on crash survivability countermeasures to reduce the number of fatal and serious injuries that occur in motor vehicle crashes in the United States each year. This research program is responsible for developing and upgrading test procedures for the evaluation of motor vehicle crash safety, and for developing test devices (e.g., ATDs and human body computer models) 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. The Crashworthiness research program conducts physical testing and analysis together with experimental- and computer-modelling-based research. The program directly supports the Department's safety strategic goal of reducing transportation-related fatalities and serious injuries across the transportation system.

Program Objectives: The purpose of this research program is to investigate the opportunities in 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 Crashworthiness research 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 and assessment.

In 2021, 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 impact crash test dummy (Test Device for Human Occupant Restraint (THOR) 5th percentile. The research on the THOR 5th will include efforts to develop and utilize female-specific response and injury data for use in developing injury criteria.

Additionally, the program focuses on vulnerable populations (e.g., 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 evaluating leading injury mechanisms for older occupants: brain injuries (subdural hematoma) and thorax injuries.

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 United States each year from crashes. This research program is responsible for evaluating new crash safety concerns and for developing safety concepts, test procedures, and performance measures. Safety Systems research examines existing designs, new and improved vehicle designs, safety countermeasures, materials, and equipment to enhance safety for all occupants in the event of a crash.

In 2021, 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. Research on vehicle crash compatibility will continue, particularly with regards to new nonoccupant ADS-equipped vehicle designs. Occupant safety in front and side crashes will be assessed using new, advanced crash test dummies. Frontal crash protection will also focus on improving safety for rear seat occupants, including continued evaluation of seat belt elongation requirements and research to reduce head injuries from contacts with seat backs and interior surfaces.

The Crashworthiness research program supports the entire private sector rather than benefitting any single company. Research on evolving crash injury mechanisms and the development of safety assessment tools is intended for widespread use in automotive design.

Anticipated Program Activities: Safety Systems will support research to evaluate new test dummies and injury metrics in current and future crash conditions, develop or revise test procedures, and assess the effectiveness of occupant protections systems. Biomechanics will fund research to develop tools (crash test dummies, mathematical models) and injury metrics that can be applied towards the assessment of advanced vehicle safety countermeasures. Specifically, the funding requested in FY 2021 will allow NHTSA to:

- Complete technical documentation for an advanced crash test dummy, the small adult female frontal dummy (THOR 5th percentile);
- Conduct research and testing with the THOR 5th percentile female dummy to evaluate its sensitivity to changes in crash type and restraint configurations;
- Continue to conduct research and testing to assess rear seat occupant protection for adults and children, including head protection, restraint performance, consequences of seat belt elongation, and booster seat performance metrics;
- Continue to conduct research focused on injury response and tolerance differences between females and males;
- Continue to support a collaborative Government and industry effort focused on the development, evaluation, and application of human body models for use by the Agency and the public in promoting the development of advanced countermeasures for reducing injuries/fatalities resulting from motor vehicle crashes. This includes the continuous improvement and demonstrated application of child, small female, and average/large male occupant and pedestrian models;
- Continue to conduct research to develop head/brain injury criteria specific to the protection of older occupants;

- Continue to collect real-world motor vehicle crash occupant-based injury data, known as the Crash Injury Research and Engineering Network (CIREN). CIREN compliments data collection efforts by NHTSA's NCSA by extending common data collection protocols to include an emphasis on medical data collection and expert engineering analysis of the crash, vehicle, and occupant factors associated with serious injuries. The current data collection efforts include an emphasis on collecting serious injury cases for occupants involved in crashes that will be of increasing relevance for the potential alternative seating arrangements that may be present in vehicles with Automated Driving Systems (SAE International Automation Levels 4-5);
- Continue to evaluate opportunities to improve occupant safety through improved integration between vehicle advanced safety technologies and restraint control systems;
- Continue to assess the performance of the THOR 50th percentile male ATD in frontal impact test conditions;
- Continue to assess the performance of the WorldSID 50th percentile male ATD in side impact test conditions;
- Continue to evaluate occupant safety considerations for small transit vehicles; and
- Continue to evaluate the implications of deregulatory options for existing FMVSSs.

Expected Program Outcomes: The Crashworthiness research program supports the Department's strategic goals of safety and innovation using several strategies, which include data risk identification, collaboration, leadership, performance, coordination, research, and technology integration. The outcomes provide information to support Agency decisions on actions aimed at reducing the number of fatal and serious injuries to occupants in motor vehicles that occur in the United States each year from crashes. The knowledge, tools, test procedures, and injury metrics resulting from this research program can be used by industry and the vehicle safety community to provide improved crash safety in vehicle designs.

The Biomechanics research program at NHTSA has long maintained a leadership role in the development of test tools (e.g., crash test dummies) and injury metrics used to ensure optimal crashworthiness of vehicles. The Safety Systems research program is responsible for evaluating new crash safety concerns and for developing safety concepts, test procedures, and performance measures. Safety Systems research examines existing designs, new and improved vehicle designs, safety countermeasures, and equipment to enhance safety for all occupants in the event of a crash.

In FY 2021, NHTSA will continue to collaborate with industry and academia in supporting research that benefits the public by promoting the development of advanced tools and knowledge for applications that aim to reduce injuries/fatalities resulting from motor vehicle crashes. Below are some expected public benefits that will result from the FY 2021 budget request:

- Public release of CIREN dataset of detailed injury and medical data associated with seriously injured motor vehicle crash occupants. Roughly 200 expert-reviewed cases would be added to the public dataset, and would provide an early insight into the types and causes of injuries that continue to occur in new vehicles as a result of motor vehicle crashes;

- Continued release of CIREN pedestrian injury data to provide the public with improved knowledge regarding the patterns and causes of injuries to pedestrians struck by motor vehicles;
- Continued public release of technical documentation for the advanced THOR 5th percentile female crash test dummy;
- Continued refinement, evaluation, demonstrated application, and public release of mathematical models such as detailed human body models, body region specific injury models, and dummy-based models along with test data and reports demonstrating model fidelity;
- Public release of test results through NHTSA's Biomechanics, Crash Test, and Component databases, which include over 20,000 NHTSA-funded or acquired tests. These results are used by the Agency, academia, industry, safety advocate and research groups, and the public for a variety of purposes, including vehicle performance and injury assessment, test procedure and injury and criteria development, and consumer information;
- Public release of test results and updated test procedures for evaluating new and vehicle-based technologies for mitigating child heat stroke incidents;
- Public release of technical reports on frontal and side impact testing using advanced crash test dummies; and
- Public release of technical research reports on roof ejection mitigation and seat belt elongation.

Collaboration Partners: NHTSA will collaborate and leverage research with key stakeholders, the automotive industry, standards setting organizations, and Government agencies, including OEMs, automotive suppliers, ADS technology companies, industry and academic consortiums, Department of Energy national laboratories, university-based research groups, and other USDOT modes.

Program Name: Alternative Fuels Vehicle Safety

$600

Program Description: NHTSA is gathering information from all sources regarding the safety of emerging transportation fuels including battery, stored gas, and fuel cell technologies. This advanced knowledge is helping to direct research projects, refine safety assessments, and develop performance tests. NHTSA is partnering with industry and other federal agencies to develop appropriate safety performance considerations for these alternative-fuel-powered vehicles. In FY 2021, NHTSA requests $674 thousand for the Alternative Fuels Vehicle Safety research program. With this funding, this program will focus on safety of vehicle interfaces for wireless charging applications for fleet and personal use. NHTSA will also coordinate with Department of Energy (DOE) research to understand the safety of solid-state battery systems and begin consideration of the need for performance testing. These technologies ideally involve research between the DOE national laboratories, 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.

Program Objectives: NHTSA is currently developing a safety assessment method for wireless charging systems, which is 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. 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.

Anticipated Program Activities: NHTSA will continue to collaborate with partner agencies on funding and other research programs. The program meets the Appropriations Act's requirement to conduct research on alternative fuels vehicle safety.

Expected Program Outcomes: NHTSA has worked closely with the DOE to understand safety concerns for emerging alternative fuel vehicles. Past collaboration allowed NHTSA to develop and assess charging safety tests for a range of electric vehicle types and charging systems. Wireless battery charging systems currently exist for a small number of large capacity lithium ion battery systems. NHTSA's research will initiate development of best practices for the safe use and operation of these systems prior to wider deployment. This research should document safety risks and provide confidence that the current commercial grade systems can be made suitable for routine consumer use and support the safe introduction of these vehicles and their charging systems.

Collaboration Partners: NHTSA will collaborate and leverage research with key stakeholders, the automotive industry, standards setting organizations, and Government agencies, including

OEMs, automotive suppliers, ADS technology companies, DOE National Laboratories, SAE International, and other USDOT modes.

Program Name: Vehicle Research and Test Center (VRTC)
($500)

Program Description: The VRTC is NHTSA's in-house applied research, development, test, and evaluation laboratory located in East Liberty, Ohio. 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 investigation support. 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 Objectives: VRTC supports a broad range of critical safety areas including:

- Crash avoidance research (light and heavy vehicles), including research to develop safety performance tests and other research data to enable Agency evaluation and support policy decisions for new emerging ADAS technologies. This program area also supports development of foundational tests, methods, and safety metrics to enable future Agency evaluation and policy decisions for emerging ADS 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
- Research into other complex emerging areas such as cybersecurity to support development of safety approaches, methods, and tests.

Research in these areas directly support the Department's goal to reduce transportation related fatalities and serious injuries across the transportation system. This aligns with NHTSA's mission and both the Department and Agency goals of the deployment of new and innovative technologies.

Anticipated Program Activities: 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's fundamental role in vehicle safety programs that include activities such as safety defects investigation support 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 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.

The FY 2021 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 cybersecurity, Automated Driving Systems, advanced safety technologies, and crashworthiness) and is in addition to support research done in collaboration with other offices within NHTSA (e.g., NHTSA enforcement and rulemaking) as well as offices within the Department (e.g., ITS JPO).

Expected Program Outcomes: The expertise and technical capability of NHTSA's VRTC has been well demonstrated for over 40 years. Numerous high-profile programs have been successfully completed by VRTC in an expeditious and thorough manner. At the same time, NHTSA has recognized the need to enhance the capabilities at VRTC for testing and analyzing emergent safety issues. Providing the capability of testing emerging technologies is necessary to maintain pace with the rapid advances in vehicle technologies and electronics and the resulting new safety issues. While enhancement of research capability in several areas has been identified, the most near-term critical areas are in ADS, cybersecurity, and defects analysis. Enhancement of capabilities for performing safety related research, testing, and analysis is critical. The FY 2021 budget request enables VRTC to maintain and update the equipment and state-of-the-art facilities necessary to assess and investigate the rapid emergence of advanced automotive safety technologies, and to assure the highest level of automotive safety for the American public.

Collaboration Partners: NHTSA will collaborate and leverage research with key stakeholders, the automotive industry, standards setting organizations, universities, and Government agencies, including OEMs, automotive suppliers, ADS technology companies, NIST, SAE International, The Ohio State University, Transportation Research Center, and other USDOT modes.

Office of Behavioral Safety Research (BSR)
Program Name: Highway Safety Research
($14,358)

Program Description: Highway Safety Research provides 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.

NHTSA's Highway Safety Research program supports the Department's safety efforts through behavioral research, demonstrations, technical assistance, and national leadership activities emphasizing alcohol and drug countermeasures, occupant protection, distraction, traffic law enforcement, emergency medical and trauma care systems, driver licensing, State and community evaluations, motorcycle rider safety, pedestrian and bicyclist safety, pupil transportation, and young and older driver safety programs.

Highway Safety Research also funds the Driver Alcohol Detection System for Safety (DADSS) project. Despite progress over the past three decades, drunk driving claims approximately 10,000 lives each year. The DADSS project is researching a first-of-its-kind technology that holds the greatest potential we have seen to reverse this trend. The technology will automatically detect when a driver is intoxicated with a BAC at or above 0.08% — the legal limit in all 50 states except Utah — and prevent the car from moving. Once it has met rigorous performance standards, it will be voluntarily offered as a safety option in new vehicles, similar to automatic braking, lane departure warning and other advanced driver assist vehicle technologies.

Lastly, Highway Safety Research funds the Behavioral Traffic Safety Cooperative Research Program (BTSCRP). BTSCRP, which is administered by the Transportation Research Board, is a forum for coordinated and collaborative research to address issues integral traffic safety professionals at all levels of government and the private sector. BTSCRP provides practical, ready-to-implement solutions to save lives, prevent injuries, and reduce costs of road traffic crashes associated with unsafe behaviors.

BTSCRP serves as an accelerator of research to practice and technology transfer. Products are developed in response to problems faced by traffic safety stakeholders. Emphasis areas are alcohol-impaired driving, autonomous vehicles, bicyclists and pedestrians, child passenger safety, distracted driving, drowsy driving, drug-impaired driving, law enforcement, mature drivers, motorcyclist safety, seat belts, speed and safety cameras, speeding and aggressive driving, teen driver safety, and traffic records. BTSCRP will produce a series of research products that traffic safety stakeholders, government agencies, and other interested parties will be able to quickly use or implement in their traffic safety practices.

Program Objectives:
The primary goal of the Highway Safety Research program is to increase the return on investment from NHTSA's Highway Traffic Safety Grant Program. The research will support five overlapping strategic categories:

- Preventing destructive traffic safety behaviors;
- Encouraging positive traffic safety behaviors;
- Leveraging public safety to improve traffic safety;
- Protecting vulnerable road users; and,
- Exploring advanced technologies to address traffic safety issues.

Anticipated Program Activities:
In 2021, NHTSA will put research emphasis on drug- and alcohol-impaired driving, distracted driving, pedestrian safety, and novice drivers. In these emphasis areas, NHTSA plans to conduct foundational research to understand the nature or scope of the problem; developmental research that is more applied and helps refine delivery of solutions; and a hybrid that combines research into the big ideas and potential ways to develop those into safety programs.

In FY 2021 Highway Safety Research plans to focus on four priority areas: preventing alcohol- and drug-impaired driving, improving pedestrian safety, preventing distracted driving, and improving novice driver safety. Human factors research, particularly related to ADAS and ADS technologies, will also remain a focus as it was in the previous plan. Planned projects to improve pedestrian and novice driver safety will address human factors issues related to ADAS and ADS technologies. Highway Safety Research will continue to collaborate with NHTSA's Automated Driving Systems and Advanced Safety Technologies research programs to address human factor issues including behavioral adaptation and child-specific safety considerations related to ADS. Examples of these issues include the use of Child Restraint Systems in shared mobility situations and human factors concerns involving unattended children in ADS vehicles.

DADSS technologies are undergoing rigorous field testing and systemic improvements as the Agency prepares to move from research to program development.

In 2021, NHTSA plans for four to six discrete BTSCRP projects to be selected that will result in applied research products that highway safety stakeholders will be able to use immediately upon the completion of the research. TRB will prepare requests for proposals and will assemble panels to select contractors to perform the work.

Expected Program Outcomes: Our expected outcome is research that contributes to the state of the knowledge through effective dissemination and to the way traffic safety is implemented at the State and local level. Not every project fits this path, however, measurable milestones for an ideal trajectory of a research project would be:

- 1-3 years post completion – Number of report downloads, press citations; demonstration project(s);
- 3-5 years post completion – Number of citations in literature; inclusion of strategy in Countermeasures that Work or an increase in the effectiveness rating of an associated countermeasure;

- 5+ years post completion – Citation in a grant program; inclusion in a standard or guideline; widespread (voluntary) adoption among States.

Success can also be measured by identifying and communicating what *doesn't* work to change behavior or enhance safety. This allows NHTSA to be a better steward of grant funds.

If fully-deployed across the entire vehicle fleet, DADSS could prevent 7,000 deaths from impaired driving every year. The expected outcome of this research is a system that meets reliability and other rigorous performance standards that could be easily deployed by a vehicle manufacturer.

For each project under BTSCRP, practical applications for highway safety are envisioned from the start. The research findings, tools, and resources developed through this program are immediately put into action by States and local highway safety practitioners who use the outcomes to change policies and practices, resulting in lives saved.

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), and NETS (Network of Employers for Traffic Safety).

NHTSA works with the Automotive Coalition for Traffic Safety (ACTS) to execute the DADSS program. The ACTS membership includes the major automobile manufacturers. A stakeholder group that includes organizations such as the Insurance Institute for Highway Safety, MADD, the National Safety Council, and Safe Kids Worldwide provides strategic input on the program direction.

Lastly, BTSCRP, NHTSA, TRB, and the Governors Highway Safety Association (GHSA) work collaboratively to identify technology transfer targets based on the research question.

Chapter 3 – FY 2022 RD&T Programs
Office of Vehicle Safety Research (VSR)

Program Name: Vehicle Electronics and Cybersecurity

Program Description: Enhanced wireless connectivity and continued innovations in electronic control systems introduce substantial benefits to highway transportation safety, mobility, and efficiency. However, with the proliferation of computer-based control systems, software, connectivity, and onboard digital data communication networks, consideration must be given to potential new failure modes, vulnerabilities, and threats that may come along. The Vehicle Electronics and Cybersecurity research program broadly covers two major research areas: Vehicle Electronics Functional Safety and Vehicle Cybersecurity. Vehicle Electronics Functional Safety is an important part of overall systems safety that deals with safety risk management associated with potential failures in sensors, components, systems, and software implementation, as well as operator errors and environmental changes. Vehicle Cybersecurity research deals with safety risk management associated with intentional manipulation of software, hardware, sensors, and associated communication networks on-board the vehicle. While functional safety and cybersecurity both focus on safety effective means of life-cycle risk management differ across these two safety domains.

Program Objectives: The goal of the Vehicle Electronics and Cybersecurity research program area is to support enhanced reliability and resiliency of vehicle electronics, software, and related vehicle control systems to both mitigate safety risks associated with failure and/or cyber compromise of such systems, but also so that such concerns do not pose public acceptance barriers for proven safety technologies and driving automation systems. The program seeks to support improvements in the cybersecurity posture of motor vehicles and to 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.

Anticipated Program Activities: Research will focus on methods for assessing the functional safety and reliability of safety-critical subsystems including but not limited to steering, braking, propulsion, perception, prediction, and decision-making systems. Vehicle Electronics Functional Safety research's scope will extend to new capabilities ADS developers are introducing such as using wireless communications (e.g., cellular) to facilitate remote manual operation (or intervention) of the vehicle if/when an ADS-equipped vehicle may find itself in circumstances unable to navigate further on its own. In executing functional safety analyses, NHTSA will leverage evolving industry process standards (such as ISO 26262) as well as traditional hazard assessment techniques such as FMEA and FTA for the electronic systems and software of various types of driving automation systems. NHTSA will also conduct analyses related to the SOTIF using industry standards (such as ISO 21448) for assessing reliability, safety and potential unintended consequences associated with advanced electronic control systems, software, and electro-mechanical systems due to misuse and/or misapplication of the systems beyond their intended functionality and operating domain. We will also employ Software Assurance Approaches to 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.

NHTSA will also continue research to advance the automotive industry's adoption and implementation of the NIST Cybersecurity Framework across their organizations and products. This will include targeted research on how the auto industry addresses the full life-cycle of cyber risks including identifying, protecting, detecting, responding, and recovering from cyber threats.

Program Name: Automated Driving Systems (ADS)

Program Description: In the highway transportation sector, where approximately nine out of ten roadway crashes involve human behaviors and decisions (errors and poor choices), ADSs offer the potential for substantial safety benefits while also delivering enhanced mobility and improved transportation system efficiency. Therefore, ADS (i.e., SAE International driving automation Levels 3, 4, and 5) is a major area of research emphasis for NHTSA.

Program Objectives: This research area supports the safety performance assessment and safe deployment of ADS-equipped vehicle technologies. Program objectives include development of ADS safety assurance frameworks; performance evaluation methods and metrics, human factors research to better understand human interactions with ADS-equipped vehicle, accessibility considerations for ADS-equipped vehicles, and ADS crashworthiness considerations and testing methods. NHTSA will also continue research to support decisions on the removal of unnecessary and unintended regulatory barriers for ADS-equipped vehicles.

Anticipated Program Activities: Vehicles equipped with ADS 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 ADS-equipped vehicles. Changes in occupant seating and restraint systems will affect the ADS-equipped vehicle occupant's response in a crash and the associated injury scenarios and risk factors. By FY 2022, several research projects will have been completed that address updates to HBMs and ATDs to support the safety evaluation for the range of seating conditions anticipated for new ADS-equipped vehicle designs. This research will include research on human response and injury metrics for various alternative seating and crash conditions. While we expect updates to the test and simulation tools to continue into FY 2022, we also expect to initiate research in FY 2022 to apply these updated HBMs and ATDs toward the evaluation of new vehicle designs and countermeasures, with the goal of demonstrating feasibility of occupant protection for new ADS-equipped vehicle seating configurations. These enhanced engineering tools will continue to be used to create objective and reproducible test procedures. The Agency will continue to develop best practices for safe interaction of non-occupied ADS-equipped vehicles with existing vehicles, roadside hardware, pedestrians, cyclists, and motorcyclists.

The Agency will also continue to investigate emerging ADS human factors topical areas (e.g., cyber, external HMI, communication of intent, etc.). Vehicles equipped with ADS that are accessible to people with disabilities will be expected to provide safety equivalent to that achieved for standard seating conditions. Research will be initiated into crash safety test methods that can be used for a wide range of manual and powered wheelchairs. ADS-equipped vehicles will likely be utilized for transport of children. Research will continue to investigate recommendations for use of child seats in ADS-equipped vehicles. Sensor systems will be evaluated for the ability to detect unattended children and prevent heat stroke occurrence.

Program Name: Advanced Safety Technology

Program Description: Advanced Safety Technologies research focuses on motor vehicle technologies and systems that assist drivers in avoiding crashes in passenger vehicles, large trucks, and buses. This safety research program addresses technologies targeted to improve the safety of motorcyclists and pedestrians, and researches the potential role and impacts of connectivity in vehicle safety. Roadway safety continues to be a major public health and economic challenge in the United States. Despite decades of progress, an unacceptable number of fatalities and serious injuries continues to occur on U.S. roadways. Furthermore, traffic fatalities cause significant societal harm and economic cost. Statistics show that most of these crashes are preventable; and ADASs have the potential to provide an additional safety margin by helping drivers avoid crashes or by significantly mitigating crash severity.

Newer vehicles increasingly feature advanced safety technologies that help drivers with crash avoidance when they find themselves in difficult and risky circumstances. This program area focuses on the safe development, evaluation, and deployment of ADAS technologies that respond to specific crash imminent situations, as well as driving automation systems that enable partial driving automation, but still require full driver engagement (SAE International Driving Automation Levels 1 and 2). Examples of systems in SAE International Driving Automation Levels 0, 1, and 2 include: AEB, BSI, LKA, PAEB, rear-cross traffic alert, and adaptive cruise control, as well as the combinations of such systems to enable features such as TJA, cross-traffic alert, parking-assist and "highway chauffeur" systems.

Program Objectives: The mission of the Advanced Safety Technology Program is to advance the safe deployment of technologies that measurably improve the safety of human-driven vehicles. This program is focused on safety systems and innovations that directly map to crashes involving light and heavy vehicles, motorcycles, and other vulnerable roadway users. Research is conducted with the objectives of attaining a comprehensive understanding of all ADAS-enabling technologies and trends; quantifying ADAS performance, capabilities, limitations, effectiveness, and risk for all classes of vehicles and all roadway users; and preparing for the safe transition to a ubiquitously connected vehicle ecosystem.

This program will continue to focus on harnessing emerging safety technologies and innovative safety systems that show potential to address real-world crashes and improve vehicle safety performance, including those that detect and react to vulnerable road users, such as pedestrians, bicyclists, and motorcyclists.

Anticipated Program Activities: As sensor and software capabilities mature, the market is evolving with increasing proliferation of systems featuring partial driving automation systems that could be classified at SAE International driving automation Level 2, which provide both lateral and longitudinal vehicle motion control. This program will perform research in assessing and supporting the advancement of the safety performance of such systems. In SAE Level 2 automation, the driver is expected to be fully and continually engaged in the driving task while the system is enabled. Further research insights are needed in the implementation strategies for drivers' interaction with these systems, and the utility and performance of different attention

management approaches as they pertain to roadway safety. Human factors challenge and benefits with these new technologies will be continually evaluated.

The Heavy Vehicle and Medium Duty Safety Technologies program is focused on safety systems and innovations that directly map to crashes involving heavy- and medium-duty vehicles on U.S. roadways. Research in this program area will focus on identifying and addressing the real-world target crashes involving trucks that result in the highest societal costs, while highlighting the special considerations associated with, and quantifying the benefits stemming from, the application of ADAS technologies in heavy- and medium-duty vehicles.

Program Name: Crashworthiness

Program Description: Crashworthiness research focuses on vehicle safety countermeasures to reduce the number of fatal and serious injuries that occur from motor vehicle crashes in the United States each year. This research program is responsible for developing and upgrading test procedures for the evaluation of motor vehicle safety, and for developing the test devices (e.g., crash test dummies and human body computer models) 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. The Crashworthiness research program conducts real-world data collection and analysis together with experimental and computer-modeling-based research. The program directly supports the Department's safety strategic goal of reducing transportation-related fatalities and serious injuries across the transportation system.

Program Objectives: 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. The near-term goal is to identify fatality and injury trends and to enhance safety requirements and best practices to improve crash occupant outcomes. This 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. Safety Systems research 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.

Anticipated Program Activities: Safety Systems will support research to evaluate new test dummies and injury metrics in current and future crash conditions, develop or revise test procedures, and assess the effectiveness of occupant protection systems. Biomechanics will fund research to develop tools (crash test dummies, mathematical models) and injury metrics that can be applied towards the assessment of advanced vehicle safety countermeasures.

Program Name: Alternative Fuels Vehicle Safety

Program Description: NHTSA is gathering information from all sources regarding the safety of emerging transportation fuels including battery, stored gas, and fuel cell technologies. This advanced knowledge is helping to direct the research projects, refine safety assessments, and develop performance tests. NHTSA is partnering with industry and other federal agencies to develop appropriate safety performance considerations for these alternative fuel vehicles. This program will focus on safety of vehicle interfaces for wireless charging applications for fleet and personal use. NHTSA will also coordinate with the DOE research to understand the safety of solid-state battery systems and begin consideration of the need for developing new performance test procedures. These technologies should all involve research between the DOE national laboratories, the automotive original equipment manufacturers (OEMs) and their suppliers. The planned research would apply past research on charging safety to new battery designs and consider both commercial and residential applications.

Program Objectives: NHTSA is currently developing a safety assessment for wireless charging systems being evaluated by the DOE. This assessment will help direct new research to assess 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. Field safety incidents will be investigated to inform where best practices can be developed to promote the safety of new alternative fuel vehicles.

Anticipated Program Activities: NHTSA will continue to collaborate with other 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 Name: Vehicle Research and Test Center (VRTC)

Program Description: The VRTC is NHTSA's in-house applied research, development, test, and evaluation laboratory located in East Liberty, Ohio. Research and testing activities conducted at the VRTC support Agency decisions and actions with respect to new vehicle systems and issues, Agency consumer information programs, test dummy development, injury criteria development, advanced research into cutting-edge technologies, and safety issues that require quick reaction, including defect investigations. The full range of testing and research capabilities available to NHTSA at VRTC allows the Agency to maximize its testing capabilities to more rapidly study emerging safety issues and more quickly provide benefits to the American public.

Program Objectives: VRTC supports a broad range of critical safety areas including:

- Crash avoidance research (light and heavy vehicles), including support for adapting existing Agency safety tests and research of new emerging ADAS 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
- Research into complex areas such as ADS and cybersecurity to support development of safety approaches, methods, and tests.

Research in these areas directly supports the Department's goal to reduce transportation related fatalities and serious injuries across the transportation system. This aligns with NHTSA's mission and the Department's goals to deploy new and innovative technologies.

Anticipated Program Activities: VRTC will continue 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, 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 ADS-equipped vehicles and cybersecurity. The FY 2022 funding will be used to procure equipment needed to maintain a well-equipped and dedicated center to test, monitor, and investigate ongoing and emerging safety issues.

Office of Behavioral Safety Research (BSR)
Program Name: Highway Safety Research

Program Description: Highway Safety Research provides 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.

NHTSA's Highway Safety Research program supports the Department's safety efforts through behavioral research, demonstrations, technical assistance, and national leadership activities emphasizing alcohol and drug countermeasures, occupant protection, distraction, traffic law enforcement, emergency medical and trauma care systems, driver licensing, State and community evaluations, motorcycle rider safety, pedestrian and bicyclist safety, pupil transportation, and young and older driver safety programs.

Highway Safety Research also funds the DADSS project. Despite progress over the past three decades, drunk driving claims approximately 10,000 lives each year. The DADSS project is researching a first-of-its-kind technology that holds the greatest potential we have seen to reverse this trend. The technology will automatically detect when a driver is intoxicated with a BAC at or above 0.08% — the legal limit in all 50 states except Utah — and prevent the car from moving. Once it has met rigorous performance standards, it will be voluntarily offered as a safety option in new vehicles, similar to automatic braking, lane departure warning and other advanced driver assist vehicle technologies.

Lastly, Highway Safety Research funds the BTSCRP. BTSCRP, which is administered by the Transportation Research Board, is a forum for coordinated and collaborative research to address issues integral traffic safety professionals at all levels of government and the private sector. BTSCRP provides practical, ready-to-implement solutions to save lives, prevent injuries, and reduce costs of road traffic crashes associated with unsafe behaviors.

BTSCRP products are developed in response to problems faced by traffic safety stakeholders. Emphasis areas are alcohol-impaired driving, autonomous vehicles, bicyclists and pedestrians, child passenger safety, distracted driving, drowsy driving, drug-impaired driving, law enforcement, mature drivers, motorcyclist safety, seat belts, speed and safety cameras, speeding and aggressive driving, teen driver safety, and traffic records. BTSCRP will produce a series of research products that traffic safety stakeholders, government agencies, and other interested parties will be able to quickly use or implement in their traffic safety practices.

Program Objectives:
The primary goal of the Highway Safety Research program is to increase the return on investment from NHTSA's Highway Traffic Safety Grant Program. The research will support five overlapping strategic categories:

- Preventing destructive traffic safety behaviors;
- Encouraging positive traffic safety behaviors;
- Leveraging public safety to improve traffic safety;
- Protecting vulnerable road users; and,
- Exploring advanced technologies to address traffic safety issues.

Anticipated Program Activities:
In FY 2022, NHTSA will decide on several emphasis areas based upon problem identification and research needs although continued efforts are expected in preventing drug-impaired driving and the effects of new technologies on behavioral safety. In these emphasis areas, NHTSA plans to conduct foundational research to understand the nature or scope of the problem; developmental research that helps refine delivery of solutions; and a hybrid that combines research into the big ideas and potential ways to develop those into safety programs.

Human factors research, particularly related to ADAS and ADS technologies, will likely remain a focus. Highway Safety Research will continue to collaborate with NHTSA's Automated Driving Systems and Advanced Safety Technologies research programs to address human factor issues including behavioral adaptation and child-specific safety considerations related to ADS.

DADSS technologies will continue undergoing rigorous field testing and systemic improvements as the Agency prepares to move from research to program development.

In 2022, NHTSA plans for four to six discrete BTSCRP projects to be selected that will result in applied research products that highway safety stakeholders will be able to use immediately upon the completion of the research. TRB will prepare requests for proposals and will assemble panels to select contractors to perform the work.

[END]